Pontifícia Universidade Católica
do Rio de Janeiro

Monica de Freitas Frias Chaves

Structural deficiency in Schizophrenia: an exploratory study of the nominal and sentential domains

Tese de Doutorado

Dissertation presented to the Programa de Pós-Graduação em Estudos da Linguagem of the Departamento de Letras of PUC-Rio as partial fulfillment of the requirements for being conferred a doctoral degree.

Adviser: Cilene Aparecida Nunes Rodrigues

Co-adviser: Sidarta Tollendal Gomes Ribeiro

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Cilene Aparecida Nunes Rodrigues
Adviser
Departamento de Letras – PUC-Rio

Sidarta Tollendal Gomes Ribeiro
Co-adviser
UFRN

Rogério Arena Panizzutti
UFRJ

Natália Bezerra Mota
UFRJ

Juan Uriagereka
UMD

Wolfram Hinzen
UPF

Rio de Janeiro, April 12th, 2022

Monica de Freitas Frias Chaves

Graduated in Letters Portuguese-English and corresponding literatures at Universidade Estácio de Sá (2008), with Master (2017) and Doctorate (2022) degrees in Language Studies at Pontifícia Universidade Católica do Rio de Janeiro. Member of the research project, in Syntactic Theory, coordinated by Cilene Rodrigues, *Reference of Pronouns: Structure and Breakdowns*, which focus on the role of grammar in the structuring and breaking down of pronouns in the population with schizophrenia spectrum disorders.

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Abstract

Chaves, Monica de Freitas Frias; Rodrigues, Cilene; Ribeiro Sidarta. **Structural Deficiency in Schizophrenia: an exploratory study of the nominal and sentential domains.** Rio de Janeiro, 2022. 168p. Tese de Doutorado – Departamento de Letras, Pontifícia Universidade Católica do Rio de Janeiro.

The present dissertation is an exploratory study of structural deficiency in schizophrenia, in which the usage of subject pronouns and type of sentence in narratives produced by native speakers of Colloquial Brazilian Portuguese diagnosed with schizophrenia is investigated. Couched within Generative Grammar Theory, in which human grammar is defined as a computational cognitive device, we explored the hypothesis that schizophrenia leads to structural impoverishment at the syntactic level. Two corpora of narratives of dream and waking reports were examined considering subject pronouns and type of sentences. Overall, our results showed significant higher proportion of matrix sentences and null pronouns, particularly of 3Person referential null pronouns in the schizophrenia group as compared to the control group. These findings are in line with the hypothesis of structural impoverishment in schizophrenia, especially if null pronouns are taken to be elements with reduced structure in comparison to full pronouns. Also, our results corroborate with the hypothesis that grammar in the face of schizophrenia might present a deficit in terms of functional categories, which leads to structural impoverishment and to anomalies in the referential use of pronouns (Tovar et al., 2019). Our findings are thus extra evidence that structural deficiency is a universal feature of schizophrenia, while suggesting manifestations of this deficiency is language dependent, being, thus, subject to parametric variation.

Keywords

Schizophrenia; grammar; structural deficiency; subject pronouns; sentential impoverishment.

Resumo

Chaves, Monica de Freitas Frias; Rodrigues, Cilene; Ribeiro Sidarta. **Deficiência estrutural na esquizofrenia: estudo exploratório sobre os domínios nominal e sentencial**. Rio de Janeiro, 2022. 168p. Tese de Doutorado – Departamento de Letras, Pontifícia Universidade Católica do Rio de Janeiro.

A presente tese apresenta um estudo exploratório sobre deficiência estrutural na esquizofrenia, no qual foi investigado o uso de sujeitos pronominais e o tipo de sentenças em narrativas produzidas por falantes nativos do Português do Brasil coloquial diagnosticados com esquizofrenia. Tomando como base a Teoria da Gramática Gerativa, na qual a gramática humana é definida como um mecanismo computacional cognitivo, exploramos a hipótese de que a esquizofrenia acarreta um empobrecimento estrutural no nível sintático. Dois corpora de relatos de sonho e de vigília foram examinados considerando o sujeito pronominal e o tipo de sentenças. No geral, nossos resultados mostram que, comparado ao grupo controle, os participantes com diagnóstico de esquizofrenia produziram uma proporção significativamente maior de sentenças matriz, de pronomes nulos, em especial de nulos referenciais de 3ª. pessoa. Nossos resultados estão de acordo com a hipótese de empobrecimento estrutural na esquizofrenia, especialmente se pronomes nulos forem considerados elementos que apresentam redução estrutural em comparação com pronomes plenos. Nossos resultados corroboram ainda com a hipótese de que a gramática em face da esquizofrenia, possivelmente, apresenta um déficit em termos de categorias funcionais, o que levaria ao empobrecimento estrutural e às anomalias no uso referencial de pronomes (Tovar et al., 2019). Nossos resultados são, portanto, evidência extra de que a deficiência estrutural e uma característica universal da esquizofrenia, ao mesmo tempo em que sugerem que a manifestação dessa deficiência depende da língua, estando, assim, sujeita à variação paramétrica.

Palavras-chave

Esquizofrenia; gramática; deficiência estrutural; sujeito pronominal; empobrecimento sentencial.

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Like everything metaphysical, the harmony between thought and reality is to be found in the grammar of the language.

Wittgenstein, *The philosophical investigations*

1
Introduction

> "Schizophrenia is currently considered by some authors as a "language related human specific disease" or 'logopathy'" (Radanovic et al., 2013:55).

The core symptoms of schizophrenia are characterized by loss of ability to distinguish what is real from what is not, and to form coherent and complex ideas about oneself and the world (APA, 2013). The speech of patients with schizophrenia is confused and hard to follow (Rochester and Martin, 1979: 2), and literature on thought and language disturbances suggest that failures in the referential function of language are possibly a trait mark: they are stable over time (Docherty et al., 2003) and are present in the speech of non-clinical first-degree relatives of patients with schizophrenia to a greater degree than in the general population (Docherty et al., 1998, 2000). Moreover, literature is full of reports on problems with referential definiteness (Ditman and Kuperberg, 2010; Docherty et al., 2012; Hinzen, 2017), particularly reflected in pronoun misuse. Recent studies showed that, compared to control subjects, patients with schizophrenia produced above normal frequency of personal pronouns in written narratives (Strous et al., 2009; Buck et al., 2015; Fineberg et al., 2015), higher use of subject pronouns in autobiographical narratives (Hong et al., 2015; Birnbaum et al., 2017), and more ambiguous 3Person pronouns in one-on-one interviews (Iter et al., 2018). Also, it has been reported that patients with schizophrenia with diagnosis of thought disorder produced more failures in pronouns and other definite nominal phrases compared to control subjects (Çokal et al., 2018), and that patients with schizophrenia produced more errors in null than in overt pronouns, and in 3Person than in 1Person and 2Person pronouns (Tovar et al., 2019a). These reports corroborate the hypothesis that people with schizophrenia have difficulty with pronouns (Frith, 1992; Mckenna, 1996; Hinzen and Rosselló, 2015; Hinzen 2017).

Neuropsychological dysfunctions in verbal working memory, sustained attention and sequencing ability (Docherty et al., 2000; Docherty et al., 2005) as well as deficits in social cognition measured by emotion perception and theory of mind (ToM) (Docherty et al., 2012) have been associated with higher frequency of unclear references in the speech of people with schizophrenia. Docherty et al.

(2012) argue that impairments in both neurocognitive and social cognitive abilities might incrementally contribute to the referential failures observed in schizophrenia.

These data support the view that, compared to the general population, people with schizophrenia have difficulty in the usage of pronouns, and that referential failures involve a combination of neurocognitive, social cognition and linguistic factors. However, the precise mechanism of interaction between these factors is not yet clear, thus, further studies examining the use of pronouns by people with schizophrenia might shed some light on the matter.

In this dissertation, we examine structural deficiency in schizophrenia focusing on the production of pronominal subjects of finite clauses, with particular interest in the production of overt and null 3Person referential pronouns in Brazilian Portuguese. Based on the literature on schizophrenia and on theoretical grammatical accounts for syntactic complexity and the internal structure of nominal expressions, we will hypothesize that difficulties in properly establishing pronoun-antecedent/referent dependency by speakers with schizophrenia might be due to the fact that these speakers are unable to carry out complex derivational syntactic procedures in a proper way.[1] During language acquisition, typically developing children present problems establishing pronoun-antecedent dependency, which has been associated with reduction in verbal working memory. Hence, one of the questions we will try to answer here is the following: are the pronoun difficulties observed in schizophrenia comparable to the difficulties observed in children under 6 years of age, who, due to working memory limitations typical of the age, fail in processing reference-set computation (Reinhart, 2006)?

To date, most studies on the production and comprehension of pronouns by people with schizophrenia have been done in English and data from other languages remains scarce (see Strous et al. (2009) for a study of Hebrew native speakers and Tovar et al. (2019a) for a study of Spanish native speakers with schizophrenia). In this dissertation, we have aimed at contributing to this arena of research by providing a fine-grained profile on pronoun use by native speakers of Colloquial Brazilian Portuguese (henceforth CBP) with a diagnosis of schizophrenia. As we will show in chapter 3, CBP provides an interesting ground for testing certain hypotheses about pronouns in schizophrenia, particularly overuse of null pronouns.

[1] This research is part of the Project *Reference of Pronouns: Structure and Breakdowns*, coordinated by Cilene Rodrigues, CNPq grant number 439434/2018-1.

CBP is a partial Pro-drop language, and one of the particularities of this language is that the use of 3Person null subject pronouns is more restricted compared to other Romance null subject languages.

In sum, the present dissertation aims at investigating subject pronoun usage by patients with schizophrenia, with special attention to the use of overt and null 3Person referential pronouns with anomalous reference (i.e., with unclear or missing reference). With that goal in mind, we present an exploratory investigation focusing on the usage of null and overt pronouns in subject position of finite clauses by native speakers of CBP with schizophrenia. Two types of narratives, based on long-term memory reports, were analyzed. The first one was based on recalls of dreams, and the second one on recalls of autobiographical daily events. In the first investigation, dream and waking reports of 20 people with schizophrenia (henceforth SZ) and 20 nonpsychotic control (henceforth CT) subjects were analyzed, while, in the second one, dream and waking reports of 11 patients with SZ undergoing first clinical contact for recent-onset psychosis and 20 well-matched healthy CT subjects were analyzed.

1.1. Hypothesis

Following what has been reported on the use of pronouns in schizophrenia, we hypothesize that the narratives of native speakers of CBP with SZ significantly differ from that of typical CT speakers. Thus, we predict that the SZ group will show higher proportion of personal pronouns, with overuse of 1Person pronouns and of null pronouns, and more anomalous use of 3Person referential pronouns. We also expect to find structure deficiency at the sentence level within the SZ group. However, based on previous studies using dream and waking reports by schizophrenic patients and controls (Mota et al. 2014, 2017), we expect different results to be found in dream compared to waking reports, with dream narratives being more informative of schizophrenia.

1.2. Goals

General

- Characterize the language profile of native speakers of CBP with diagnosis of schizophrenia considering the subject pronouns and type sentences
- Contribute to a better understanding and profiling of language impairments of patients with schizophrenia.
- Contribute to an approximation between areas of knowledge such as formal linguistics, psychiatry, neurocognitive psychology, and neuroscience.
- Contribute to linguistic theories, investigating aspects of syntax-semantic-pragmatic interfaces that might interfere with pronoun licensing.

Specific

- Examine syntactic combinations of sentences and sentence truncation within schizophrenia.
- Examine the use of pronouns in schizophrenia, considering null and overt pronouns.
- Examine referential anomaly in 3Person pronouns in schizophrenia.

1.3. Justification

Understanding language deficits in schizophrenia is a crucial step towards a proper characterization of this condition. Recent studies have pointed towards a variety of grammatical deficits, including those related to structuring reference. Difficulties establishing referents for pronouns is patent in schizophrenia; however, as languages vary among themselves with respect to the morpho-phonological realization of pronouns, it is important to verify whether or not crosslinguistic differences affect the observed difficulties in schizophrenia.

The theoretical framework of the Generative Grammar is relevant in this area of investigation. Since its early days, Generative Grammar has been investigating the intrinsic relation between language and cognition. Also, generativists have gathered robust evidence on the grammatical processes responsible for linking pronouns to their referents in many different languages. Consequently, formal analyses of pronouns within this theory can be quite relevant for studies on speech pathologies. These analyses might provide us with important information on the grammar of patients with schizophrenia, enabling us to conduct

more fined-grained investigations on how, why, and where Grammar is hinged in this mental disorder.

1.4. Methodology

Memory reports produced by native speakers of CBP diagnosed with schizophrenia were first morpho-syntactically annotated at the sentence level and the nominal (pronoun) level, then they were statistically analyzed and compared to memory reports by control groups. The following parameters were considered: (a) sentence type (sentence count, matrix sentence, embedded sentence, and truncated sentence (anomalous and non-anomalous)); (b) total of pronouns; (c) type of subject pronoun in function of phonological form (overt or null); (d) type of subject pronoun in function of person feature (1Person, 2Person and 3Person); (e) type of null 3Person subject pronouns in function of referentiality (referential and non-referential); and (f) types of overt and null 3Person subject referential pronouns in function of anomaly (anomalous and non-anomalous).

1.5. Organization

This dissertation is organized as follows. Chapter 2 discusses schizophrenia from a diagnostic and conceptualized point of view, considering main definitions of thought and language disturbances in schizophrenia. It also presents a more refined view of the linguistic issues observed in speakers with schizophrenia. Chapter 3 focuses on discussing the formal properties of pronouns in human language. It includes a presentation on parametric variation among languages, focusing on null subject languages. Pronominal subject usage is discussed in connection with typical and atypical language acquisition and atypical aging. In the last section, we take on pronouns in schizophrenia. Chapter 4 is dedicated to the exploratory studies conducted by us, presenting, and discussing the obtained results. Chapter 5 brings our conclusions, revisiting our basic observations, and pointing to possible ramifications of the present research.

2
What is Schizophrenia

> "Schizophrenia is a severe mental disorder, characterized by profound disruptions in thinking, affecting language, perception, and the sense of self. It often includes psychotic experiences, such as hearing voices or delusions" (WHO, 2016).

Schizophrenia is a brain-based disorder that leads to chronic problems, abnormal experiences and behaviors, affecting the ability to organize thoughts, to handle emotions and to socially relate to others. Disturbances of thought, language and communication are core symptoms of schizophrenia, responsible for causing considerable disability and more often than not interfering with people's occupational, social and educational performances. This is a lifelong condition that affects approximately 23 million people around the world (WHO, 2016), with average age of onset, gender differences aside, ranging from the late teens to early adulthood. Nevertheless, although the diagnosis of schizophrenia in children or adults over 40 years of age is extremely uncommon, incident cases occur at all ages with marked differences in symptoms and social outcome (Häfner, 2014).

In this chapter, we will present a brief overview of schizophrenia. First, in sections 2.1 and 2.2, we will present its main symptoms, and the different ways in which this condition was conceptualized since Bleuler, in 1908, named it schizophrenia, or the splitting (schizo) of psychic functions (phrene). Section 2.3 will focus on thought disorder, one of the core symptoms of schizophrenia, and its relation to language. Here, we will also try to give some perspective on how this specific symptom has been conceptualized over time, focusing on the different approaches to thought disorder. Having as a starting point the most used and first characterization of language in schizophrenia (Andreasen, 1979a), we discuss levels of the language structure that have been shown to be impaired in schizophrenia. Section 2.4 brings a closer look into specific language issues in schizophrenia, presenting studies focusing on the two main aspects of language investigated in relation to schizophrenia: form (syntax and morphology) and content (semantic and pragmatics). In section 2.5, we offer Crow's (2008) theory, which tries to link language and schizophrenia evolutionarily, treating both as consequences of the same biological event that changes the structure of the brain. We also briefly present Hinzen and Rosselló's (2015) view of schizophrenia as a disintegration of the language cognitive system, as well as recent studies looking

for syndrome-specific language features under the latest Research Domain Criteria (RDoC) framework.

Two appendices are included. Appendix I explores the so-called schizophrenia paradox (why schizophrenia was not ruled out by natural selection?). Appendix II presents a cultural overview on the history of madness while considering that maybe schizophrenia should not be treated solely as a disease, but also as an expression of human neurocognitive diversity.

2.1. Schizophrenia symptoms

The complexity of this mental condition relies on the heterogeneous variety and combinations of symptoms, with the same patient presenting multiplicity of symptoms over different phases of the disorder.

A lot of effort has been put into identifying what the causes (or the cause) of schizophrenia are, but, although there is an agreement upon a very strong genetic predisposition, accumulating evidence suggest that the etiology of schizophrenia is multifactorial, involving complex results of the combination of a variety of factors including genetic, environmental, social, and psychological. As a result, schizophrenia diagnosis is based on the presence or absence of different clinical symptoms and the degree of functional impairment exhibited by the patient (APA, 2013).

2.1.1. Classification system for schizophrenia diagnosis

In an effort to meet a system of classification (i.e., nosological system) for the diagnosis and treatment of schizophrenia, the World Health Organization (WHO) and the American Psychiatric Association (APA) have been integrating, for almost 70 years, information about schizophrenia, as well as other mental disorders, trying to put it all together in a useful and organized way. In this pursue, WHO and APA systematically review and update their coding systems.[1]

[1] The international Classification System (ICD) is a coding system maintained by World Health Organization (WHO) that, since its 6th edition, incorporated a section related to mental disorders. The Diagnostic and Statistical Manual (DSM) is a handbook organized by the American Psychiatric Association (APA) since 1952, when its 1st edition was published.

Since the first editions of the International Classification of Disease (ICD), maintained by WHO, and of the Diagnostic and Statistical Manual (DSM), maintained by APA, there have been differences in the way these systems classify schizophrenia symptomatology, with the last editions (ICD-11 and DSV) showing the best correspondence ever (Choudry and Farooq, 2018).[2] In these recent reviews, both systems adopted a dimensional classification, instead of a categorical one, and, although there is still no final consensus about how to adequately describe major psychopathological dimensions of schizophrenia, a general agreement regarding relevant symptoms has been put forward (see table 1).

ICD-11 *Schizophrenia and other primary psychotic disorders*	**DSM-V** *Schizophrenia spectrum and other primary psychotic disorders*
For schizophrenia diagnosis, at least two of the following symptom categories are required to have been present for most of the time during a period of one month, or longer, one of which should be one of the core symptoms (a-d):	For schizophrenia diagnosis, two of the 5-key symptoms of psychotic disorders are required to be present for a significant portion of the time during a 1-month period, one of which should be of the core symptoms (a-c):
(a) persistent delusions of any kind, (b) persistent hallucinations on any modality, (c) thought disorder, (d) distortions of self-experience (e.g., passivity phenomena, thought insertion or thought withdrawal), (e) negative symptoms such as apathy and anhedonia, and (f) psychomotor disorders.	(a) delusions, (b) hallucinations, (c) disorganized speech, (d) disorganized or catatonic behavior, and (e) negative symptoms.

Table 1: Comparison between the schizophrenia diagnostic criteria of classification of the ICD-11 versus the DSM-5.

As shown in table 1 above, there are some differences between the ICD-11 and the DSM-V classification systems; however, they agree that, to meet diagnostic criteria for schizophrenia, a person must present at least two of the symptoms listed as key-symptoms, in the DSM, and as symptom categories, in the ICD, during a certain period of time, but one of them must be a core symptom, delusions, hallucination (corresponding to 'a' and 'b' respectively), and thought/language disturbances (corresponding to 'c' and 'd' in the ICD-11 and to 'c' in the DSV-V).

[2] ICD-11 was presented to the World Health Assembly in May 2019 for adoption, and it is supposed to replace all earlier revisions from 1 January 2022; whereas DSM-5 is fully adopted since 2013.

Importantly, schizophrenia symptoms are broadly grouped into three basic domains (or clusters). The positive symptoms indicate exacerbation of sensations, beliefs, and behaviors (e.g., hallucinations, delusions, disorganized speech/thought disorder). The negative ones indicate reduction, or an absence of traits often present in healthy individuals (e.g., flattened affect, anhedonia, alogia, lack of initiative). Disorganized symptoms are related to deficits in cognitive abilities (e.g., executive function, processing speed, memory, attention, verbal fluency) (Habtewold et al., 2019).

2.1.2. Neurocognition in Schizophrenia

Although schizophrenia is presented with heterogeneity of neuropsychological dysfunctions affecting both general and specific cognitive domains (Harvey, 2013), cognition in schizophrenia is characterized by general impairment with severe deficits in executive skills and memory (Harvey, 2013: 73). Task differences aside,[3] it has been emphasized that there is a consistent role of executive function, working memory, and theory of mind (ToM) deficits in schizophrenia and, thus, they have been broadly investigated.

Executive skills are characterized as higher-level cognitive abilities involved in planning and executing goal-directed operations, allowing an individual to adapt to new situations, to prepare, plan, implement and achieve an objective, as well as to intervene in the performance of complex tasks (Lezak et al., 2004). Deficits in executive functions are present in adolescents at risk, in patients with a first outbreak, and possibly in first-degree relatives of people with schizophrenia. Poor performance of patients with schizophrenia in measures of executive function are particularly associated with negative and disorganized symptoms (Dibben et al., 2008), with significant association between executive dysfunction and psychosocial impairment (Orellana and Slachevsky, 2013).

Working memory are cognitive processes involved in temporarily holding and manipulating information during complex tasks performance, such as in comprehension, learning and reasoning (Lezak et al., 2004). Working memory impairment is associated to a number of symptoms of schizophrenia. Forbes et al.

[3] Different tests vary in their degree of difficulty and their sensitivity to the effects of impaired functioning (Forbes et al., 2009).

(2009) meta-analysis of 187 studies showed large working memory deficits in schizophrenia groups in phonological, visuospatial, and central executive working memory functioning, with no clear distinction across tasks. Docherty et al. (1996b) reported that in the speech samples of outpatients with schizophrenia, but not samples of bipolar and nonpsychiatric groups, poor linguistic reference performance was strongly associated with working memory scores, suggesting that working memory deficits might have strong impact on linguistic referential performance in people with schizophrenia. Agreeing results are reported in Bagner et al. (2003), who showed that working memory, measured by reading span task, correlated with the performances of the group of subjects with SZ and of the group of CT subjects in language comprehension tests. However, working memory measures of the subjects with SZ were more strongly associated with comprehension scores than that of CT subjects, especially in terms of the comprehension of complex sentences (e.g., object-relative sentences).

ToM is a broad construct involving the ability to correctly attribute intentions, thoughts, and beliefs to others, which develop during childhood (de Villers, 2000; Hale and Tager-Flusberg, 2003). Deficits of ToM have been widely reported in association with schizophrenia, especially the ability to correctly predict and interpret other people's states of mind. It has been associated with overall pronoun use in schizophrenia (Buck et al., 2015), and with several symptom subgroups of the disorder (Pickup and Frith, 2001). A meta-analysis of 29 studies by Sprong et al. (2007) reported significant and stable mentalizing deficits, with robust ToM impairment found in 4 symptom subgroups: symptoms of disorganization, no symptom of disorganization, paranoid symptoms, and remitted patient groups. Corcoran and Frith (2003) found clear evidence of a relationship between ToM and autobiographical memory retrieval in schizophrenia (59 subjects with SZ vs. 44 healthy CT subjects), with strong association between the ability to recollect events and the comprehension of hints in false belief/deception task, especially in second/higher order deception situations. The implication of ToM and other social cognition measures was informed by Docherty et al. (2012b), who reported that social cognition, measured in terms of ToM and emotion perception each explained the variance of communication failures found in the narrative samples of outpatients with schizophrenia.

Overall, schizophrenia symptoms, as in most psychotic disorders, point to a disruption of the higher functions of the mind, leading to abnormal states of consciousness, in which perceptions, beliefs and emotions appear to have lost touch with reality. To make things more complicated, a person does not need to exhibit all symptoms included in the coding systems mentioned above; however, they must show impairment in social, occupational, and everyday functioning together with a certain number of symptoms (as informed in table 1) to be diagnosed with schizophrenia. This means that two people with schizophrenia might not exhibit the same set of symptoms, and that the same person might exhibit different sets of symptoms during the course of the condition (Kuperberg, 2010).

However difficult, from a diagnostic standpoint, it is extremely important to differentiate schizophrenia from other conditions affecting the brain and the mind. Whereas laboratory tests and physical signs differentiate schizophrenia from neurological disorders (e.g., Huntington's disease, epilepsy, central nervous system traumas etc.), differentiating schizophrenia from other psychotic disorders (e.g., bipolar disorder, drug-induced psychosis etc.) demands considering several distinctive criteria, even exclusion.

In sum, schizophrenia is a heterogeneous multi-faceted disorder that disturbs a wide range of human features including thought, perception, affect, and language. Since Kraepelin's definition of *dementia preacox* and Bleuler's concept of schizophrenia, the definitions of this psychotic disorder, its core symptoms and limits have experienced significant changes throughout the years, but still, the existing coding systems of classification have been largely based on Kraepelin's, Bleuler's and Schneider's views.

In the next section, we will present a brief overview of this history, discussing the main analyses.

2.2.
A brief history of the concept of schizophrenia

The concept of schizophrenia is relatively recent. Although there were reports on insanity dated from previous times (see appendix 1), it was only in 1893 that Emil Kraepelin (1856–1926) first integrated, in the same nosology, a variety of mental disorders that, although of unknown causes, mainly affected young adults

and were associated with progressive deterioration and chronicity (Elkis, 2000; Häfner, 2014). Prior to Kraepelin, there were two views of psychiatric illnesses. On the one hand, a unitary view of psychosis that assumed the existence of one basic form, with diverse manifestations depending on endogenous and environmental factors. On the other hand, an opposite view assumed the existence of several distinct disorders (e.g., catatonia, hebephrenia[4], folie circulaire[5], dementia paranoids, melancholia etc.). Kraepelin's great accomplishment was to take notice of the distinct patterns of onset, course, and outcome of each of these mental disorders and use the information as criteria to group these conditions. In the 6th edition of Kraepelin's textbook of Psychiatry, mental disorders were integrated under two distinct psychiatric entities (i) dementia preacox, which integrated catatonia, hebephrenia and paranoid states, and (ii) manic-depressive insanity, which integrated folie circulaire and melancholia.

Dementia preacox, later named schizophrenia by Bleuler, was, then, defined based on the onset (adolescence or early adulthood), course (deterioration), and outcome (dementia or mental dullness) of the condition. Although acknowledging the wide variety of clinical expressions of dementia preacox, Kraepelin mainly considered a categorical notion of psychotic disorders that consisted of dementia preacox and manic-depressive.

Eugene Bleuler (1857–1939) used the term schizophrenia (splinting of the mind) for the first time during a lecture, in 1908. In this occasion, he maintained the unit of the group of mental disorders under dementia preacox, as defined by Kraepelin. However, he emphasized that there was something more behind the general manifestations of schizophrenia, which he thought were reflexes of disruptions in the associative processes of the mind (Bleuler, 1911).

> ''I call dementia praecox 'schizophrenia' because (as I hope to demonstrate) the 'splitting' of the different psychic functions is one of its most important characteristics'' (Bleuler, 1911: 8).

[4] *Hebephrenia* was the name given by Hecker (1871) to what today is known as disorganized schizophrenia, a subtype of schizophrenia whose symptoms are incoherent and illogical thoughts and behaviors (see Kraam and Phillips (2012)).

[5] *Folie circulaire* was the name given by Falret (1851) to alternating moods of mania and melancholia intercalated by lucid periods of different duration, a definition of what today is named bipolar disorder (see Haustgen and Akiskal (2006)).

Bleuler argued that this mental disorder should be better defined as "the group of schizophrenias", and that the 'splitting of the different psychic functions' affected patients' thoughts and perceptions, particularly compromising their ability of thinking and speaking in an organized way (Tandon, 2012).

Schizophrenia symptoms were then characterized in two ways: (i) fundamental (or basic) versus accessory symptoms, and (ii) primary versus secondary symptoms. The fundamental symptoms were those considered to be unique to and always present in patients with schizophrenia. These were also known as the 4 A's —ambivalence, affective incongruity, autistic thinking, and associative disturbances. The accessory symptoms were those that might or might not occur in schizophrenia; therefore, they were variable and nonspecific. In Bleuler's view, delusions and hallucinations were accessory symptoms. Primary symptoms were the expression of a subjacent disruption of psychic functions, while the secondary ones represented a personality reaction, manifesting as a result of a primary disturbance. Among the 4 A's, for example, only associative disturbances symptom (or loosening of associations) was also considered a primary symptom and, thus, was considered the core deficit underlying schizophrenia (Moskowitz and Heim, 2011; McGlashan, 2011).

Contrary to Kraepelin, Bleuler argued that course and outcome could vary in schizophrenia, and that a distinctive diagnostic profile of this disorder were to be provided on the basis of the basic symptoms (see Jablensky (2010) for a discussion). In Bleuler's broader dimensional view of schizophrenia, basic symptoms could also manifest in attenuated forms such as in subtle abnormal personality traits in nonclinical population, particularly in relatives of patients with schizophrenia.

In an effort to improve psychiatric diagnosis, Kurt Schneider (1887–1967) proposed the concept of first rank symptoms as an important diagnostic tool for schizophrenia (Schneider, 1959). These symptoms, consisting exclusively of a range of hallucinations and delusions, comprised audible thoughts (hearing voices speaking your thoughts aloud), voices arguing (hearing voices speaking without talking directly to you), voices commenting (hearing voices commenting on your thoughts or behavior), thought insertion (thoughts are inserted into your mind), thought withdrawal (thoughts are removed from your mind, leaving a state of complete blank), thought broadcast (your thoughts escape and everyone can hear them), and delusional perception (perceiving events/things as specially

meaningful). Later, Schneider added to this list the symptom of somatic passivity (experiencing impulses and feelings as caused by an outside agency). As pointed out by Jablensky (2010), Schneider considered the first rank symptoms prevalent in severe psychotic disorders to the point that they were considered decisive in the diagnosis of schizophrenia.

Importantly, Schneider's classification of first rank symptoms was incorporated in the elaboration of the Present State Examination (PSE), one of the first tests developed to standardize the identification of psychiatric cases. The PSE was the test used by WHO (1973) in the International Pilot Study of Schizophrenia, which aimed at identifying schizophrenia invariants in the world population. This pilot study examined patients with schizophrenia in 9 countries, concluding that schizophrenia is a universal mental disorder. Few common culture-independent symptoms were mapped in this pilot study: lack of insight, oral and verbal hallucinations, thought broadcasting, affective flattening, and ideas and delusions of reference (WHO, 1973).

Although Kraepelin's, Bleuler's and Schneider's ideas have been the base for characterization of schizophrenia ever since its conceptualization, how Kraepelinian chronicity, Bleulerian basic (or negative) symptoms and Schneiderian positive symptoms were incorporated in the diagnostic tools —basically the ICD and the DSM— has varied throughout the years (Tandon, 2014). Still, the main challenge imposed by schizophrenia is understanding the range and variety of its symptoms (Andreasen, 1979a). Hence, various attempts have been made throughout the years to identify clinical, psychopathological, neurocognitive as well as other factors that might be involved in the outcomes of this mental disorder.

In a broad way, schizophrenia can be defined as a disorder in which the person exhibits difficulties in recognizing what is real and what is not, as if the mental processes enabling one to form coherent and complex ideas about themselves and about the world are somehow disrupted. In this scenario, the domains of language and of thought are central to the understanding of schizophrenia and, thus, have long been part of this arena of research.

2.3.
Language and thought disorder in schizophrenia

In accordance with Bleuler's first observations, disturbances of speech had initially been thought of as manifestations of underlying disruptions on subjacent thinking processes. Hence, the name 'thought disorder' was used to refer to the disorganized and incoherent speech of people with schizophrenia. However, there is not a perfect mapping between language and thought (Radanovic, 2013) and the only way of evaluating people's thinking is through their verbal behavior, so much so that a clear-cut definition of these phenomena was necessary (Andreasen, 1979a).

Even today the term 'thought disorder' is used to refer to the language disturbances observed in schizophrenia and other mental illnesses, yet some prefer to name it 'disorganized speech' instead. As we saw in table 1 (section 2.1), the ICD-11 uses the first term while the DSM-V uses the second in reference to the same syndrome.

Thought Disorder has been broadly characterized as "a disruption in the interconnectivity of meaning and ideas within an individual" (Cohen et al., 2017). Although not exclusively of schizophrenia, it is an important symptom of this mental condition, and one that is heterogeneous in itself. As Cohen et al. (2017: 506) puts it, "despite decades of research on thought disorders, our present understanding of its nature is poor, our clinical assessment focuses on a limited set of extreme behaviors, and our treatments are far from optimal".

Even before the conceptualization of schizophrenia, there have been many observations of what is now named thought disorder by some and disorganized speech by others. However, after Kraepelin and Bleuler, the disorders of thought have been subject to much more detailed investigations and, thus, are more thoroughly defined (Jerónimo et al., 2018).

In the 6th edition of Kraepelin's textbook, for example, almost all symptoms of schizophrenia were related to thinking and speaking problems —auditory hallucinations, thought broadcasting, thought of being influenced, disturbance of the course of thinking and incoherence of thoughts. Kraepelin defined *akataphasia* as a symptom in which patients seemed not to find the correct words and expressions to communicate their thoughts, leading both to the production of words connected by sound and neologisms. Also, in his observations on thought

disturbances (or "incoherence of thought"), Kraepelin (1913) emphasizes that they could manifest in a "complete loss of connection between ideas" or, in less severe cases, in the form of increased "facility of distraction".

In Bleuler's description of schizophrenia, associative loosening was a core and primary symptom. This means that he took it to be an underlying abnormality present in every case of schizophrenia, but one that manifested in various degrees even in extremely subtle forms. As such, for Bleuler, all language and speech disturbances observed in people with schizophrenia reflected a disorder of thought.

> "In this malady the associations lose their continuity. Of the thousands of associative threads which guide our thinking, this disease seems to interrupt, quite haphazardly, sometimes such single threads, sometimes a whole group, and sometimes even large segments of them. In this way thinking becomes illogical and even bizarre" (Bleuler, 1911: 14).

Schneider too contributed to the characterization of thought disorders. Five of the eight first ranking symptoms defined by Schneider (see description above) are related to language and/or thought disturbances —thought echo, auditory hallucinations, hallucinations commenting on the person's own actions, thought withdrawal, thought insertion, thought of being influenced by others and thought broadcast.

Basically, disorders of thought can be grouped into (i) disorders of the content of thought and (ii) disorders of the form of thought. Disorders of the content of thought consist of those in which the content of the thought is disturbed, such as in delusions; while disorders of the form of the thought consist of the many abnormalities of language that are observed in schizophrenia, such as anomalies in the logical sequencing of ideas, disturbances in the meaning of words and phrases, and lack of coherent meaning (see Covington, 2005; McKenna and Oh 2005, among others).

As the history of schizophrenia shows, differentiating thought from language, especially in cases of speech disorders, has been proven to be a hard task. One of the first modern attempts to classify each type of disorganized speech, which at that time were grouped under the name Formal Thought Disorder (FTD), was made by Nancy Andreasen in 1979. Her study with 113 psychiatric patients (Andreasen, 1979a and Andreasen, 1979b) resulted in a comprehensive set of definitions of speech and language behaviors observed in psychiatric patients,

which were adopted by the DSM since its 3rd edition (APA, 1980). Andreasen later used this data to develop a scale for the assessment of thought/language disturbances, the *Thought, Language and Communication* (Andreasen, 1986), consisting of 18 items —poverty of speech (laconic speech), poverty of content of speech (wordy vagueness), pressure of speech (excessive speed or emphasis), distractibility (by environmental stimuli), tangentiality (partly irrelevant replies), derailment (flight of ideas, which lack a meaningful relationship), incoherence (word salad, severely disrupted structure), illogicality (illogic inferences between clauses), clanging (words associated by sound), neologisms (novel made-up words), word approximations (coined substitutes for existing words), circumstantiality (numerous digressions), loss of goal (wonder away from never returning to topic), perseveration (persistent repetition of words, ideas, etc.), echolalia (echoing of words or sentences), blocking (sudden stoppage), stilted speech (pompous or overly formal style), and self-reference (talking about oneself excessively) (for detailed explanation and examples, see Andreasen, 1979a). This study showed that 4 of the 18 symptoms were the most common ones (derailment, loss of goal, poverty of speech, and tangentiality), 4 were relatively common (poverty of content of speech, pressure of speech, illogicality and perseveration), and 2 were fairly uncommon (self-reference and incoherence); the other 8 symptoms were hardly ever observed in patients with schizophrenia (Andreasen, 1979b).

Andreasen proposed classification was, then, used in an experiment with people with manic disorder, schizoaffective disorder and schizophrenic disorder (Andreasen and Grove, 1986). The results showed that some of the scale's items were more suggestive of severe psychopathology (e.g., poverty of speech, poverty of content, derailment, tangentiality), while others were less pathological (e.g., neologisms, blocking, echolalia, stilted speech). It was observed, yet, that patients with mania tended to be more fluent and disorganized than those with schizophrenia, exhibiting high rate of pressure of speech, derailment, loss of goal, circumstantiality, incoherence, and illogicality (Andreasen and Grove, 1986: 351). Patients with schizophrenia presented a tendency towards poverty of speech and content, which was identified as an emptiness factor (Andreasen and Gove, 1986). Andreasen and Grove (1986), then, argued that the so-called FTD does not represent a unitary dimension and can be subdivided into subtypes and, more

importantly, it is neither specific of schizophrenia nor present in all patients with schizophrenia.

Other studies on FTD focusing on language impairments presented alternative scales of speech disturbances (Chen et al., 1996; Docherty et al., 1996a; Liddle et al., 2002 among others). These studies either simplified or restructured Andreasen's classification, approaching language from different perspectives. Chen et al. (1996), for example, developed a language disorganization assessment scale based both on clinical characterization of disorganized speech and on levels of linguistic organization such as phonemics, syntax, semantics, and discourse. Factorial analysis of the *Clinical Language Disorder Rating Scale*, which consists of 17 items, showed three major domains: syntactic (associated with sentence and word formation), semantic (associate with *loose association*) and production (associated with *poverty of speech*).[6]

Today, FTD is defined in terms of thought, language, and communication disturbances (Andreasen, 1979a; Andreasen and Grove, 1986; Kuperberg, 2010; Jerónimo et al., 2018) that contribute to impairments in social, occupational, and vocational functioning (Bowie and Harvey, 2005, 2008). At clinical level, these symptoms can be broadly divided into negative (related to *alogia*) and positive (related to Bleuler's *associative disturbances*). Negative symptoms of thought disorder are characterized by a tendency to a reduction in speech production (e.g., poverty of speech) or an impoverishment of content (e.g., poverty of content of speech); whereas positive symptoms of thought disorder are characterized by a disorganized discourse, that is difficult to follow (e.g., derailment, tangentiality, incoherence, illogicality) (Frith and Allen, 1988; McKenna and Oh, 2005; Andreasen and Black, 2009).

At the level of language/grammar organization, studies have broadly divided symptoms of disorganized speech into three basic levels: syntactic (impairments in structure-based properties), semantic (impairments in meaning-based properties), and pragmatic (impairments in the relation of language and context). These levels have been investigated both in production and in

[6] List of Clang's 17 items: excess phonetic association, abnormal syntax, excess syntactic constrains, lack of semantic association, referential failures, disclosure failure, excess details, lack of details, aprosodic speech, abnormal prosody, pragmatics disorder, dysfluency, dysarthria, poverty of speech, pressure of speech, neologisms, paraphasia error.

comprehension, by different studies and approaches (DeLisi, 2001; Covington, 2005; Kuperberg, 2010).

Besides supporting differential diagnosis of psychotic conditions, characterizations of speech disturbances have proven to be useful tools for examining (dis)similarities between the speech of patients with SZ and with brain damage (e.g., stroke, aphasia etc.), and for verifying associations between language and cognition (general cognition, social cognition, and metacognition).

In this arena of research, several studies (Chaika, 1990; Covington et al., 2005; DeLisi, 2001; Docherty et al., 1996a; Kuperberg, 2010; Kuperberg, 2008) have focused on grammatical properties of language to understand disorganized speech. This is the focus of the next section.

2.4. Grammar in schizophrenia: a closer look

As already emphasized, although not all people with schizophrenia exhibit patent language impairments, patients' speech is crucial for schizophrenia diagnosis (McKenna and Oh, 2005; Kuperberg, 2010). Besides, language and speech behavior can be directly looked into (differently from other schizophrenia symptoms), so they have been investigated more than any other feature of this disorder (Frith, 1992: 95).

All things considered, one of the most difficult tasks in this field of research is to identify which component(s) of grammar is impaired in schizophrenia, especially since abnormalities occur at any linguistic level, as well as at their interfaces (Covington et al., 2005; Ditman and Kuperberg, 2010; Kuperberg, 2010). It has been reported, for example, that verbal communication in schizophrenia tends to be guided by phonological and semantic features of words instead of by topic/goal (Chaika, 1974, 1990), and that it may present grammatical errors (Hoffman and Sledge, 1988) and a reduction in syntactic complexity (Morice and Ingram, 1982; Fraser et al., 1986). Also, meaning might be impaired because of poor understanding of figurative language (Rossetti et al., 2018; Mitchel and Crow, 2005) or the production of narratives lacking logical sequencing of propositions (Rodriguez-Ferrera et al., 2001; Docherty and Gottesman, 2000). Even when none of the above-mentioned impairments occur, the speech of people with

schizophrenia might sound strange due to failure in matching language with the context of speech (Chaika, 1990; Fine, 1999; Done and Leinonen, 2013).

Considering that each linguistic level has its own set of constraints on combinations of linguistic information, and that coherent meaning is a product of all levels functioning as a set of interrelated components, looking into language impairments involves understanding each of these components separately and how they relate to each other (see chapter 3, section 3.1). Still, given our current formal understanding of Grammar, this task may face theoretical and methodological failures. Having said that and following the understanding that the literature on schizophrenia often reports impairments in the form and content of language, we will review data related syntax and morphology (*form*) as separated from semantics and pragmatics (*content*).

2.4.1. Form (syntax and morphology)

Reports from old comprehension studies focusing on sentence boundaries showed that at least at the sentence level, the syntactic component is fairly intact in schizophrenia (Rochester et al., 1973; Carpenter, 1976; Grove and Andreasen, 1985); however, there is evidence of syntactic impairments in schizophrenia from studies both in comprehension and production.

Studies measuring speech production have shown that syntactic problems, other than 'word salad' (i.e., mix of words lacking structural markers), distinguish speech of people with schizophrenia from that of healthy individuals. It has been reported that patients with schizophrenia produce shorter and simpler sentences, which, besides being less structurally complex (e.g., reduction in sentential embedding), contain more syntactic errors (e.g., verb agreement and tense violations) (Morice and Ingram, 1982; Morice and McNicol, 1985; Fraser et al., 1986; DeLisi, 2001; Özcan et al., 2017).

DeLisi (2001) reported that, compared to healthy CT subjects, patients with chronic SZ produced fewer conjoined and embedded clauses, fewer words, and more inappropriate content, with reduction in sentence complexity being more significant in chronic schizophrenia and related to age onset.

Morphosyntactic impairment was also reported on a controlled production task involving inflectional morphology conducted by Walenski et al. (2010). The

authors adopted a linguistic paradigm based on "dual-system model" (Pinker, 1999), in which declarative memory is assumed to be involved in lexical knowledge, and procedural memory in combinatorial knowledge. Participants (43 subjects with SZ and 42 healthy CT subjects) were asked to read sentences aloud, filling in the missing past tense of verbs, which were either regular (*slip-slipped*), irregular (*swim-swan*), or novel (*plag-?*). Subjects with SZ exhibited impairment in regular and novel verbs, with relative sparring of irregulars. Errors in regular and novel past-tense productions were significantly predicted by participants' global scores on the *Thought, Language and Communication* scale (Andreasen, 1986). It was suggested that the performance of subjects with SZ derived from deficiency in grammatical processing (i.e., impairments of -ed-affixation). The authors interpreted these results as indicating that schizophrenia leads to problems with procedural memory, while spearing declarative memory.[7]

Comprehension studies have reported reduced accuracy related to more complex syntactic structures in schizophrenia. Patients with SZ have been shown to exhibit problems in comprehending syntactically complex sentences (Morice and McNicol, 1985), in deriving meaning from sentences with embedded clauses (i.e., comparing matrix sentences with subject-and object-relative clauses) (Condray et al., 1992; Condray et al., 1995; Condray et al., 1996), and in understanding of agent and object roles in subject-and object-relative clauses (i.e., "who did what to whom") (Condray et al., 2002).

In addition, Moro et al. (2015) reported impairments in knowledge of syntactic structure and of syntactic relations among the terms of a structure in an experiment aiming at verifying possible syntactic and semantic deficits in short and long sized sentences. To dissociate the syntactic and the semantic components of language, they adopted the anomaly detection paradigm, in a task of comprehension of grammatical sentences. Participants (58 subjects with SZ and 30 healthy CT subjects) were asked to decide if visually presented Italian sentences were correct (binary acceptability judgment task). Structural deviances involved violations of locality restrictions on *wh*-movement (e.g., 'Who does John want to contact before meeting the doctor?' *vs.* '*Who does John want to contact the nurse before

[7] Similar results were reported on second language (L2) acquisition, where performance of patients with schizophrenia on L2 was not different from controls', which was interpreted in terms of spared declarative memory in schizophrenia (Bersudsky et al., 2005).

meeting?'), clitic placement in affirmative sentences (e.g., 'Of these pictures, Maria thinks that Gianni of-them$_{clitic}$ wants to see two.' *vs.* '*Of these pictures, Maria of-them$_{clitic}$ thinks that Gianni wants to see two.'), and assignment of contrastive focus involving subject-verb inversion (e.g., 'Gianni not arrives/not arrives Gianni *vs*. Gianni not arrives, but leaves/*not arrives Gianni but leaves.). Semantic errors involved semantic contradictions (e.g., 'I have dried my new shirt with water'). Compared to CT subjects, accuracy rates of subjects with SZ in the syntactic anomaly detection task were significantly lower, suggesting impairment of syntactic knowledge in schizophrenia. Contrastingly, no significant differences were found in detection of semantic anomalies, suggesting that, in schizophrenia semantic composition abilities (i.e., ability to derive meaning from syntactic structure) are not impaired.

Çokal et al. (2018) reported significant group differences of syntactic complexity measured by the ratio number of embedded and dependent clauses. Narratives of subjects with SZ with thought disorder diagnosis showed significantly less syntactic complexity compared to first-degree relatives of patients with SZ, and to neurotypical CT subjects, but no significant difference was found between subjects with SZ with and without thought disorder diagnosis, or between subjects with SZ without thought disorder diagnosis and both groups of CT subjects. They also reported no significant group differences of syntactic errors, which included truncated sentences and other errors such as agreement and tense violations.

Impairments at the level of truth value assignment to propositions have also been observed in a study of the comprehension of embedded clauses (factive and non-factive) (Çokal et al., 2019). The task consisted in verifying the truth value of sentences paired with pictures. Çokal et al. reported that the performance of the subjects with SZ with thought disorder diagnosis was significantly worse compared to that of subjects with SZ without thought disorder diagnosis, first-degree relatives of patients with SZ, and to neurotypical CT subjects.

In sum, there is evidence of speech deviances at syntactic level of language organization in schizophrenia, and these disturbances have been measured in both production and comprehension tasks.

2.4.2.
Content (semantics and pragmatics)

Studies focusing on the semantic relationship between individual words and meaning within one-clause sentences have shown that the speech of patients with SZ is mostly driven by lexical semantic associations (Chapman et al., 1976; Chaika, 1990; Titone et al., 2000; Ditman et al., 2011). Semantic priming studies indicate that production and comprehension of inappropriate meaning seem to be triggered by failure in inhibiting the strong meaning of words and/or hyperactivation of semantic network nodes (Gernsbacher et al., 1999; Kuperberg et al., 1998; Ditman and Kuperberg, 2010; Kuperberg et al., 2018). Thus, it has been suggested that lexical knowledge is not affected *per se*, but rather the organization and/or access to lexical material is affected in schizophrenia (Kuperberg et al., 2009).

Moreover, patients with SZ have been shown to exhibit deficits in comprehending figurative language (e.g., metaphor, indirect requests, irony etc.), often choosing concrete/strong meaning of words (Chapman et al., 1964; Brüne and Bodenstein, 2005; Kiang et al., 2007), exhibiting poor understanding of irony and metaphors (Langdon et al., 2002) and of idiomatic expressions (Titone et al., 2002; Schettino et al., 2010). Deficits in understanding metaphors and indirect requests (Champagne-Lavau and Stip, 2010) as well as problems in processing both novel and conventional metaphors (Mossaheb et al., 2014) have also been reported. These data highlight the fact that, although people with SZ understand literal meaning of words, they fail to understand non-literal ones, which might suggest failures in inhibiting the literal meaning of idioms and words block the access to alternative meanings in schizophrenia (Kuperberg et al., 2009).

Together, these data corroborate findings of strong association between incoherency and the ability to match language and context in schizophrenia (see Ditman and Kuperberg, 2010), which are also strongly related to ambiguity and lack of definiteness, especially in the use of definite nominal expressions (Hinzen, 2017).[8]

[8] Chaves (2017) and Chaves and Rodrigues (2020) present experimental studies on the interpretation of definite DPs, suggesting that non-clinical, healthy speakers of Brazilian Portuguese with high level of schizotypal traits also have difficulty integrating contextual information into semantic meaning.

In fact, classical communication failures in schizophrenia are characterized in terms of referential impairments, vagueness, and lack of definiteness (Rochester and Martin, 1979; Docherty et al., 2003; Hinzen and Rosselló, 2015; Hinzen, 2017), markedly in the use of referential markers (Ditman and Kuperberg, 2010), and especially affecting definite, rigid, deictic, and personal forms of reference (Hinzen and Rosselló, 2015; Hinzen, 2017). Narrative production in schizophrenia is full of unclear references (Rochester and Martin, 1979; Barch and Berenbaum, 1996; Docherty et al., 2003; Kuperberg, 2008), with ambiguous and vague use of personal pronouns (e.g., *he*, *she*, *they*) and demonstratives (e.g., *this*, *that*) (Çokal et al., 2018). Given the centrality of this discussion to our research, we will consider difficulties with pronoun interpretation separately, in chapter 3, section 3.5.

Several studies (Docherty et al., 1997; Docherty et al., 1998; Docherty and Gordinier, 1999; Kuperberg, 2010; Rubino et al., 2011) have shown that vague, confused, ambiguous and missed references are amongst the most common cause of communicative failures in patients with schizophrenia. Consider examples (1)-(3) where the speech of subjects with SZ fails to communicate meaning.

(1) Being sick is, it's not bad. You can do things and plus you can make people afraid of you.

(2) I saw George and Lester at the store. He looked very sad.

(3) I like to work all right. Some of those shops were filth. I liked the bakeries, some of the shops are clean. (no prior mention of any shops or bakeries)

(Docherty et al., 1997: 502)

In (1), the overinclusive word *things* causes the speech to be vague. In (2), the ambiguity between *George* and *Lester* as the pronoun referent causes the speech to be confused. In (3), the referents of the definite descriptions *the shops* and *the bakeries* are not given.

The examples in (1)-(3) demonstrate failures in establishing proper anaphoric links with previously mentioned expressions, in identifying the real-world entities that the speaker is referring to, and in keeping reference clear and

without excessive repetition of words at the discourse level (Rochester and Martin, 1979; Ditman and Kuperberg, 2010).

Several researchers (Chaika, 1990; Rochester and Martin, 1979; Ditman and Kuperberg, 2010; Hinzen and Rosselló, 2015) have highlighted the need to examine the different linguistic aspects/levels to fully understand what is really impaired in schizophrenia. However, up until now, as pointed out by Çokal et al. (2018), anomalies in referential markers are mostly studied under the label of communication disturbances (Docherty and Gordinier, 1999; Docherty, 2012a) or discourse cohesion (Rochester and Martin, 1979; Harvey, 1983). Very few studies have presented a formal approach to semantic and pragmatic difficulties observed in schizophrenia.

In this arena of research, it has been emphasized that, since pronouns are "the most grammaticalized form of reference that exists in language" (Hinzen and Rosselló, 2015), these linguistic items are potential indicators of schizophrenia (Frith, 1992; Hinzen and Rosselló, 2015) and a promising area of research (Ditman et al., 2010; Tovar et al., 2019a). Thus, we will devote chapter 3 to pronouns.

In what follows we present theories, according to which language and psychosis are intertwined.

2.5. Language and schizophrenia as two sides of the same coin

2.5.1. Crow's big bang theory

Building on a continuum view of psychosis, and assuming that a linguistic dimension is central to the problem, it has been argued that the genetics of language and the genetics of schizophrenia are tied together. Crow (1997, 1998b, 2000, 2008) proposes that schizophrenia is the price we pay for having language. He reasons that schizophrenia and language are both consequence of a speciation event that changed human brains.[9] This event allowed a gradual process of hemispheric speciation that culminated in the left hemisphere dominance so critical for

[9] The neuro-developmental re-organization of human brain is defined as the cerebral torque (a change in the brain's anatomy (see Toga et al., 2003)) that enabled the faculty of language (see Crow (2008) for a full description).

language, with the massive expansion of the human pre-frontal cortex playing an important role in this new evolved capacity.

Brain asymmetries in speciation of function are universally observed in our species, and are linked to changes in cortical connectivity, which might express genetic changes (e.g., differently from any other species, 85% of human population is right-handed). As for language, though this ability is bi-hemispheric, in 90% of the human population, the left hemisphere is dominant for language (Gazzaniga 2009).

Crow (2000) proposes that a delay in establishing hemisphere dominance for language might predispose to schizophrenia. Data from the UK National Child Development study (Shepherd, 1995) have shown that degrees of lateralization of left-and right-hand skills are associated with verbal ability in general population, with a decrease in verbal ability in those who are close to the equal hand skill line (L=R) (Crow, 1998b). Crow et. al. (1996) and Crow (2000) reported that children from the National Cohort, who were diagnosed with schizophrenia by the age of 28, were described, by parents, as ambidextrous for writing at the age of 7 years. These children were also less likely to be strongly lateralized for hand skills at the age of 11 years and have shown poor reading ability by the ages of 7, 11 and 16 years when compared to the general population (Crow, 2000).[10]

According to Crow (2010), the left-hemisphere areas of Broca and Wernicke are, respectively, in charge of structuring motor and sensory units of cognitive information (or *engrams*), while the non-dominant right-hemisphere deals with planning (associated with human thought). For each left-hemisphere phonological *engram,* there must be a corresponding mirror image in the right-hemisphere, and, thus, inter-hemispheric interactions encode speakers' thoughts/concepts into speech and decode perceived linguistic signal (acoustic or otherwise) into meanings or concepts. It is assumed that brain anatomical asymmetries cause the anterior and posterior pathways of inter-hemispheric *engrams* transmission to be reversed (see figure 1). In other words, in the anterior

[10] Cohort studies have reported significant language impairment in patients with schizophrenia as children (Eggers et al., 2000; Cannon et al. 2002; Nicolson et al., 1999). Moreover, studies on age onset schizophrenia show that the majority of patients with childhood-onset schizophrenia exhibit language deficits, both in production and comprehension, with more severe impairment in language development when compared to patients with adolescent- and adult-onset schizophrenia (Biswas, 2008).

(motor) part of the brain, transmission goes form right (thought planning) to left (speech generation), whereas in the posterior (sensory) part of the brain, from left (speech perception) to right (meaning)[11] (see figure 1).

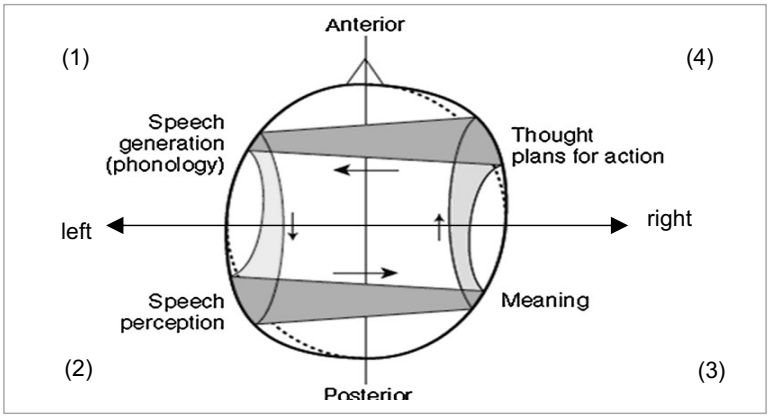


Figure 1: Inter-hemispheric transmission of information. The different pathways are indicated by the arrows. The four chambers of the human brain are indicated by the numbers (1)-(4). The dotted lines inside the circle, at the anterior-right (4) and posterior-left (2) quarters, indicate areas of asymmetries of the brain, simulating the enlargement of the right frontal lobe paralleling the enlargement of the occipito-temporo-parietal region caused by the cerebral torque[12] (adapted from Crow 2010: 5).

Crow claims that the scheme displayed in figure (1) captures both Saussure's characterization of the linguistic sign, the left brain side corresponds to the signifier and the right brain side, to the signified, as well as Chomsky's distinction between sensory-motor and conceptual-intentional interfaces, motor and sensory respectively correspond to left anterior (1) and left posterior (2) quarters of the brain, while conceptual and intentional, to right posterior (3) and right anterior (4) brain quarters.

Crow proposes that the nuclear symptoms of schizophrenia[13] reflect anomalies in specific pathways connecting thought planning, speech generation, speech perception and meaning. Thus, psychotic symptoms are pictured as abnormalities of language (Crow, 2008: 38) related to specific alterations on the neuronal system that connects the cerebral hemispheres (Crow, 1997, 1998a, 2008,

[11] Crow (2010: 5) characterizes the human brain as a four-chambered organ highlighting the left-right and motor-sensory pathways of engrams transmission.
[12] Cerebral torque is an asymmetry tendency observed in the human brain (Toga et al., 2003; Crow, 2010) (see note 9).
[13] Crow defines the symptoms of schizophrenia according to the glossary of the Present State Examination (Wing, Cooper, and Sartorius, 1974): Thought echo or commentary, Voices commenting, Passivity [delusions of control], Thought insertion, Thought withdrawal, Thought broadcast, and Primary delusions [delusional perceptions] (see section 2.2).

2010 for reviews). Delusion is characterized by failures in the pathway connecting thought planning and speech generation, and verbal hallucination as failures related to speech perception.

Schizophrenia is, thus, in Crow's view, associated with subtle but important failures of lateralization of the language system that manifest in critical form late in development (Crow, 2008). However, what triggers the stage of critical anomalies in language as we see in schizophrenia is not known, and needs further investigation.

2.5.2. Psychosis as a disintegration of language

Although we will not discuss it in detail, Hinzen's linguistic view of schizophrenia (see Hinzen and Rosselló (2015), Hinzen and Schroeder (2015) and Hinzen (2017)) follows Crow's theory in understanding that language is more than just a symptom of schizophrenia. The rationale is to approach language as an integrative system in which different cognitive abilities are integrated and participate in harmony with each other. So, when language disintegrates, some sorts of fragmentation in psychic mental functions emerge.

According to this approach, grammar mediates referential and propositional content, and the cognitive function of grammar is to convert lexical concepts into specific referential expressions.[14] For instance, the lexical concept SMILE can be grammaticalized as a noun "Mary's smile" or a verb "Mary smiles". Thus, meaning specification depends on the grammatical context in which concepts are inserted (Hinzen, 2017: 178).

Arguing that language structures our experience in the world, and that human-specific thought is mediated by language, Hinzen's approach explains schizophrenia's core symptoms (delusions, hallucinations and formal thought disorder) as a breakdown in the language structure (Hinzen and Rosselló, 2015). As such, the propositional and the referential functions of language are expected to collapse in schizophrenia (Zimmerer et al., 2017).

[14] Following Longobardi (1994, 2005), Hinzen and Sheenan (2013) propose that grammar encodes referential and propositional content by combining lexical items with functional categories (Hinzen and Sheenan, 2013: 127).

In sum, when applied to schizophrenia, the main point of Hinzen's view is that, when there is a breakdown in the language system, the cognitive principles that hold our mind together disintegrate. Delusions are associated with impairments of speech content, hallucinations with impairments of speech perception, and formal thought disorder with impairments of speech production. Thus, schizophrenia is conceptualized as a specific type of language disorder marked by a disintegration of different aspects of the language faculty and reflecting failures in language-mediated forms of meaning.

2.5.3. Syndrome-specific language features

As we have shown in this chapter, for over a century, language have been used as a qualitative diagnostic tool of schizophrenia. Disturbances in language have been largely studied in relation to schizotypy (Minor and Cohen, 2010; Minor and Cohen, 2012, Chaves and Rodrigues, 2020), clinical high risk for psychosis (Bearden et al., 2011; Perkins et al., 2015), early-stage psychosis (Minor et al., 2016), and prolonged schizophrenia (Docherty, 2012a, 2012b, Docherty et al., 2013). So much so that language and communication disturbances are considered trait-like features of schizophrenia, treatment-resistant, and linked to poor clinical outcomes (Bowie and Harvey, 2008; Docherty, 2012a; Holshausen et al., 2014).

Based on such strong evidence for language-specific anomalies, the Research Domain Criteria (RDoC)[15] has classified this complex biological trait as "an independent construct under the Domain Cognitive Systems" (Elvevåg et al., 2016: 904). Under this framework, possible syndrome-specific language features are being broadly investigated in association with positive and negative symptoms, as well as with neurocognitive deficits. The results of studies adopting this framework suggest that language has great potential to be used also as a quantifying measure of schizophrenia risk and progression.

Recently, in addition to approaches using clinician-rated (e.g., *Thought, Language and Communication* (Andreasen, 1986)) and hand-scoring instruments (e.g., *Communication Disturbance Index* (Docherty et al., 1996a)) to assess speech disorder (see section 2.3), computational methods have shown great potential to

[15] The Research Domain Criteria (RDoC) project is an initiative being developed by US National Institute of Mental Health.

assess language disturbances (Elvevåg et al., 2007; Cohen and Elvevåg, 2014; Bedi et al., 2015; Minor et al., 2015; Fineberg et al., 2016). Both structural and semantic analysis, for example, have shown great power to differentiate schizophrenia and other psychosis (Elvevåg et al., 2010; Mota et al., 2012; Mota et al., 2014; Cohen and Elvevåg, 2014), as well as to predict the onset of psychosis (Bedi et al., 2015; Mota et al., 2017; Corcoran et al., 2018). Together, these studies reinforce the idea that subtle deviances in different aspects of language might provide a rich source of information in the search for schizophrenia biomarkers (Elvevåg et al., 2016; Boer et al., 2020).[16]

But this is no simple task, as any complex trait, language comprehends many components and levels of analysis, and distinct language features might interact with a broad range of different cognitive mechanisms (see Elvevåg et al., 2016). As pointed out by Boer et al. (2020), the heterogeneity of schizophrenia spectrum disorders demands the combination of several quantifiable features of language, as well as crosslinguistic analyses in order to improve the predictive power of language measures towards cross-diagnostic tools.

Thus, following studies in which the speech of people with SZ is characterized in terms of referential impairments, vagueness, and lack of definiteness (Rochester and Martin, 1979; Docherty et al., 2003; Hinzen and Rosselló, 2015; Çokal et al. 2018), the present examination aims at contributing to this investigation by focusing on the referential use of pronouns as a potential quantifiable schizophrenia-specific language feature. Pronouns are universal elements, with quite homogeneous crosslinguistic usage, and whose features have been broadly investigated in different areas of language research such as in typical (e.g., first and second language acquisition) and atypical (e.g., Specific Language Impairment, and Autism spectrum disorders) language acquisition, and language loss (e.g., Alzheimer disease). As we will show in chapter 3, literature on language in schizophrenia is filled with reports of overuse of pronouns (Strous et al., 2009; Fineberg et al., 2015; Buck et al., 2015; Hong et al., 2015; Birnbaum et al., 2017) and of ambiguous and vague use of 3Person referential pronouns (e.g., *he*, *she*, *they*) (Çokal et al., 2018; Sevilla et al., 2018; Tovar et al., 2019a).

[16] According to the Biomarkers Definitions Working Group, biomarkers take a broader, less ambiguous definition as 'a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes or pharmacological response'.

In addition to this main task, we will extend our analysis to verify syntactic complexity at the sentential level, quantifying over the use of matrix, embedded and truncated clauses.

It is our hope that the present exploratory investigation will contribute to the research on language-specific features of schizophrenia not only by providing crosslinguistic data on the usage of pronouns, referential anomalies, and syntactic complexity in schizophrenia, but also by providing a formal approach to this arena of research.

APPENDIX 1
Darwin's paradox: the constant prevalence rate of schizophrenia

The incidence of schizophrenia is relatively low (15.2 per 100.000 individuals per year (Murray and Lopez, 1996)), yet it presents us with a paradox: schizophrenia shows 1% prevalence rate across different cultures worldwide (WHO, 1973) regardless of the significant reduced fertility, arguably, caused by the impact of psychosis on social relations (Huxley et al., 1964; Larson and Nyman, 1973; Crow, 1997; Nichols, 2009; Power et at., 2013). Thus, the question is: how does this disorder bypass natural selection? This is often called Darwin's paradox.

In the face of this puzzle, evolutionary theories have put together evidence supporting strong genetic basis (Jablensky and Satorius, 1988; McGuffin and Thapar, 1995; Gottesman, 1991; Amann-Zalcenstein, 2006), and evidence that schizophrenia is culture independent, such as findings of this disorder in Australian Aboriginal groups (Mowry et al., 1994), which suggests that schizophrenia has been here since ancient times. It is, however, important to point out that many variables seem to be at play in the etiology of schizophrenia. First, the contribution of genetic factors is supported by studies with homozygotic twins (see Sullivan et al. (2003) for a quantitative meta-analysis of 12 published studies on twins) and on cases of adoption, which shows that offspring of parent(s) with schizophrenia have high risk of developing schizophrenia independently of the mental condition of the adoptive parents (Tienari et al., 1994). Contrastively, children of parents without schizophrenia did not present an elevated risk even when raised by parents with psychotic conditions (Wender et al., 1974). In addition, recent experimental studies on Genome-wide indicate a polygenetic basis for schizophrenia (Keller and Miller, 2006; Gejman et al., 2010). Environmental factors, such as migration, famines,

advanced paternal age, prenatal complications, and prenatal infection (e.g., influenza) seem to play a role, although their individual effects seem to be relatively small. (St. Clair et al., 2005; Gejman et al., 2010).

Schizophrenia is, thus, universal, has a genetic basis, and is culturally independent, although there are environmental issues that favor its development.

It is not possible to reconstruct cases reported in the past. However, the idea that schizophrenia is a universal condition is in line with ancient reports describing a condition that is compatible with schizophrenia, as the following excerpt of Greco-Roman medical writings portrays.

> "There is a third kind of madness, the longest of all so that it does not injure life itself, and which is accustomed to be a disease of a strong body. But there are two kinds of this; for some are deceived by false images, not in their judgment: such as poets report the raving Ajax or Orestes to have perceived: Some are disordered in their judgment" (Aulus Cornelius Celsus (first century AD, cited by Jeste et al., 1985: 498).

In accordance, Polimeni and Reiss (2002) argued that schizophrenia appears to have ancient origins, although the evidence supporting this claim is not conclusive. Even though schizophrenia was only formally named and conceptualized in the late eighteenth century, looking through historical documents as old as the third millennium BC (see Jeste et al., 1985) and many other ancient reports (see Jaynes (1976) for detailed account), one can find examples of cases that could fall under today's definition of schizophrenia.

Different hypotheses have been built to explain the constant prevalence rate of schizophrenia. One possibility is that the genetics of schizophrenia remains within the population due to high mutation rates. Adopters of this hypothesis argue that advanced paternal age is a crucial factor since it is an important source of new mutation in humans. That is, spermatogonia replicates many times during lifetime increasing the probability of new spontaneous mutations that can favor psychotic disorders (Malaspina, 2001).

Another way of explaining Darwin's paradox is by associating schizophrenia with a 'substantial and universal advantage' caused by a genetic variation as old as the origin of our species (Crow, 2008: 37). The idea that an evolutionary advantage must keep schizophrenia balanced was first advocated by Huxley et al. (1964), who suggested that the balance lays in the resistance to

wounds, shock, and stress. Kuttner et al. (1967) was the first to point out that the genetic advantage of schizophrenia should be related to psychological features and not physical ones. They proposed that intelligence, complex social ability, and language were the best candidates. This hypothesis is supported by many other researchers, who considered cognitive abilities (such as creativity) to be a compensatory advantage for psychosis (Debbané and Barrantes-Vidal, 2014). Altogether, these suggestions are in line with Crow's idea that schizophrenia is a consequence of the evolutionary innovation that gave us high cognitive abilities.

APPENDIX 2
A brief digression on the history of madness

Although schizophrenia has a biological basis, the way it was perceived throughout historical times is determined by cultural norms, and, thus, has accompanied huge and complex series of changes of mentality through the ages.

Julian Jaynes, in his book *The origin of consciousness in the breakdown of the bicameral mind* (1976), reckons that, before the Axial Age (before 800 BC),[17] man's volition was perceived in the form of inner voices/words commanding actions, thus, what it is now called auditory hallucinations was once taken to be of divine nature (e.g., oracles, gods, demons etc.),[18] which, nevertheless, were products of the nervous system that transformed stored "admonitory and preceptive experience" into articulated speech telling man what to do and how to behave. During the Axial Age (800-200 BC), a change of mentality from the god-like commands determining social conduct to that of man's volition being a product of their own minds occurred (Jaynes, 1976: 99). This change led the god-like voices to be muted and replaced by the internal dialogues of one's own (as in our imaginary plans), and people who exhibit this condition today are often diagnosed as

[17] The Axial Age (or Axis Age) characterizes a historically liminal period of time, from about 800 to 200 BC, when a shift of mentality occurred, culminating in today's human civilization (see Jasper, 1953).

[18] Jaynes (1976) presents several examples of inner voices in ancient texts: (i) cuneiform writings show that each man had a personal god, and the bond between man and his god was so strong that the person's name included the name of the personal god (Jaynes, 1976: 184); (ii) mythology is full of examples of oracles (e.g., Delphi) and "hallucinated voices" of dead kings commanding people's actions (e.g., Osiris mummified body from which the voice once came need to be kept preserved) (Jaynes, 1976: 187); and (iii) Plato' writings often make reference to dead heroes who turned into demons, telling people what to do (Jaynes, 1976: 164).

psychotics (Ribeiro, 2014: 1). Jaynes claims that changes of mentality are analogous to changes that occurred in language usage over the centuries.

It has been shown that it is possible to quantify changes of mentality by tracking language usage in historical texts, and that changes in language might point towards changes of mentality. For example, Diuk et al. (2012) used Latent Semantic analysis to track changes of mentality on corpora of texts from different historical times. Their analysis showed increased incidence of concepts semantically similar to introspection in texts from 800-200 BC, which was interpreted as evidence for a change in consciousness during this period. Pinheiro et al. (2020) used graph analysis to examine a body of historical texts, from 3000 BC to 2010 AC, reporting that ancient texts exhibit graphic structure (measured by nonsemantic direct graph representing word trajectories with structural attributes) similar to today's narratives of psychotic individuals, supporting the hypothesis that, before 800 BC, the prevalent mentality was psychotic-like.

Thus, in line with Jayne's neurological model (see Rowe, 2012), different lines of research indicate that human mentality changed through time as a result of adaptability in face of environmental change. In this process, psychotic-like symptoms were reinterpreted as abnormal internal thought processes.

Foucault (1961) also analyzed the notion of insanity, focusing on different historical periods: renaissance, classical age, and modern times. His conclusion is that insane people had a special role in society until the renaissance period, being perceived as sources of wisdom and linkers between worlds. During the Renaissance, a more rational and objective way of analyzing the world emerged, imposing a breach between reasonable and unreasonable thinking processes. In the 17th century, the age of reason, confinement and segregation was imposed upon insane people in Europe.

Although, this issue is outside the scope of the present thesis, we want to point that (a) more research is needed to evaluate cross-cultural differences and life quality in psychosis (Katz et al., 1988; Whitaker and Read, 2010) and (b) schizophrenia spectrum disorders should be better referred to as *different minds,* in line with the expression of neurodiversity (Singer, 1998). This expression hints towards the role played by psychosis in nourishing diversity among us, human beings.

3
Pronouns: universals and variations in natural language

In this chapter, we will explore the architecture of human grammar as proposed by Generative Grammar, focusing exclusively on the role played by pronouns in acts of reference. Two major issues in this area of research are: (a) how pronominal-antecedent relationships are built by Grammar, (b) the division of labor between different types of pronouns, particularly null and overt subject pronouns in null subject languages. We will suggest, following recent theoretical developments, that establishing an antecedent-pronoun relationship is a process that involves different components of grammar, from syntax to pragmatics. Also, null pronouns have less syntactic structure compared to overt pronouns. In liaison with these suggestions, we will consider acquisition and loss of pronouns. Children with typical development (TD) present a delay in mastering the linguistic constraints that regulate the distribution of strong pronominal forms, while studies show that children with atypical development (e.g., Autism spectrum disorders (ASD) and Specific Language Impairment (SLI)) present permanent difficulties with pronouns. Problems with pronouns are also observed in atypical aging processes (e.g., Alzheimer's disease), and in psychosis (e.g., schizophrenia). We will try to integrate all these findings by arguing that similar to what has been proposed for children under 6 years of age non-adult like behavior, problems in the usage of pronouns might reflect working memory limitation, which arguably compromises grammatical processes at both pronoun and sentence levels. This discussion will pave the way to chapter 4, where we present two exploratory studies conducted by us on the distribution of overt and null subject pronouns in narrative reports by native speakers of Colloquial Brazilian Portuguese (CBP) diagnosed with schizophrenia.

The chapter is divided in five main sections. In section 1, we present a brief overview of the concept of Language within the Generative Grammar framework. In section 2, we discuss how personal pronouns have been recently analyzed within this framework, considering parametric variations, focusing particularly on the division between overt and null subject pronouns in the so-called null subject languages. We will also discuss null subjects in Brazilian Portuguese, a partial null subject language. In section 3, we present the idea that interpreting strong/overt

3Person referential pronouns involves reference-set computation, a complex grammatical process involving the comparison of more than one derivation. In section 4, we present reports on typical and atypical language acquisition, and language loss indicating that pronouns are difficult to acquire but easy to lose, and emphasizing the role played by working memory in sustaining complex grammatical processes. In section 5, we present the literature on the usage of pronouns in schizophrenia, while considering as a hypothesis that, similar to what has been argued for the problems with pronouns observed in first and second language acquisition, in atypical language development (ASD and SLI), and in atypical language loss (Alzheimer's disease), working memory limitation prevents the grammatical process of reference-set computation, thus leading to the patent failures in building reference for pronouns.

3.1. Grammar as a cognitive computational tool

The Generative Grammar theoretical paradigm has put forth a biolinguistic program to study grammar, conceptualizing human language as a computational cognitive mechanism (I(nternal) Language) that evolved independently and, above all, processes specific type of information for specific purposes (Hauser, Chomsky and Fitch, 2002; Berwick et al., 2013; Friederici, 2017; Yang et al., 2017). Thus, the so-called I-language is, in this view, a domain specific module of the human mind, responsible for weaving sound/sign and meaning together in a productive way. This module is composed by a group of submodules (phonology, morphology, syntax, semantics and pragmatics), and, although the submodules are arguably independent from each other, the interactions among them, interfaces internal to grammar, are responsible for linking sound/signs to meaning. The role played by the internal interfaces will be evident in the next section, as we discuss pronouns.

As already said, I-language is composed of a computational system capable of generating infinite sets of ordered instructions (or infinite expressions) to be sent to the external interfaces between language and other cognitive modules involved in sensory-motor information (articulatory-perceptual systems) and thought processes (conceptual-intentional systems).

I-language, together with the other cognitive systems with which it interacts, is referred to as the faculty of language broad sense, and it is involved not only in

language, but also in other systems of the mind, and might not be specific to our species. On the other hand, the faculty of language narrow sense is exclusive to *Homo sapiens* and can be defined as a combinatorial system, comprised only by the operation Merge. Merge concatenates linguistic material/features in an unbound and recursive way. Thus, Merge is a universal, recursive operation that defines the computation system of human grammar. The output of applications of Merge are sets of ordered expressions or structures to be sent to the external interfaces.

In sum, I-language or grammar is a domain specific computational system responsible for producing and processing linguistic information. I-language is composed by an internal set of submodules connected to each other through grammar-internal interfaces, and it is connected to external cognitive abilities through external interfaces. In addition, let us emphasize that proper functioning of I-language depends on mental resources such as memory.

3.2. Pronouns

Personal pronouns are a small bundle of functional features used by grammar to refer and to build discourse coherence. They are found in every single language of the world. Hence, these elements are universal, and their use is quite homogeneous: in every grammar we know of, personal pronouns are minimal nominal expressions (DP – Determiner phases) used to replace a full DP already mentioned in the sentential or in the discourse domain, or that is salient in the discourse context (e.g., the speaker and the hearer). Personal pronouns, can, thus, be thought of as proxies used by human grammar to substitute full DPs.

While looking at subject pronouns in general, in this dissertation, we will focus primarily on 3Person referential pronouns.

Even though 3Person pronouns are elements with low descriptive content, being arguably formed only by *phi*-features (person, gender, and number) (Reuland, 2011; Johnson, 2012), they can substitute quite complex DPs, as illustrated in (1), where the pronoun in the second conjoined sentence may refer back to the object of the matrix clause. (This coreferential process will be marked by shared indices throughout the dissertation.)

(1) Yesterday I saw [$_{DP}$ a boy that was riding an old grumpy lazy donkey]$_1$, but he$_1$ seemed completely unaware of the situation.

The more salient a reference is in discourse context, the more likely it is to be replaced by a pronominal form (Ariel, 1990; Almor, 1999; Gordon et al., 2004; Saab et al., 2004). In fact, using pronouns to refer back to a given salient referent is obligatory whenever substituting the pronoun by the referent/DP itself or by another full DP that does not alter or add anything to the meaning of the sentence (Schlenker, 2005). Within language processing, this restriction is known as the *Repeated Name Penalty* (Gordon, 1993). To see this, compare (1) with (2), where (2), in contrast with (1), is a complex unnatural way of building coreference and discourse coherence, which do not add any extra informational context to the sentence.

(2) Yesterday I saw [$_{DP}$ a boy that was riding an old grumpy lazy donkey]$_1$, but [$_{DP}$ the boy that was riding the old grumpy lazy donkey]$_1$ seemed completely unaware of the situation.

In contrast, (3) is fine because the full DP used in the second sentence adds the speaker's attitude towards the entity denoted by the DP under consideration (see Schlenker, 2005).

(3) Yesterday I saw [$_{DP}$ a boy that was riding an old grumpy lazy donkey]$_1$, but [$_{DP}$ the absent-minded boy]$_1$ seemed completely unaware of the situation.

Since pronouns are just proxies, they are unable to introduce new entities in the discourse. They are subject to the familiarity condition, hence requiring an antecedent. (4), for example, does not receive a full interpretation if uttered out of the blue, without a context from which we can retrieve an antecedent for the pronoun *she*. When accompanied by a pointing gesture, which establishes the pronoun antecedent via extra-linguistic means, (4) is fine.

(4) She is really into astronomy.

In addition, the pronominal form varies according to the structural environment in which the antecedent is determined. Considering the sentences in (5) as examples, pronouns can be anaphors or not. (The asterisk symbol (*) is used within generative grammar technically, marking a sentence or an interpretation as not possible in the language under consideration.)

(5) a. John$_1$ said that Peter$_2$ adores himself$_{*1/2}$
b. John$_1$ said that Peter$_2$ adores him$_{1/*2}$

Although the anaphor *himself* and the pronoun *him* in (5) occupy the same syntactic position inside the same predicate, they have different interpretations. The reflexive pronoun in (5a) is forcefully interpreted as coreferential with *Peter,* the subject of the embedded clause*,* being unable to refer back to *John*, the matrix subject. The pronoun *him* in (5b) has the opposite behavior. It is allowed to be interpreted as referring to *John* but not to *Peter.* This contrast shows that anaphors and non-anaphoric pronouns have different distributions, which are regulated by structural constraints. Anaphors must find their antecedents within the smallest sentential domain in which they are contained. That is, they have to be bound locally. Non-anaphoric pronouns, on the other hand, must find their antecedents outside the smallest sentential domain that contains them, being bound in a non-local fashion. See Chomsky (1981, 1986, 1993) and Chomsky and Lasnik (1993) for a formulation and implementation of the structural constraints that regulate the distribution of anaphoric and non-anaphoric nominal expressions in terms of principles. Non-anaphoric pronouns are considered to be regulated by Principle B, which, skipping technical details, can be defined as in (6), where bound means co-indexed with a c-commanding DP (See Chomsky, 1981, 1986, 1993):

(6) Principle B
A pronoun must be free (not bound) in this local domain.

Importantly, not all non-anaphoric pronouns are alike. It has been shown that, in terms of interpretation, non-anaphoric pronouns can vary in form as well. This will be discussed in the next section.

3.2.1.
Weak and strong pronouns in English

Fiengo and Higginbotham (1981) observed that English pronouns can be weak, phonologically reduced, non-stressed forms, as in (7), or full phonological forms, as in (8). These two forms correspond to different interpretations. While *'m* in (7) refers back to *John*, subject of the sentence, *him* in (8) may refer to someone else, an entity mentioned in the discourse context, not mentioned in the sentence. The weak forms are also called bound pronouns, while the strong forms are taken to be deictic pronouns.

(7) John$_1$ said that Peter admires 'm$_1$

(8) John$_1$ said that Peter admires him$_2$

Weak pronouns and strong pronouns are considered to be subject to different interpretative conditions. Weak pronouns are bound to their antecedents through syntactic means (maybe by application of Principle B at the interfaces (Chomsky, 1993; Chomsky and Lasnik, 1993)), or via movement during the derivation of the sentence (Hornstein, 2000, 2006). Strong pronouns, on the other hand, find an antecedent at discourse level, within Pragmatics. In (8), *him* may not refer to *John*, but to someone else. For that reason, we may say that strong pronouns are free in interpretation, being not bound at all. Hence, they trigger deictic interpretations, while weak pronouns are triggers for bound interpretations. Reinhart (2006) uses the term covaluation to name the referential relationship between strong pronouns and their antecedents. That is, both the pronoun and the DP-antecedent may denote the same entity, but this coreference is purely accidental, not determined by the grammar.

The difference between bound and deictic interpretation may be clearer if we consider that not all DPs refer to entities. Quantified DPs, for instance, do not denote any specific entity. example (9) shows, the DP *no teenage girl* does not denote a specific teenage girl. Therefore, the pronoun-antecedent relationship observed in (9) cannot be resolved at the discourse level, as the discourse storage does not contain any *teenage-girl* entity that the pronoun could refer to. If (9) is pronounced in a context in which we have 3 teenage girls (e.g., Julia, Maria, Anna),

then it tells us that none of them are proud of their own mothers (i.e., Julia is not proud of her own mother, Maria is not proud of her own mother, Anna is not proud of her own mother). Thus, the pronoun *her* in (9) works as a variable, its interpretation varies in accordance with the entity to which the description *teenage girl* applies. Hence, in cases involving quantified antecedents, only a bound interpretation is possible.

(9) [No teenage girl]$_1$ is proud of her$_1$ mother

Another example is given in (10), which is ambiguous for it allows both readings given in (11). (11a) has a *good-wife* reading: only Lucie is a wife that admires her own husband, the other wives under consideration do not admire their own husbands. Contrastively, (11b) has a *bad-husband* reading: only Lucie admires her husband, the other wives do not admire him, maybe because Lucie's husband is a bad guy. This ambiguity emerges because the pronoun *her* can be either bound, giving rise to the interpretation in (11a), or deictic, giving rise to (11b).

(10) Only Lucie admires her husband

(11) a. Only Lucie is an x, such that x admires x husband.

(Bound reading)

b. Only Lucie is an x, such that x admires z's husband, where z = Lucie

(Deictic reading)

In sum, non-anaphoric pronouns differ in form and interpretation. Weak pronouns are bound elements used primarily to link a referent previously mentioned within the sentential domain, and their relationship with their antecedent is subject to structural/syntactic conditions. Strong pronouns, on the other hand, are deictic elements that pick up their antecedents at the discourse level.[1]

[1] See Rodrigues (2020) for an assessment of different formal analyses of weak and strong pronouns English.

In what follows, we will see that, within Romance languages, the division between weak and strong pronouns corresponds roughly to the division between null and overt pronouns.

3.2.2.
Weak and strong pronouns in null subject languages

Languages vary with respect to how different pronominal interpretation is grammatically encoded. The so-called null subject languages, in contrast to English, have a different set of pronominal forms to encode bound and deictic readings. This parametric variation can be even more sophisticated, as null subject languages may vary among themselves with respect to the syntactic and semantic restrictions imposed upon pronouns. A subset of null-subject languages presents a different cut between null and overt pronouns. These are the so-called partial null subject languages. Colloquial Brazilian Portuguese is a partial null subject language.

3.2.2.1.
Overt and null pronouns in bona fide null subject languages

In the so-called null subject languages, also known as pro-drop languages, a pronoun in subject position can be either null or overt. This is illustrated in (12) and (13) from European Portuguese (Costa and Ambulate, 2010), where the null pronoun is represented by the element *pro.* In (12), the embedded null pronoun can be interpreted as referring to the matrix subject, the DP *o Pedro*, while in (13), the embedded overt pronoun cannot be interpreted as referring to the matrix subject. *Ele* in (13) refers to someone previously mentioned in the discourse context.

(12) O Pedro$_1$ disse que *pro$_1$* conhece a Maria
the Pedro said-3PSg that know-3PSg the Maria

(13) O Pedro$_1$ disse que ele$_{*1/2}$ conhece a Maria
the Pedro said-3PSg that he know-3PSg the Maria
'Pedro said that he knows Maria.'

The data in (14), from Italian, another null subject language, shows that both null and overt pronouns can occur in the subject position of a matrix clause, having no sentential antecedent, recovering, thus, a discourse antecedent. That is, these pronouns can both refer to an entity mentioned in the discourse domain, although it has been observed that null pronouns have a strong preference to be used when a salient syntactic antecedent (e.g., a c-commanding antecedent) is being recovered. In (15) and (16), for instance, the null pronoun is used to refer back to the matrix subject, while the overt pronoun might refer to the matrix object.

(14) Lui/*pro* ha trovato il libro
he has-3PSg brought the book
'He has brought the book'

(15) Quando Carlo$_1$ ha picchiato Antonio$_2$, *pro*$_1$ era ubriaco
when Carlo has-3PSg hit Antonio, was-3PSg drunk
'When Carlo hit Antonio, he (Carlo) was drunk.'

(16) Quando Carlo$_1$ ha picchiato Antonio$_2$, lui$_2$ era ubriaco
when Carlo has-3PSg hit Antonio, he was-3PSg drunk
'When Carlo hit Antonio, he (Antonio) was drunk.'

All in all, the cut between null and overt pronouns in null subject languages is very similar to the cut between reduced and full pronouns in English. Therefore, we might say that weak/null pronominal forms have a preference for a bound interpretation, being coreferential with syntactically salient antecedents, whereas strong/overt pronouns have a preference for a deictic interpretation, referring to non-salient syntactic antecedents or to discourse antecedents (Chomsky, 1981; Calabrese, 1986; Alonso-Ovalle et al., 2002; Carminati, 2002; Filiaci, 2010; Chamorro, 2018). However, no non-anaphoric pronoun (either weak or strong - in contrast to anaphors) can refer back to a DP that is its clause mate, as presented in the previous section.

Romance languages have yet another type of weak pronominal form, clitics, which occur in object position, as the example in (17), from Standard Brazilian Portuguese shows. Clitics pattern together with null pronouns, having a strong

preference for referring to sentential antecedents, although a sentential antecedent is not obligatory. In (18) for instance, the clitic antecedent is within the discourse, rather than within the sentence.[2]

(17) O João$_1$ disse que a Maria o$_1$ conhece
the João said-3PSg that the Maria him know-3PSg
'John said that Maria knows him.'

(18) Speaker A: Você conhece o Fernando$_1$?
você know-3Sg the Fernando
'Do you know Fernando?'
Speaker B: Sim, eu o$_1$ conheço pessoalmente
Yes! I him know-3Sg personally
'Yeah, I know 'm personally.'

In sum, morphosyntactic weakness induces coreference, weak pronouns have preference for coreferential readings, as opposed to strong pronouns (Burzio, 1999). This proposal capitalizes on Cardinaletti and Starke's (1999) typology of pronouns in terms of internal structure, according to which weak pronouns are composed by a proper subset of the set of features that compose strong pronouns. That is, the internal structure of weak pronouns is properly contained in the internal structure of strong pronouns, as shown in figure 2:

a. Strong pronouns b. Weak pronouns

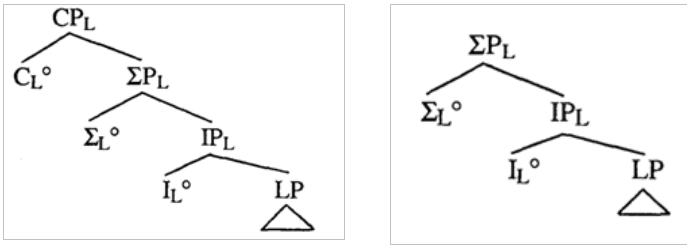


Figure 2: Strong and weak pronouns structures (adapted form Cardinaletti and Stark (1999: 86).

[2] The same behavior is observed in weak pronouns in English. They can take a sentential antecedent as in (7) or they can refer to discourse antecedent, as in (i):
(i) Speaker A: Fernando$_1$ has very radical ideas!
Speaker B: Yeah! I know 'm$_1$.

According to Cardinaletti and Stark (1999), the interpretative asymmetries involving strong and weak pronouns can be stated in terms of referential deficiency: weak pronouns are less referential than strong pronouns. That is, whereas strong pronouns must refer, weak pronouns need not, which allows for weak pronouns to be expletive and impersonal subjects, and to have non-human reference. The resolution of weak pronouns involves syntactic processes allowing its coreference with an appropriate antecedent, while that of strong pronouns basically rely on discourse-pragmatic information.

This structural deficiency analysis of pronouns suggests that the class of pronouns consists of different elements with distinct referential status, while at the same time reinforcing the intuition that different conditions are involved in the licensing of reference to different elements.

Chomsky (1981) encodes the difference between null and overt subjects in terms of a grammatical principle called *Avoid Pronouns Principle*, which states that null pronouns take preference over overt pronouns. Whenever a null pronoun fits the syntax and semantic of a given structure, it will be inserted blocking the insertion of an overt pronoun.

In what follows, we present null and overt 3Person pronouns in Colloquial Brazilian Portuguese, the language under investigation in our research.

3.2.2.2. The division of labor between null and overt pronouns in Brazilian Portuguese

Colloquial Brazilian Portuguese (CBP) is a partial null-subject language (Rodrigues, 2004a, 2004b; Holmberg et al., 2009; Nunes, 2020 among others). Similar to bona fide Romance null subject languages, in CBP, 3PersonSg null subjects are licensed in a variety of syntactic contexts. Nevertheless, the interpretation of these elements is more restricted in CBP compared to other null subject languages (e.g., Spanish, European Portuguese etc.). The examples in (19) show that null subjects in matrix clauses can be interpreted as expletives, generic or impersonal pronouns. However, a referential interpretation is not possible, thus, (20a) is ungrammatical. If we are talking about someone (say Pedro – a colleague of ours), I cannot utter (20a), but (20b), in which the subject pronoun is overt (Galves, 1987; Modesto, 2000; Rodrigues, 2004a; Kato and Duarte, 2014). The

ungrammaticality of (20a) is not observed in other null subject Romance languages, where referential 3Person null pronouns are allowed in matrix clauses, as shown in (14).

(19) a. *pro* está chovendo no Rio (Expletive)
is-3Sg raining in.the Rio
'It is raining in Rio'

b. Na praia, *pro* vende cachorro quente (Impersonal)
in.the beach sells-3Sg dog hot
'Hot dogs are sold on the beach.'

c. No Brasil, não *pro* vê mais amolador de faca na rua (Generic)
in Brazil not see-3Sg more sharpener of knife in.the street
'In Brazil, we don't see knife sharpeners on the streets anymore.'

(20) a. * *pro* chegou cedo hoje (Referential)
arrived-3Pg early today

b. Ele chegou cedo hoje
he arrived-3PSg early today
'He arrived early today.'

CBP referential null subjects are licensed inside embedded sentences. Nevertheless, they obligatorily have a sentential salient antecedent as shown in (21), where the null subject cannot refer to a discourse antecedent, as the indexes indicate.

(21) O João$_1$ disse que *pro*$_{1/*2}$ pegou Covid
The João said-3Sg that got-3PSg Covid
'João said that he got Covid.'

In addition, this antecedent must be the closest DP, as illustrated in (22), where the antecedent must be the DP *o Pedro*, and the DP *O João*.

(22) O João$_1$ disse que o Pedro$_2$ contou que *pro*$_{*1/2}$ pegou Covid
the João said-3PSg that the Pedro told-3Sg that got-3Sg Covid

'João said that Pedro said that he got Covid.'

This is not observed in other Romance null subject languages, where null subjects have a preference for being interpreted as referring back to sentential antecedent, but discourse antecedents are possible, as shown in the previous section and, a locality condition is not imposed.

Another strong contrast between CBP and other Romance null subject languages is that overt pronouns can be coreferential with a sentential antecedent in CBP, as in (23), which contrasts with (13) from European Portuguese.

(23) O João$_1$ disse que ele$_{1/2}$ pegou Covid
the João said-3PSg that he got Covid
'João said that he got Covid.'

All in all, the data above, reported in the literature about null 3Person referential pronominal subjects in CBP, suggest that these elements are weaker than null pronouns in other null subject languages.[3] Rodrigues (2004a), Nunes (2020), among others, have, thus, proposed that these elements are the result of syntactic displacement, rather than null pronouns. Applying this to example (22), it is argued that the null subject inside the embedded clause results from movement of the DP *o João* from the embedded to the matrix domain. We acknowledge this analysis as a possibility, but we will not discuss it in detail here. The main issue here is to emphasize that, in CBP, these elements are locally bound.

Importantly, the frequency of null pronominal subjects produced by CBP speakers is decreasing over the years due to a syntactic change towards overt pronominal subjects (Duarte, 2021). According to Duarte, the frequency of null referential subjects has dropped approximately 10% over a period of 16 years. The results of Duarte's (1995) analysis of a sample of interviews with CBP speakers collected in the 1990s showed that 38% of all 3Person referential pronominal subjects were null. While the frequency in the sample analyzed in 2009/2010 was only 28%. Also, Duarte (2021) reported that the frequency of null 3Person referential pronominal subjects was much lower in the CBP sample of interviews

[3] See Rodrigues and Dal Pozzo (2017) for an experimental study showing that null possessive pronouns have the same behavior in CBP and Colloquial Finnish.

compared to the European Portuguese one. Of all 3Person referential pronouns found in the sample of interviews by CBP speakers, 29% were null, while 67% of the total found in the sample of interviews by European Portuguese speakers were null.

3.2.2.3. Notes on pronominal subject omission in child language acquisition

Subject omission in typically developing children has been attested crosslinguistic regardless of whether or not they are acquiring a null-subject language. The observed pattern of children's subject omission differs in function of parametric variation. Subject omission by children acquiring consistent null-subject language (e.g., Italian, Spanish, European Portuguese etc.) and partial null-subject languages (e.g., CBP) is qualitatively like that of the adult speakers of the language. While children acquiring non-null subject languages (e.g., English, French, German etc.) do not follow the pattern of subject omission observed in adult speakers of their languages.[4]

Interestingly, the frequency of subject omission between 2;5 and 3;0 years by children acquiring CBP is similar to that of children acquiring non-null subject languages, as shown in figure 3 (adapted from Simões, 1999). As children get older (around 5 years), the frequency of null subjects produced by children acquiring CBP decreases, and children acquiring non-null subject languages stop omitting subjects.

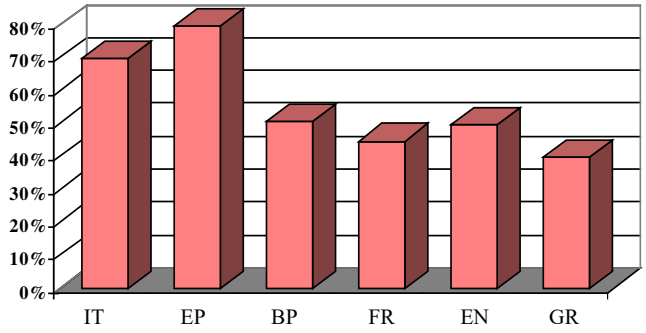


Figure 3: Null subject production of children acquiring Italian (IT), European Portuguese (EP), Brazilian Portuguese (BP), French (FR), English (EN), and German (GR).

[4] Subject omission by child speakers of non-null subject language has been attributed to a processing deficit: children omit subjects to reduce processing demands, in order to plan their utterances according to more informative parts of the sentence (for accounts of this analysis see Bloom (1970, 1990) and Valian (1990), but see Hyams and Wexler (1993), Lillo-Martin (1994) and Rizzi (2000) for critiques).

Lopes (2003) analyzed the use of null subjects by children between 1;09 and 3;03 years acquiring CBP. The results showed that 32% of all pronominal subjects were null, which, compared to the 55,5% frequency reported in Simões (1999), shows a significant decrease. Lopes highlights that the frequency observed in her data is closer to the 29% of null pronouns reported for adult speakers of CBP in Duarte (1995).

3.3. The grammatical procedure underlying pronominal referential dependencies

As shown in section (3.2), in the 1980s, pronouns were understood to be either subject to Principle B (6) when the antecedent is sentential (coreference), or subject to pragmatic conditions when the antecedent is within the discourse (covaluation). Recently, however, data on pronouns were revised and they are now considered to be elements that trigger a complex derivation process involving the comparison of akin structural representations at the pragmatic interface. This new analysis brought about a whole new understanding of the role played by pronouns in human grammar. We will suggest that it also allows us to have a better understanding of the difficulties observed during typical and atypical acquisition of language, in atypical aging and in mental disorders, such as schizophrenia. These difficulties will be presented and discussed separately in the next sections. For now, we will focus on the notion of reference-set computation.

Hornstein (2000, 2006), analyzing English sentences involving coreference, proposes that weak pronouns are grammatical formatives inserted in the sentential structure whenever syntactic displacement (movement of a DP from one syntactic position to another) is not possible. This analysis is consistent with data from other languages. In Hebrew, Palestinian and Lebanese Arabic, for instance, pronouns are inserted within relative clauses to replace a DP, whenever extraction of that DP from inside the relative clause is not possible (Shlonsky, 1992; Aoun, 2000). In addition, experimental studies suggest that pronouns induce island amelioration effects (Asudeh, 2004). Thus, technical details aside, pronouns, under this view, are a last resort strategy used whenever movement is not possible. The rationale is that movement (internal Merge) is an operation that is cheaper than pronoun insertion,

and, for that reason, application of movement preempts application of pronoun insertion. Therefore, in order to do pronoun insertion, first, the computation system of human language runs the same structure trying to do movement. If movement is possible, pronoun insertion is blocked. If movement is not possible, pronoun insertion takes place. In sum, under this analysis, weak pronouns are grammatical elements inserted by the computational system, and this insertion has a derivational cost.

Reinhart (2006, 2011) investigates preference for coreference (bound reading) vis-à-vis covaluation (deictic reading) from a perspective that is different from Hornstein's, presenting a yet similar analysis. Based on Grodzinsky and Reinhart (1993), the author observes that, whenever coreference is possible, it will block covaluation. That is, if a pronoun can receive a bound interpretation, it will do so, blocking, thus, a deictic interpretation. In other words, syntactic-semantic processes take preference over pragmatic processes. Covaluation/deictic interpretations, established at pragmatic level, happen only when coreference/bound interpretation, established at the syntax-semantic level, is not possible or when the two processes have different outcomes in terms of meaning. For example, as shown in (10)-(11) above, repeated here as (24)-(25), coreference and covaluation result in different semantic outcomes:

(24) Only Lucie admires her husband

(25) a. Only Lucie is an x, such that x admires x husband.
(Bound interpretation)

b. Only Lucie is an x, such that x admires z's husband, where z = Lucie
(Deictic interpretation)

Reinhart formalizes preference for coreference in the following way: once a sentential structure containing a pronoun that is not yet bound reaches the pragmatic interface, a computation process called reference-set computation is activated and another structure with the same set of features is built. If they both have the same meaning, the structure involving coreference will block the structure in which the pronoun is not yet bound (covaluation). The name Reference-set

computation evokes the idea that the same set of features will be used to build different structures that will be compared at the interface.

Reinhart's and Hornstein's approaches to pronouns are similar in that they both assume that pronouns involve building and comparing akin representations at the interfaces.

Reinhart suggests that there is an upper bound limit on the number of structural representations that grammar can compare via reference-set computation, and this limit is due to working memory capacity. She proposes that no more than 3 structural representations can be compared at once.

If this is so, then the question is: what can the performance of different populations in terms of pronouns tell us about cognition? In other words, when speakers have problems with pronoun reference, can we attribute such problems to the processing of complex computations, which is associated to working memory capacity? This approach predicts difficulties in the production and comprehension of pronouns. This is exactly what we want to investigate in this dissertation.

We will not explore the technical details of the reference-set computation mechanism, we will rather investigate whether or not we can use the idea of reference-set computation à la Reinhart to better understand the behavior of pronouns in schizophrenia in comparison with typical and atypical language acquisition and language loss.

In what follows, we will present data from typical and atypical language acquisition, and from language loss in atypical aging showing that these populations have difficulties in comprehension and production of pronouns. We will entertain the idea that the problems observed in the referential use of pronouns in schizophrenia might be similar to what has been reported in language acquisition literature for child interpretation of pronouns in unbound contexts. In other words, we will consider that the elevated processing load associated with attributing the reference of 3Person strong pronouns can be the cause of the referential failures observed in schizophrenia. Pronouns in schizophrenia will be discussed in the last section of the present chapter.

To finalize the discussion, it may be important to consider that production and comprehension of pronouns do require more than internal grammatical processes. It arguably requires engagement of cognitive functions such as working memory, ToM skills and executive functions. Working memory seems to play an

important role in language functions, although it is rather unclear whether it is the same type of working memory that is used in all language tasks. It has been argued, for example, that the working memory system has specializations for different verbal processes, and that working memory for syntactic information is one of such specialized components (Waters and Caplan, 1996; Caplan and Waters, 1999; DeDe et al. 2004; Caplan et al., 2007). Working memory is also involved in the activation of referents by enabling the referential use of pronouns (Almor, 1990). Correct usage and comprehension of pronouns also require understanding the other's mental stage, especially their discourse context knowledge. As discussed in section 3.2, 3Person pronouns follow under a familiarity condition, as they can be used only when both speaker and listener are familiar with the entity to which the pronoun refers. In other words, the speaker's and the listener's discourse storages have to be equally updated in order to guarantee an optimal resolution of a pronoun-antecedent relationship. Thus, the speaker must provide the necessary linguistic information to fill in the listener. To do so, ToM needs to be properly working. Executive functions are also engaged as understanding the other's mental state/knowledge requires inhibiting our own perspective (Gundel and Fretheim, 2006; Sorace et al., 2009; Arnold et al., 2009).

3.4. Pronouns: acquisition and loss

3.4.1. Typical acquisition

Children with typical development (TD), by the age of 4, exhibit adult-like judgment of sentences with anaphors, such as (26). However, a delay in mastering accuracy on pronouns has been reported. Before 6 years of age, children do not make adult-like judgments of sentences with pronouns as (27). Similar to adults, a four-year-old child has no problem in interpreting the anaphor *himself* in (26) as obligatorily coreferential with *Frodo*. In (27), however, a child under 6 allows coreference between the pronoun *him* and *Frodo.* That is, differently from adults, children do not block coreference between a pronoun and a DP when they both are within the same clause (Chien and Wexler, 1990; Grodzinsky and Reinhart, 1993; Thornton and Wexler, 1999; Crain et al., 2017). Chien and Wexler's (1990)

experimental study showed that with pronoun interpretation child performance is at chance.

(26) Frodo$_1$ hurt *himself*$_{1/*2}$ (adult-like knowledge)

(27) Frodo$_1$ hurt *him*$_{1/2}$ (non-adult-like knowledge)

This delay in mastering the constraints on pronominal coreferentiality has been observed in languages other than English, such as Dutch, Icelandic, Brazilian Portuguese, Hebrew and Russian (Jakubowicz, 1984; Philip and Coopmans, 1996; Sigurjónsdóttir, 1992; Avrutin and Wexler, 1992; Grolla, 2004, Friedman at al., 2010). However, in languages with clitic pronouns, such as French, Italian, European Portuguese, Spanish, and Greek, the reported delay is not observed. Children speakers of these languages present adult-like knowledge, blocking coreferentiality between clitics and DPs within the clausal domain (McKee, 1992; Hamann et al., 1998; Baauw et al., 1997; Varlokosta, 2002; Cristóvão, 2006; Costa and Ambulate, 2010). European Portuguese children, for example, know that in (28) a coreferential reading is not possible (data from Costa and Ambulate, 2010).

(28) O Pedro$_1$ conhece-o$_{*1/2}$ (adult-like knowledge)
the Peter know-3Sg-him
'Pedro knows him.'

In addition, it has been reported that the acquisition of weak pronouns in English is similar to the acquisition of clitics: children do not accept coreferentiality with a DP within the same clause, as in (29) (Hartman et al. 2012):

(29) Cow$_1$ washed 'm$_{*1/2}$ (adult-like knowledge)

The acquisition of null pronouns in null subject languages seems similar to the acquisition of clitics. Costa and Ambulate (2010) present experimental data showing that European Portuguese children, compared to adult native speakers of European Portuguese, did not have any difficulties understanding that an embedded null subject pronoun can be coreferential with a DP in the matrix subject position, as in (30). In contrast, however, children performed poorly, compared to adults,

when the embedded subject was an overt pronoun. Different from the adult group, they accepted its coreference with the matrix subject, as shown in (31).

(30) O Noddy$_1$ disse que *pro$_1$* tinha fome (adult-like knowledge)
the Noddy said-3Sg that had-3Sg hungry
'Noddy said that he was hungry.'

(31) O Noddy$_1$ disse que ele$_{1/2}$ tinha fome (non-adult like knowledge)
the Noddy said-3Sg that had-3Sg hungry
'Noddy said that he was hungry.'

Altogether, crosslinguistic studies on typical acquisition show us that children have no problem acquiring weak pronouns, but they do have problems with strong pronouns.

Assuming Reinhart's (2006) analysis, we may say that these reported difficulties with strong pronominal forms reflect the fact that children under 6 years of age have a reduced working memory capacity. Working memory develops during childhood (Swanson et al., 1996; Swanson, 2017; Camos and Barrouillet, 2018). This observation is already in Reinhart (1999), which connects children's guess patterns in acquisition with working memory limitations. The main idea, thus, is that, due to working memory limitations, children's linguistic computational systems crash at the interface syntax-pragmatics, when reference-set computation is required and, as a result, the referent for the pronoun is picked up randomly.

A similar issue has been observed in second language acquisition (White, 1998, Belletti et al., 2007; Sorace and Filiaci, 2006; Sorace, 2011, 2016; Slabakova et al., 2017). For example, native speakers, children and adults, of non drop-drop languages (e.g., English) have difficulties in acquiring pronouns in pro-drop subject languages (e.g., Italian, as a second language). Their difficulties are related to the structural distribution of null and overt pronouns, with an overuse of overt pronouns being observed in bilinguals, especially contexts where monolinguals would use null pronouns, (Belletti et al., 2007; Sorace and Filiaci, 2006; Sorace et al., 2009; Sorace, 2011, 2016). Sorace et al.'s (2009) results show that bilingual children (English>Italian and Spanish>Italian), compared to monolinguals, have more difficulties using overt pronouns appropriately, allowing more coreference between

an embedded overt subject pronoun and a matrix subject. The authors consider this to result form an overload of cognitive resources to integrate information from grammar and pragmatics.

Slabakova et al. (2017) reported the results of an experimental study on the potential role of reference-set computation on bilingual' pronoun interpretation. Adult native speakers of Spanish and French acquiring English as a second language were asked to make truth-value judgments of orally presented stimuli, involving full and phonologically reduced pronouns with quantificational and referential antecedents. The results showed that, in consort with 6-year-old children (Chien and Wexler, 1990), these second language learners have difficulties in conditions with full pronouns and referential antecedents. These difficulties were not found in conditions with weak pronouns. Thus, the authors interpret this difficulty, similar to that observed in young children (Chien and Wexler, 1990), as resulting from difficulties in terms of Reinhart's reference-set computations. Notice, however, that their subjects were healthy adult bilinguals. Hence, if difficulties in referent-set computations reflect reduced working memory, as proposed by Reinhart, then Slabakova et al.'s results are rather mysterious, as reduced working memory issues are not expected in healthy adults. Nevertheless, we might raise the hypothesis that bilinguals, when speaking the second language, make extra use of working memory to deal with information from the native and the second language. Thus, when they have to process reference-set computations in the second language, they face an overload of working memory.

3.4.2. Atypical acquisition

3.4.2.1. Autism spectrum disorder

Autism spectrum disorders (ASD) are associated with visible problems in production and comprehension of pronouns. First, pronoun reversals are common, which involves error in establishing the person feature of the pronoun (Wetherby and Woods, 2006; Tager-Flusberg et al., 2005; Luyster and Lord, 2009; Naigles et al., 2017). The child produces (32a) with the intended meaning in (32b):

(32) a. You want some more milk.

b. Intended meaning: I want some more milk.

As for 3Person pronouns, it has been reported that these pronouns are avoided in Autism spectrum disorders. Children with ASD present a preference for repeating DPs, instead of using coreferential 3Person pronoun, in violation of the *Repeated Name Penalty* discussed in section 3.2.

Hobson and Lee (2010) carried out a series of three experiments showing that children with ASD present a deficit in use and comprehension of pronouns. In comparison to the children with typical development (TD), children with ASD presented significant higher rate of 1Person and 2Person pronoun reversal and higher rate of 3Person pronoun evasion, with proper names and full DPs being used instead of pronouns.

Novogrodsky (2013) reported experiments adopting story-telling and story-retelling tasks. The results showed that, in the story-telling task, children with ASD had trouble establishing antecedents for pronouns, displaying high rate of pronominal ambiguity. Children with ASD, compared to children with TD, produced significantly more pronouns with agreement error (example (33)), with no antecedents (example (34)), and with unintended antecedents (example (35)).

(33) *Agreement error*: "and they said "mom, can I go outside to play?"

(34) *No antecedent*: "Once upon a time there was a frog", and he said "Frog, where are you?"

(In the story, a boy is looking for the frog)

(35) *Unintended ante*cedent: "The bees were chasing the dog. He had climbed up on a rock and went into a tree."

(In the story, the boy climbed up the tree, not the dog.)

These results were interpreted in terms of the story retelling task being less challenging compared to the storytelling, suggesting that children with ASD present deficits in the pragmatic domain.

Meir and Novogrodsky (2019) investigated the production of 3Person pronouns in subject and object position in monolingual (Hebrew) and bilingual

(Hebrew and Russian, Russian as heritage language) [5] children with high functioning autism (HFA), aged 4 to 9 years. The elicitation task was conducted in Hebrew. The results showed no effect of bilingualism, but a significant effect of HFA on the use of pronouns. Children with HFA produced less overt 3Person pronouns than the group of matched children with TD. In addition, children with HFA produced less overt object pronouns compared to overt subject pronouns. This pattern contrasts with adult-grammar, in which overt pronouns occur more frequently in object position. The omission of overt 3Person subject pronouns was predicted by ToM (measured via "Smartie task – Perner et al., 1987) and working memory skills (measured via Backward spam digit – Wechsler, 1991).

3.4.2.2. Specific Language Impairment

Omission of subject pronouns by children with Specific Language Impairment (SLI) is attested crosslinguistically (Hamann, 2003; Bottari et al, 1998; Leonard, 1998; van der Lely, 1998), and has been considered a possible clinical trait (Grela and Leonard, 1997; Grela, 2003; Schaeffer et al., 2001; Haeusler et al., 2005).

Grela and Leonard (1997) analyzed the rate of subject pronouns in spontaneous utterances by 20 English-speaking children with SLI (10 children - between 3;8 and 5;7) and children with TD (10 younger MLU-matched children). For the purpose of the experiment, verbs were categorized according to the number and placement of their obligatory arguments, as unergative intransitives (e.g., *run*), unaccusative intransitives (e.g., *break*), transitives (e.g., *bite*, *push*), and ditransitives (e.g., *put*, *give*). Results showed that subject omission was more frequent in children with SLI, compared to younger children with TD, and significantly higher in contexts of unaccusative predicates.

Grela (2003) reported an increase in subject omission associated with syntactic complexity in spontaneous production of English-speaking children with SLI (10 children - between 4;0 and 6;9 years) and children with TD (10 MLU-matched, and 10 age-matched children). A story completion task was adopted to

[5] Both Hebrew and Russian, as CBP, are considered partial null-subject languages. They allow null subject pronouns, but their distribution is highly constrained (Holmberg et al, 2009).

elicit sentences involving varied types of argument structure, with an increase in complexity (from intransitives to transitives to ditransitives). No significant group difference was found; however, children with SLI, but not age-matched children with TD, omitted more subjects as argument-structure complexity increased. The results were interpreted suggesting that subject omission in both children with SLI and younger MLU-matched children with TD was possibly caused by problems with processing complex linguistic information rather than with limitations in linguistic knowledge. See also Schaeffer et al. 2001, for similar finding.

Haeusler et al. (2005) analyzed subject omission in children with SLI (3 children: 5;3, 5:6 and 6;4 years) compared to children with TD (2 children: 3 and 5 years) speakers of Brazilian Portuguese. The experiment consisted of a game in which participants, after seeing some pictures, were asked to tell a puppet what a given character in the picture had said. The experimenter would say *"Now, let's tell the puppet what the giraffe said"*, thus, the child would respond *"She said that…"*. Three types of predicates were elicited: unergative, unaccusative, and transitive. Results showed that transitive verbs were more affected than intransitive ones, and that children with SLI were more affected, showing a pattern of subject omission similar to that of younger children with TD. Similarly, Grinstead et al. (2017) examined the rate of null subject pronouns in non-imperative verbal utterances in spontaneous production of monolingual Spanish-speakers children with SLI (20 children: age range 58–76 months) compared to children with TD (20 children: age range 58–79 months). They reported that utterances of children with SLI showed significantly higher rate of null subjects, compared to that of children with TD.

It has been shown that the referential choices of children with SLI, including the use of pronouns (Marinis and Chondrogianni 2011; Stegenwallner-Schütz and Adani, 2020), and their comprehension of syntactic complexity (Montgomery and Evans, 2009) are associated with working memory abilities.

3.4.3. Alzheimer's disease

Difficulties with pronouns have been observed in atypical aging as well (Kempler, 1995; Almor et al., 1999; Ulatowska et al., 1999). Almor et al. (1999) reported the results of three experimental studies aiming at investigating whether

patients with Alzheimer's disease have problems in the production and comprehension of pronouns. In the first experiment, they analyzed the spontaneous speech production of 11 subjects with Alzheimer's and 9 age-matched healthy CT subjects. The results showed that subjects with Alzheimer's produced greater ratio of pronouns to full DPs, compared to CT subjects. The second experiment, a cross-modal naming task, indicated that subjects with Alzheimer's were less sensitive to the grammatical information necessary for processing pronouns than CT subjects. Results of experiment 3 showed that subjects with Alzheimer's performed better at a task of remembering a reference information given in a short paragraph, when the reference was encoded by a full DP rather than a pronoun. Whereas CT subjects showed the opposite pattern. To illustrate the difficulties within the group of subjects with Alzheimer's, consider (36) (experiment 2). The discourse fragment in (36a) was presented auditorily and participants had to judge a visual target, which was a pronominal form (either (36b) or (36c)), as a good or bad continuation of (36a). Note that (36b) is an appropriate continuation of (36a), but (36c) is not. Subjects with Alzheimer's were significantly less sensitive to the appropriateness of the pronominal form than CT subjects.

(36) a. The children loved the silly clown at the party. The show was very funny. During the performance the clown threw candies to _____
b. them.
c. him.

Together with the linguistic test, participants took the MMSE - Mini-Mental state Examination (Folstein and McHugh, 1975), measuring semantic and working memory. Semantic memory was measured by a picture-meaning task and working memory by a month-ordering task. Independently of other measures (e.g., age and education), the scores on the linguistic test were not correlated with the scores on the picture-naming task but were strongly correlated with the scores on the month-ordering task. The authors concluded that, due to working memory impairments, subjects with Alzheimer's were not able to keep the representation of the information necessary for processing pronouns active.

Drummond et al. (2015) reported an experimental study on the narrative productions of healthy CT subjects, subjects with amnestic mild cognitive

impairments (a-MCI) and subjects with Alzheimer's, all native speakers of Brazilian Portuguese. The experiment consisted of asking participants to narrate a story (a car accident) based on seven scenes that were visually presented in linear order. Different linguistic factors were considered, including discourse type (narrative *vs*. just description of the given scenes), semantic coherence (number of relevant and irrelevant propositions), referential cohesion (use of appropriate linguistic element (DPs) to refer to entities), and narrative structure (e.g., ability to elaborate a full story with the events forming a full episode). Subjects with Alzheimer's performed significantly worse than subjects with a-MCI and CT subjects in referential cohesion. Only 28% of the narratives of subjects with Alzheimer's showed appropriate use of DPs (versus 79% for CT subjects and 63.1% for subjects with a-MCI). The main errors were omission of explicit referent, inappropriate or ambiguous use of pronouns, and full DPs replacing pronouns. These errors are illustrated in (37 – Drummond et al., 2015 (the indices are ours)). The pronoun *she* is used to refer to an antecedent with a masculine gender feature and the DP *the boy who was in the backseat* is used as referring to the DP *the passenger who is in the backseat*, in violation of the *Repeated Name Penalty* discussed in section 3.2.

(37) "The man$_1$ is driving. She$_1$ got out of the car. [The passenger who is in the backseat]$_2$ threw himself$_1$ forward. [The boy who was in the backseat]$_2$ released the parking brakes."

Drummond et al. highlighted that their findings were associated with reduced working memory. Thus, difficulties with pronouns in Alzheimer's disease might be considered another case illustrating failure on reference-set computations.

Interestingly, the results of experiment 1 of Amor et al. (1999) showed that subjects with Alzheimer's produced more pronouns than full DPs. This is compatible with the hypothesis we are putting forward: given that reference-set computations are miscarried due to working memory limitation, patients with Alzheimer's might use pronouns in contexts in which full DPs would be more appropriate, and vice versa as in (37). Notice, however, that Almor et al. did not show which personal pronouns are overly produced by subjects with Alzheimer's.

3.5.
Pronouns in schizophrenia

Similar to what has been reported for Autism spectrum disorders and for Alzheimer's disease, patients with schizophrenia also fail in the comprehension and production of pronouns. Speech incoherence in schizophrenia is largely associated with the use of pronouns whose reference is missing (i.e., not mentioned), ambiguous (i.e., not clear), and vague (i.e., uncertain or only mentioned after the occurrence of the pronoun) (Rochester and Martin, 1979; Barch and Berenbaum, 1996; Docherty et al., 2003).

It has been observed that ambiguous and vague references in schizophrenia mostly concern definite DPs than indefinite ones, and within definite DPs, pronouns are the main source of reference difficulties (Hinzen, 2017; Çokal et al., 2018; Tovar et al., 2019a).

Iter et al. (2018) reported significantly more ambiguous pronouns in interviews of subjects with schizophrenia and schizoaffective disorder compared to the interviews of CT subjects. Additionally, their results showed that 3Person pronouns were the most commonly vague and ambiguous pronouns. This is illustrated in the examples below, from Iter et al. The 3PersonPl pronoun *they* is used in a vague way, without a clear antecedent in (38) and (39). In (40), the 3PersonSg *he* also lacks a clear antecedent, which might be *Dalton*.

(38) Well it's a ... I believe they use it, it's a multipurpose room. They use it for report, they have snacks in here, they interview patients.

(39) Joe Montana having a remarkable season coming off his Super Bowl Win where they upset the Cincinnati Bengals is off to another fabulous year.

(40) Sure, I had fun... and I'd scream at him, like a girl, so *Dalton* says.

However, it is important to observe that data from studies reporting on the usage of pronouns in schizophrenia are mixed, as they have different goals, adopted different methodologies, types of data, as well as consisted of different groups of participants. In this dissertation, given the nature of our exploratory study, we organized previous studies' reports as follows: (a) reports of overuse of pronouns,

(b) reports of referential (mis)use of pronouns in patients with and without thought disorder diagnosis.[6]

3.5.1. Overuse of pronouns

Higher frequency of personal pronouns has been reported by several studies, most of which, however, showed overuse of 1PersonSg pronouns.

Bersudsky et al.'s (2005) examination of sociolinguistic interviews of 16 Russian immigrants to Israel (8 subjects with SZ and 8 healthy matching CT subjects), going through L2 acquisition of Hebrew, showed that SZ group produced significant more 1PersonSg pronouns in L2 interviews compared to CT group. Strous et al. (2009) analyzed Hebrew written essays of 36 subjects with chronic SZ and matching CT subjects. Participants were asked to write about someone important in their lives. Data showed higher rates of 1PersonSg pronouns in the essays of the SZ group. Moreover, 3Person pronouns were less used by subjects with SZ. Buck et al. (2015) examined emotional narratives of 42 subjects with SZ compared to 48 non-clinical CT subjects presenting similar results. The two groups significantly differ in overall pronoun use, with the SZ group using more personal pronouns than the CT group, specially 1PersonSg pronouns. Fineberg et al. (2016) reported data from 2 experiments. First, 10min interview samples of 23 subjects with SZ and of 23 CT subjects talking about themselves were analyzed. The results showed higher use of 1PersonSG pronouns in the narratives of the SZ group. Then, they analyzed blog entries of 3 groups of subjects: (i) 54 subjects with schizophrenia and schizoaffective disorder, (ii) 178 subjects with physical or psychiatric conditions, and (iii) 141 subjects with strong or odd beliefs but no mental or physical problems. The results also indicated that 1PersonSg pronouns were more frequent in the psychosis group (i.e., group (i)), less frequent in the group of subjects with physical or psychiatric conditions (i.e., group (ii)), and even less frequent in the no mental or physical problem group (i.e., group (iii)). Zomick et al. (2019) reported that comments from *Reddit* social media of people with SZ (66,454), compared to CT group (113,570), showed more personal pronouns. But

[6] For space and time reasons, we will not explore difficulties with pronouns in people at high risk of schizophrenia. See Bearden et al. (2011), Watson et al. (2012), and Birnbaum et al. (2019), among others.

comments of the SZ group contained more 1PersonSg and 2Person, and less 1PersonPl and 3PersonSg pronouns compared to CT group.

In contrast, Hong et al.'s (2015) results from the analysis of autobiographical narratives of basic emotions (anger, disgust, fear, happiness, and sadness) of 23 subjects with SZ and 16 CT subjects showed significant higher use of subject pronouns (1Person, 2Person, and 3Person, both singular and plurals) in the SZ group. Birnbaum et al.'s (2017) analysis of self-reports of individuals with SZ obtained from twitter timeline also showed greater use of personal pronouns in general (both singular and plural) when compared to self-reports of healthy CT group. Bae et al.'s (2021) analysis of a large corpus of social media posts from Reddit platform (13,156 of people with SZ and 247,569 of CT group) showed significant group differences in pronoun use, with posts of the SZ group showing more 2Person and 3PersonPl pronouns, and less 1PersonPl and 3PersonSg pronouns compared to posts of the CT group.

The studies reported above indicate that high rates of pronouns in SZ are largely associated with 1PersonSg pronouns. The emphatic role played by 1PersonSg pronouns in SZ is also seen in delusions (Hinzen, Rossello and Mckenna, 2016) and in auditory verbal hallucinations (Tovar et al., 2019b).

3.5.2. Anomalies in the referential use of pronouns

Fairly new studies have taken a grammatical approach to the investigation of language deficits in schizophrenia. Differently from previous studies, these new ones have moved away from the communication or discourse-theoretical perspective focusing rather on grammatical variables of disorganized speech. Within these studies, some investigated the types of DPs involved in the anomalous references, and their results suggest that most of the ambiguous/unclear references occurred when definite DPs, especially personal pronouns, failed to establish coreference with already established referents (Hinzen, 2017).

Sevilla et al. (2018) examined Spanish-Catalan narrative samples of participants recounting a fairytale (40 subjects with SZ: 20 with and 20 without thought disorder diagnosis, and 14 CT subjects). Anomalies in the referential use of definite DPs, particularly pronouns, distinguished the group of SZ with thought disorder from the one without thought disorder, and the group of SZ with thought

disorder from CT subjects. No significant difference was found between the SZ group with SZ without thought disorder and the CT group.

Çokal et al. (2018) analyzed narratives produced by 60 English native speakers telling a story depicted by a comic strip (30 subjects with SZ:15 with and 15 without thought disorder diagnosis, 15 first-degree relatives of patients with SZ, and 15 CT subjects). Results showed that the SZ group with thought disorder produced not only more referential anomalies in general, but also more anomalies in the referential use of pronouns, when compared to CT subjects.

Tovar et al. (2019a) analyzed a subsample of a historical corpus consisting of free conversations of 38 Spanish and Catalan speakers, in-patients with schizophrenia, with an interviewing doctor. From this corpus, a set 15 conversations from Spanish speakers were randomly selected. All 15 selected samples were of patients with SZ previously diagnosed with thought disorder by a psychiatrist not involved in the study. With respect to DPs, results showed that full DPs presented a higher rate of anomaly than pronouns. However, when full DPs were compared to 3PersonSg pronouns, no significant difference was found. Also, 1Person and 2Person pronouns presented a lower rate of anomaly than 3Person pronouns. In addition, it was reported that null referential pronouns were significantly more affected than overt pronouns. To see this, consider the example in (41) from Tovar et al. (2019a), where the 3Person null subject of the second coordinated clause is being used as if it were a 1PersonSg pronoun. (In (41), we inserted *pro* to mark the null pronouns and glossas.)

(41) Porque yo nascí por el campo y *pro* me dijo:
because I born-1Sg around the countryside and me told-3Sing
"Estate aquí que yo ahora vengo"
stay here that I now came
'Because I was born around the countryside and she told me: "Stay here as I come now.'

3.5.3.
Do speakers with schizophrenia fail to hold complex grammatical computations?

Although the difficulties with pronouns reported for schizophrenia population are not exactly like those reported for atypical acquisition (ASD and SLI) and atypical aging (Alzheimer's disease), differences aside, all these populations have problems attributing the reference of 3Person pronouns. Hence, it is rather natural to hypothesize that the difficulty with strong pronominal forms results from the same cognitive and linguistic impairments observed in typical language acquisition (see section 3.4.1). Thus, if we are right, the pronominal anomalies observed in these three groups of speakers are due to failures in grammatical processes of complex computations (i.e., reference-set computations), which, in turn, might reflect impairments in working memory.

As discussed in chapter 2, schizophrenia is associated with working memory issues. Docherty (2012b) showed that the performance of 60 outpatients with thought disorder on tests of working memory (assessed by digit spam test and Wisconsin Card Test (WCST)), attention (assessed by continuous performance task (CTP)), and conceptual sequencing (assessed by a subtest of the Shipley Institute of Living Scale) explained 29% of the variance of the communication failures. The author argued that failures in communication reflect schizophrenia-related neuropsychological impairments, including working memory deficits.

The results reported in this section show that 1Person and 2Person differ from 3Person pronouns in the following way: (a) 1Person, but not 3Person pronouns are overused; (b) 1Person and 2Person pronouns present lower rates of anomaly compared to 3Person pronouns. This is in accordance with the reference-set-computation hypothesis. In most contexts, 1Person and 2Person pronouns are rigid designators, and as such they do not trigger reference-set computations, which are activated only when the interpretation of a pronoun is still open at the interface with pragmatics. Interestingly, Tovar et al. (2019a) observed that the anomalies with 1PersonSg pronouns were more marked in cases like (42), which is a structural context in which indexical shifting happens and the 1PersonSg pronoun refers not to the speaker, but to a sentential antecedent. That is, in (42), the 1PersonSg pronoun behaves semantically as a 3Person pronoun.

Tovar et al.'s (2019a) results are particularly important to the hypothesis under consideration here for two other reasons: it indicates that DPs in general, not only pronouns, present high rates of anomalies. Second, it shows that null referential pronouns are more prone to anomalies than overt pronouns.

We understand, however, that Tovar at al.'s findings of anomalies within the DP domain need to be further investigated. It is unclear whether full DPs and pronouns present the same types of anomalies. The anomalies related to 3Person pronouns are due to failures in establishing proper reference-dependencies, but anomalies related to full DPs are arguably of a different nature.

As for null referential pronouns triggering more anomalies than overt pronouns, this is a very interesting observation that also requires further investigation. As shown in 3.4.1, in typical language acquisition, difficulties with pronouns seems to be significantly more pronounced in overt rather than null referential pronouns (Costa and Ambulate, 2010). An opposite pattern is suggested by Tovar at al. in the context of schizophrenia. Notice, however, that the results reported by Costa and Ambulate with respect to language acquisition showed only that children under 6 years of age are able to assign a bound interpretation to null pronouns; nothing is said about their ability to interpret these pronouns as deictic elements.

While holding the reference-set computation hypothesis for schizophrenia, thus, we can consider two possible ways of analyzing the pattern described by Tovar et al.:

(a) Since null pronouns are less structured elements, they are preferred by speakers with schizophrenia. Their lack of morphosyntactic cues leads to a higher number of ambiguous and vague references.

(b) Null pronouns in Spanish can be used deictically, thus, similarly to overt pronouns, they might trigger reference-set computations. Therefore, the high number of errors in the use of null pronouns could be due to the processing of complex computations.

A way of tearing these two possibilities apart is investigating the production of overt and null pronouns in patients with schizophrenia focusing on the

production of native speakers of a language in which null pronouns are not allowed to have a deictic interpretation, such as Colloquial Brazilian Portuguese. This is, thus, one of the topics to be discussed in our next chapter, in which we will present our exploratory study of the production of subject pronouns in narrative reports of native speakers of Brazilian Portuguese with a diagnosis of schizophrenia.

4
Examining subject pronouns in schizophrenic narratives of native speakers of Brazilian Portuguese

Based on the studies discussed in chapters 2 and 3, this chapter will deal with our exploratory study on the usage of subject pronouns in subject position of finite sentences. Narratives of native speakers of CBP (Colloquial Brazilian Portuguese) diagnosed with schizophrenia and of control non-psychotic subjects were examined and statistically analyzed, considering the following parameters: (i) type of subject pronouns in function of phonological form (overt and null) and (ii) pronominal person feature (1Person, 2Person and 3Person), (iii) null 3Person subject pronouns in function of referentiality (referential and non-referential), and (iv) 3Person subject pronouns in function of referential anomaly (anomalous and non-anomalous). Also, since reduced grammatical complexity has been associated with schizophrenia (Fraser et al. 1986; Morice and McNicol, 1986; Hoffman and Sledge, 1988; DeLisi, 2001; Condray et al., 2002; Marini et al., 2008; Tavano et al., 2008; Çokal et al., 2018), we examined structural deficiency at the sentence level by considering sentence types: matrix vs. embedded, and sentential truncation, which was analyzed as anomalous or non-anomalous, where anomaly were cases of non-regular ellipsis.

The following predictions were made about the narrative productions of subjects with SZ compared to that of CT subjects:

(P.1) Overuse of reduced and anomalous structures at the sentential level (more matrix and less embedded sentences, and more anomalous sentential truncation)
(P.2) Overuse of pronouns in general
(P.3) Overuse of 1Person pronouns (overt and null)
(P.4) Overuse of null pronouns in general
(P.5) More 3Person referentially anomalous pronouns, especially overt ones (strong)

Our main goal in this chapter is to provide a fine-grained description of subject pronoun usage by native speakers of CBP diagnosed with schizophrenia, discussing

our findings vis à vis the results of previous studies conducted in other languages, as well as observations on the reduction of grammatical complexity at the sentence level.

4.1. Method

The present research in its totality was approved by PUC-Rio Research Ethics Committee (permit 26.2019). The basis for the study were two corpora of narratives of native speakers of CBP, previously collected for the purpose of two studies using graph-theoretical analysis, in which, after being transcribed, each narrative was represented as a word-graph and quantified in terms of connectedness attributes (Mota et al., 2014 and Mota et al., 2017).

Mota et al. (2014) examined dream and waking reports of psychotic subjects either with schizophrenia or bipolar disorder type I, in comparison with non-psychotic control subjects. The results showed that speech graph attributes obtained from dream narratives, as opposed to waking narratives, were able to differentiate between the three groups. Also, the pattern of reduced connectivity of the speech of subjects with SZ anti-correlated with psychometric measures of negative and cognitive symptoms.

Mota et al. (2017) investigated whether speech graph attributes of dream, waking and image reports (negative, positive, and neutral images from the IAPS database of affective images (Lang et al., 1993)) of psychotic subjects during first-onset episode could discriminate schizophrenia 6 months in advance of the conventional diagnosis. The results indicated that only the speech graph attributes of dream or negative image reports could discriminate subjects with SZ from those with bipolar disorder and CT subjects, with dream reports showing the best classification. However, connectedness attributes of negative image reports correlated better with negative symptoms than connectedness attributes from dream reports.

In the present study, we analyze Mota's et al. (2014 and 2017) corpora, considering oral dream (DM) and waking (WK) narratives of subjects with SZ and CT subjects only. Thus, we will present the analysis of a subset of Mota's et al. original corpora, including only the narratives from subjects with SZ and CT subjects. Importantly, our analysis aims at a different linguistic level, considering as already

stated, pronoun usage and sentential structure. To do so, syntactic structural analyses were conducted, instead of graph-theoretical analyses.

Since the corpora used in the present study consists of two types of oral productions, we also investigate the performances of the SZ and CT groups in the tasks of reporting a dream versus reporting daily events and activities.

Although DM and WK narratives are long term memory reports, these are tasks with different demands. DM narratives are a special type of story-telling activity, where speakers/dreamers might make out a story on the fly, trying to put together mnemonic fragments of events, places and individuals that are not connected in any mental representation.[1] This process arguably overloads the speaker's memory, impacting, thus, the structural organization and the semantic coherence of the narrative. WK narratives, on the other hand, are basically episodic recollections of the speaker's own activities, which are put together as a sequence of chronological events. Reports of daily events and activities are less forgettable and more grounded on reality than dream events, which are more internally generated.

Arguably, there is more narrative planning and linguistic demands placed on the speaker when he/she reports a dream compared to reporting activities and events of the day. Thus, along with the results of Mota et al. (2014 and 2017), we make one extra prediction (P.6), namely that DM narratives will be more informative compared to WK narratives in terms of the variables analyzed in the present study.

In the next section, we describe the general procedure adopted in our study. The details of each experiment, as well as the results will be presented in separate subsections.

4.2. Procedure

4.2.1. Analyzed Parameters

(a) *Type of sentence (matrix, embedded, and truncated):*

[1] See Ribeiro (2021) for an analysis of how the brain works in a probabilistic way when dreaming, sewing non-connected memories together.

The total number of sentences per narrative were manually annotated, counted, and divided into 3 main classes: matrix (MS), embedded (ES), and truncated (TS), which was analyzed separately. Embedded sentences included subordinated sentences in object and adjunct position. Matrix and embedded sentences that were syntactically incomplete were further marked as truncated sentences, which were then classified as Anomalous (+A) or Non-anomalous (–A) depending on the recoverability of their contents and their grammatical status. Sentences with null subject pronouns were not considered truncated.

(b) *Total number of subject pronouns:*

The total number of subject pronouns per narrative was manually counted and statistically analyzed.

(c) *Subject pronoun in function of phonological feature:*

Overt (O) and null (N) subject pronouns were tagged and analyzed as such.

(d) *Subject pronoun in function of person feature*:

Pronouns were classified with respect to their person feature: 1Person (1P), 2Person (2P) and 3Person (3P). Number feature was not included because the contrast singular/plural was not robustly represented in the corpora analyzed.

(e) *Null 3Person subject pronouns in function of referentiality*:

Null 3Person pronouns were tagged as either Referential (+R) and Non-referential (-R). Null 3Person pronouns with impersonal and generic readings and expletives were considered non-referential. The Referential class included all 3Person null pronouns with definite interpretation.

(f) *3Person subject referential pronouns in function of referential anomaly:*

Overt and null 3Person referential pronouns were classified as Anomalous (+A) or Non-anomalous (–A) depending on the recoverability of their

antecedents/referent. Pronouns with missing, unclear, or ambiguous referents were classified as anomalous.

4.2.2. Annotation scheme

The final text of each transcribed narrative was divided into units of speech corresponding to sentences, containing subject and predicate, and conveying a proposition. Following the analyzed parameters (subsection 4.2.1), sentences were coded as either matrix ([MS]) or embedded ([ES]). Truncated sentences ([TS]) were tagged either as non-anomalous ([TS-A]), or anomalous ([TS+A]). Agreement errors were not accounted since CBP allows for a variety of different agreement patterns.[2]

Subject pronouns occurring in the context of finite predicates were tagged for form (overt (O) and null (N), and person feature (1Person (+1P), 2Person (+2P), and 3Person (+3P)). All null 3Person pronouns were tagged for referentiality (referential (+R) and non-referential (-R). Referential 3Person pronouns were tagged for referential anomaly (anomalous (+A) and non-anomalous (-A)), and non-referential pronouns were tagged expletive (+EXPL), generic (+GEN) and impersonal (+IMP).

All transcripts were independently coded by Monica de Freitas Frias Chaves, the present author, and Cilene Rodrigues, the research supervisor, who were blind to group status, and 37% of the data (15 transcripts in Experiment 1, and 12 transcripts in Experiment 2) were randomly selected and distributed to two raters also blind to group status. The two raters hold PhD in linguistics with expertise in formal syntax. Under the supervision of Cilene Rodrigues, all annotated items were later compared and discussed before a final decision was reached.

Importantly, while the transcripts of the narratives of Mota et al. (2017) included all interviewer-participant interactions, the interviewers' comments and questions were missing in some of the narrative transcripts of Mota et al. (2014). Therefore, prior to

[2]As examples in (i) with versions of sentence *"The boys went to the park"* show, vernacular BP allows for more than one agreement. Thus, a decision was made not to consider subject-verb agreement differences as errors.

(i) a. Os meninos estão no parque.
The-PL boys-SG are-PL at-the park
b. Os meninos está no parque.
The-PL boys-PL is-SG at-the park
c. Os menino estão no parque.
The-PL boy-SG are-PL at-the park
d. Os menino está no parque.
The-PL boy-SG is-SG at-the park

analyzing the narratives of Mota et al. (2014), we accessed each available audio, and completed the transcripts. We did not, however, have access to audios of all the narratives of Mota et al. (2014). Thus, some of our transcripts of experiment 1 remained without the interviewer's questions. Of the final sample of 40 DM narratives, 20 were missing the interviewers' questions (9 of the CT group and 11 the SZ group), and 20 were complete (11 of the CT group and 9 of the SZ group). Of the final sample 40 WK narratives, 16 were complete (11 of the CT group and 5 of the SZ group), and 24 were missing the interviewers' remarks (9 of the CT group and 15 of the SZ group).

Samples of annotated narratives from experiments 1 and 2

In our annotation, null pronouns were represented as *pro*.

- *Exp.1: DM - CT group*

Int: [...]

Part: [^{MS} eu$^{O+1P+R-A}$ tenho um sonho não tão recente] [^{MS} mas *pro*$^{N+3P+R-A}$ é um sonho [^{ES} que eu$^{O+1P+R-A}$ não esqueço]] [^{MS} os outros sonhos {^{RP} os outros sonhos eu$^{O+1P+R-A}$ já esqueci [^{ES} porque *pro*$^{N+3P+R-A}$ têm passado]] [^{MS} mas esses é um sonho [^{ES} que eu$^{O+1P+R-A}$ não esqueço]] [^{MS} que *pro*$^{N+3P-R+EXPL}$ é [^{ES} quando eu$^{O+1P+R-A}$ sonho com o meu avó]] [^{MS} que ele$^{O+3P+R-A}$ já morreu]

Int: [...]

Part: [^{MS} ah digamos [^{ES} que [^{MS} deixa [^{ES} eu ver]] *pro*$^{N+3P-R+EXPL}$ faz um {^{RP} um mês {^{RP} um mês]

Int: [...]

Part: é

Int: [...]

Part: [^{MS} todas as vezes [^{ES} que eu$^{O+1P+R-A}$ sonho com ele] eu$^{O+1P+R-A}$ não esqueço do sonho] [^{MS} *pro*$^{N+2P+R-A}$ entendeu] [^{MS} os outros sonhos eu$^{O+1P+R-A}$ até lembro alguns dias ainda] [^{MS} mas depois *pro*$^{N+1P+R-A}$ acabo [^{ES} esquecendo]] [^{MS} mas o dele eu$^{O+1P+R-A}$ não esqueço] [$^{MSTS+A}$ eu$^{O+1P+R-A}$ tenho uma ligação muito grande] [^{MS} eu$^{O+1P+R-A}$ tinha uma ligação muito grande com ele] [^{MS} *pro*$^{N+1P+R-A}$ considerava ele mais que meu pai] [^{MS} o amor o carinho por ele era muito grande]

Int: [...]

Part: [MS *pro*N+3P-R+EXPL fazem dois anos] [MS *pro*N+1P+R-A posso contar o sonho?]

Int: [...]

Part: [MS bem euO+1P+R-A sonhei [ES que eleO+3P+R-A estava em um jardim] [MS *pro*N+1P+R-A não sei [ES se vocêO+2P+R-A lembra a lateral do prédio de Macaíba {CR um jardim bem verde bem bonito ali] pronto [MS a minha impressão é [ES que euO+1P+R-A estava ali em um jardim como aquele ali] [MS e de repente euO+1P+R-A via [ES meu avó caminhando]] [MS e eleO+3P+R-A era deficiente meu avó] [MS só que no sonho eleO+3P+R-A não era deficiente] [MS *pro*N+3P+R-A era uma pessoa normal] [MS deficiente eleO+3P+R-A era deficiente de uma perna] [MS *pro*N+3P+R-A tinha uma perna amputada] [MS aí euO+1P+R-A chegava] e [MS *pro*N+1P+R-A dizia] [MS vovô o que é [ES que o senhor está fazendo aqui]] [MS aí eleO+3P+R-A começava [ES a rir]] e [MS *pro*N+3P+R-A dizia] [MS não *pro*N+1P+R-A vim só [ES conversar um pouco com você]] [MS aí no sonho euO+1P+R-A falava] [MS vô mas euO+1P+R-A estou tão triste com alguma coisa [ES que aconteceu]] [MS euO+1P+R-A contava para ele uma coisa [ES que tinha acontecido comigo]] [MS aí eleO+3P+R-A dizia assim] [MS não fique triste [ES porque euO+1P+R-A não gosto [ES de ver [ES você chorando]]]] [MS *pro*N+1P+R-A não gosto [ES de ver você triste]] [MS euO+1P+R-A sempre disse a você [ES que a genteO+1P-R+GEN na vida tem [ES que lutar {CR lutar muito por tudo [ES que a genteO+1P-R+GEN quer]]]] [MS aí euO+1P+R-A falava] [MS *pro*N+3P-R+EXPL está bom vô] [MS mas euO+1P+R-A vou pedir uma coisa] [MS não vá embora] [MS aí eleO+3P+R-A me abraçava] [MS euO+1P+R-A segurava ele bem firme] e [MS *pro*N+1P+R-A dizia assim] [MS vovô não vá {RP não vá embora] [MS não me deixe] [MS fique comigo] [MS euO+1P+R-A preciso demais de você] [MS a não ser [ES que o senhor queira [ES me levar]]] [MS [ES se o senhor quiser [ES me levar]] euO+1P+R-A vou também] [MS euO+1P+R-A prefiro [ES ir do que ficar]] [MS aí eleO+3P+R-A dizia assim] [MS mas vocêO+2P+R-A tem uma criança] [MSTS+A vocêO+2P+R-A precisa] [MS essa criança precisa de você] [MS então vocêO+2P+R-A não pode ir] [MS aí eleO+3P+R-A começava [ES a caminhar]] e [MS euO+1P+R-A via bem o Antônio {CR o Antônio do trabalho] [MS eleO+3P+R-A dizia] [MS *pro*N+3P+R-A é seu avó?] [MS/TS-A euO+1P+R-A dizia] [MS mas

eu$^{O+1P+R-A}$ achava [^{ES} que só eu$^{O+1P+R-A}$ que estava vendo ele]] [^{MS} mas o Antônio também via] [^{MS} então ele$^{O+3P+R+A}$ desaparecia] e [^{MS} eu$^{O+1P+R-A}$ acordava]

Literal translation: - […] - I have a dream not so recent, but (it)[1] is a dream that I don't forget. The other dreams… the other dreams[2], I already forgot, because (they)[1] have a past. But these is a dream that I don't forget. (It)[3] is when I dream with my grandpa. He is already dead. - […] - ah, lets' say that… let me see... (it)[3] has been a… a[2] month… a month[2]. - […] - (it) is[4]. - […] - Every time that I dream about him, I don't forget the dream. Do (you) understand? The other dreams, I remember for a few days. But then (I) end up forgetting. But the one with him I don't forget. I have a very strong relation (?)[5]. I had a very strong relation with him. (I) considered him more than my father. The love, the caring for him was very strong. - […] - (It)[3] has been two years. Can (I) tell the dream? - […] - Well, I dreamt that he was in a garden. (I) don't know if you remember the side of the Macaíba building… a garden very green[6], very beautiful there. Right. My impression is that I was there in a garden like that one. And suddenly I saw my grandpa walking. And he was disabled my grandpa. Only that in the dream he wasn't disabled. (He)[1] was a normal person. Disabled, he was disabled of one leg. (He)[1] had one leg amputated. Then I arrived, and (I) said: grandpa, what is it that you are doing here? Then he started to laugh, and (he)[1] said: no, (I) came just to talk a little with you. Then, in the dream, I said: grandpa, but I am so sad about something that happened. I told him something that had happened to me. Then he said this: I don't like to see you crying. (I) don't like to see you sad. I always told you that, in life, we have to fight… fight a lot[6] for everything that we want. Then I said: (it)[3] is alright grandpa. But I will ask something. Don't go away. Then, he hugged me. I held him very tight, and (I) said this: grandpa, don't go, don't go[2] away. Don't leave me. Stay with me. I need you too much. Unless you want to take me. If you want to take me, I will go too. I'd rather go than stay. Then, he said this: but you have a child. You must (?)[5]… This child needs you. So, you cannot go. Then, he started to walk. And I saw, right there, Antônio… Antônio from work[6]. And he said: is (he)[1] your grandpa? I said (?)[5]. But I thought that only I was seeing him. But Antônio also saw. Then, he[7] disappeared. And I woke up.

Comments: [1]null 3Person referentially non-anomalous pronouns; [2]phrase/word repetition; [3]null 3Person non-referential expletive pronouns; [4]affirmative answer, which was not annotated; [5]truncated anomalous sentences; [6]correction or adding of information; [7]overt 3Person referentially anomalous pronoun, its reference is ambiguous.

- *Exp.1: DM - SZ group*

Int: Então, me conta como é que foi esse sonho?

Part: [^{MS} eu$^{O+1P+R-A}$ {^{RP} eu$^{O+1P+R-A}$ entrava numa igreja] [^{MS} uma mulher muito bonita arrumou um casamento] [^{MS} *pro*$^{N+3P+R-A}$ ia ser muito feliz]

Int: Que legal! Aí o que mais?

Part: [^{MS} *pro*$^{N+3P-R+EXPL}$ tem uma casa]

Int: Tem uma casa, já. Que bom! A casa é como? Diga a ela, como que é.

Part: com internet de frente uma cisterna d'água

Int: Eita! E essa casa era no sonho?

Part: [^{MS} *pro*$^{N+3P-R+EXPL}$ é só um sonho [^{ES} que eu$^{O+1P+R-A}$ tenho]]

Int: Só um sonho? Muito bem. Aí no sonho, vocês entravam na igreja?

Part: era

Literal Translation: - So, tell me how was that dream? - I… I[1] walked into a church. A very pretty woman … arranged a wedding. (She)[2] was going to be very happy. - That's cool! What else? - (There)[3] is a house. - There is a house already. How nice! How is the house? - with internet facing a water tank - Uau! And was this house in the dream? - (It)[3] is just a dream that I have. - Hum. - (It)[3] is just a dream. - Just a dream? Very good. And in the dream, did you enter the church? - (it) was[4].

Comments: [1]word repetition; [2]null 3Person referentially non-anomalous pronoun, [3]null 3Person non-referential expletive pronoun; [4]affirmative answer, which was not annotated.

- *Exp.1: WK – CT group*

Int: Não. O dia antes de ter tido o sonho.

Part: um dia antes sim normal [MS *pro*N+1P+R-A conversei com minha família [CR com mamãe] tudinho] [MS *pro*N+1P+R-A fui dormir] [MS *pro*N+1P+R-A dei boa noite pra minha mãe tudo] [MS e eleO+3P+R+A saiu] [MSTS+A aí tipo assim euO+1P+R-A venho naquela] [MS sonhando] e [MS vendo [ES aquelas coisa acontecendo] né [MS *pro*N+1P+R-A acordei assombrada] né

Literal translation: - No. The day before you had the dream. - One day before. Yes. Normal. I talked with my family, with mom an all[1]. (I) went to bed. I gave good night to my mom, all. And he[2] left. Then, kinda, I come in that (?)[3]… Dreaming and seeing those things happening, alright. (I) woke up haunted, alright".

Comments: [1]correction or additional information; [2]overt 3Person pronoun missing reference; [3]truncated anomalous sentence.

- *Exp.1: WK - SZ group*

Int: […]

Part: não [MS euO+1P+R-A trabalhei] [MS *pro*N+1P+R-A trabalhei o dia depois] [MS aí *pro*N+3P+R+A teve muita dor na coluna [uma dor na cabeça]] [MS como *pro*N+3P+R+A está agora]] [MS *pro*N+3P-R+EXPL faz é tempo [ESTS+A que *pro*N+1P+R-A estou com uma]] [MS *pro*N+3P+R+A está doendo direto doutora] [MS *pro*N+1P+R-A fui me deitar] [MS *pro*N+1P+R-A tomei um comprimido] [MS aí *pro*N+1P+R-A estava dormindo] e [MS *pro*N+1P+R-A estava acordado]

Int: […]

Part: não só com o advogado mesmo

Literal translation: - [...] - No, I worked. (I) worked the day after. Then, (?)[1] was much pain in the back, a pain in the head. Like (?)[1] is now. (It) has been a long time that (I) am with a (?)[2]… (?)[1] is hurting unstoppable, doctor. (I) went to bed. I took a pill. Then, (I) was sleeping and (I) was awake. - [...] - No, only with the lawyer indeed.

Comments: [1]null 3Person anomalous pronouns, its reference is missing; [2]truncated anomalous sentence.

- *Exp.2: DM – SZ group*

Int: Certo, agora me conta o último sonho que você teve, mais recente?

Part: [$^{MSTS+A}$ Conversar com Deus] e [$^{MSTS+A}$ fazer muita coisa]]. [$^{MSTS+A}$ Rezar], [$^{MSTS+A}$ ler bíblia], [$^{MSTS+A}$ brincar], e [$^{MSTS+A}$ fazer bastante coisa]. E muita coisa ainda [$^{ESTS+A}$ que eu$^{O+1P+R-A}$ fazia], [$^{MSTS+A}$ fazer], [$^{MSTS+A}$ conversar com muita coisa], [$^{MSTS+A}$ conversar com cobras], e só.

Literal translation: - Right, now tell the last dream you had. The most recent one. - To talk[1] to God and to do[1] many thing. To prey[1], to read[1] the Bible, to play[1] and to do[1] a lot of thing. And many thing still[2] that I did, to do[1], to talk[1] to many thing, to talk[1] to snakes, and that's all.

Comments: [1] truncated sentences anomalous, ungrammatical use of the infinite verbal form; [2]truncated sentence anomalous, unclear meaning.

- *Exp.2: DM – CT group*

Int: Agora, conta pra mim o sonho mais recente que você lembra.

Part: [^{MS} *pro*$^{N+1P+R-A}$ acho [^{ES} que *pro*$^{N+3P+R-A}$ foi semana passada] [^{MS} *pro*$^{N+3P+R-A}$ era um sonho [^{ES} que era [^{ES} se eu estivesse em 2 corpos ao mesmo tempo]]] [^{MS} tipo eu$^{O+1P+R-A}$ era um menino e uma menina ao mesmo tempo] e [^{MS} eles$^{O+3P+R-A}$ estavam tentando [^{ES} se encontrar]] [^{MS} e *pro*$^{N+3P-R+EXPL}$ era um lugar muito estranho tipo um labirinto] [^{MS} e eu$^{O+1P+R-A}$ não conseguia [$^{ESTS+A}$ encontrar]] [^{MS} e às vezes eu^{O+1P} estava no corpo de uma pessoa e outras no de outra] [^{MS} e o sonho todo era [^{ES} tentando [^{ES} achar essas 2 pessoas]]] [^{MS} que eu$^{O+1P+R-A}$ era ambas as pessoas]

Literal translation: - Right, now you tell me the most recent dream that you remember. - (I) think that (it)[1] was last week. (It)[1] was a dream that was as if I was in 2 bodies at

the same time. Like, I was a boy and a girl at the same time, and they were trying to meet. And (it)[1] was a very strange place, kind of a maze, and I couldn't find (?)[2]. And, sometimes, I was in the body of one person, and, other times, of another. And the entire dream was trying to find these two people, that I was both people.

Comments: [1] null 3Person non-referential expletive pronouns; [2]truncated sentence anomalous, unclear meaning.

- *Exp.2: WK – SZ group*

Int: Então me conta como foi teu dia ontem.
Part: [^{MS} *pro*$^{N+3P+R-A}$ foi bom]
Int: Fez o quê tanto ontem?
Part: [^{MS} *pro*$^{N+3P+R+A}$ foi bom]
Int: Foi bom?
Part: [^{RP} foi bom]
Int: O que você fez?
Part: [$^{MSTS+A}$ ir no shopping]
Int: Shopping. Que mais?
Part: [$^{MSTS+A}$ ir para o parque]
Int: Ir para o parque. Que mais?
Part: [$^{MSTS+A}$ brincar]

Literal translation: - Then tell me how your day was yesterday - (It)[1] was good. - What did you do so much yesterday? - (?)[2] was good. - Was good? - (?)was good[3]. - What did you do? - To go[4] to the shopping. -What else? - To go[4] to the park. - To the park. What else? – To[4] play.

Comments: [1]null 3Person non-anomalous pronouns; [2]null 3Person anomalous pronoun, its referent is missing; [3]phrase repetition; [4]truncated anomalous sentences, ungrammatical use of the infinite verbal form.

- *Exp2.: WK – CT group*

Int: Agora, conta para mim, o que você fez ontem.

Part: [MS eu O+1P+R-A acordei] [MS *pro* N+1P+R-A fui direto para o computador] [MS *pro* N+1P+R-A fiquei 12 horas no computador] [MS *pro* N+1P+R-A saí] [MS *pro* N+1P+R-A fui comer] [MS [ES quando *pro* N+1P+R-A terminei] *pro* N+1P+R-A escovei os dentes] [MS *pro* N+1P+R-A tomei banho] [MS *pro* N+1P+R-A fui para o colégio] [MS *pro* N+1P+R-A passei o quinto horário] [MS *pro* N+3P-R+EXPL teve uma aula extra [ES que foi com um dos professores [ESTS-A que vieram]] [MS *pro* N+1P+R-A fui para casa] [MS *pro* N+1P+R-A cheguei] [MS *pro* N+1P+R-A arrumei o quarto]. [MS *pro* N+1P+R-A entrei no computador de novo] [MS *pro* N+1P+R-A saí] [MS *pro* N+1P+R-A andei de bicicleta] [MS *pro* N+1P+R-A voltei] [MS *pro* N+1P+R-A li um pedaço de um livro] [MS e *pro* N+1P+R-A fui dormir]

Literal translation: - Now, tell me what you did yesterday. - I woke up, (I) went straight to the computer. (I) stayed 12 hours at the computer. (I) left, (I) went to eat. When (I) finished, (I) brushed my teeth, (I) took a shower. (I) went to school. (I) passed the fifth period. (There)[1] was an extra class, which was with one of the professors that came (to school)[2]. (I) went home. (I) arrived, (I) cleaned the room. (I) entered the computer again. (I) left, (I) rode a bicycle. (I) returned. (I) read part of a book and (I) went to bed.

Comments: [1]null 3Person non-referential expletive pronoun; [2]truncated non-anomalous sentences, meaning is clear.

4.2.3. Statistical Analysis

Our data consisted of speech narratives of different sizes; therefore, to control for the overall quantities of speech produced by each participant, all linguistic variables were quantified as the percentage of the occurrence of a target item per number of produced words (i.e., word count - WC) (see Table 2).

Parameter	Calculation	Variables

(a) Type of Sentence	percentage ratio of the total of sentences, matrix, embedded, truncated, and truncated anomalous and non-anomalous sentences per WC.	Sentence Count (SC)
		Matrix Sentences (MS)
		Embedded Sentences (ES)
		Truncated Sentences (TS)
		TS Anomalous (TS+A)
		TS Non-anomalous (TS-A)
(b) Total number of pronouns	percentage ratio of the total of subject pronouns per WC.	Pronoun Count (PC)
(c) Pronoun in function of phonological form	percentage ratio of overt and null subject pronouns per WC.	Overt Pronoun (OP)
		Null Pronoun (NP)
(d) Pronoun in function of person feature	percentage ratio of 1Person, 2Person and 3Person subject pronouns per WC.	1Person Pronoun (1P)
		2Person Pronoun (2P)
		3Person Pronoun (3P)
(e) Null 3Person subject pronouns in function of referentiality	percentage ratio of 3Person null referential and non-referential subject pronouns per WC.	Null 3P Referential (N+3P+R)
		Null 3P Non-Referential (N+3P-R)
(f) 3Person referential pronouns in function of referential anomaly	percentage ratio of null 3Person referential anomalous and non-anomalous, and of overt 3Person referential anomalous and non-anomalous subject pronouns per WC.	Null 3P Referential Anomalous (N+3P+R+A)
		Null 3P Referential Non-anomalous (N+3P+R-A)
		Overt 3P Referential Anomalous (O+3P+R+A)
		Overt 3P Referential Non-anomalous (O+3P+R-A)

Table 2: Description of the dependent linguistic variables

All statistical analyses were conducted on the Statistical Package for the Social Sciences (SPSS) version 27 for MacBook. Data of experiment 1 and 2 were analyzed separately, and the statistical analyses of both experiments were conducted in four stages. Stage 1: Linguistic variables (Table 1 above) were calculated for DM and WK narratives separately, and significant group effects (SZ x CT) of the calculated linguistic variables were determined. Stage 2: Data from DM and WK narratives were summed up, linguistic variables were recalculated, and significant group effects were

redetermined. Stage 3: Correlation analyses between the linguistic variables with significant group effect obtained in stage 2 and the scores of the psychometric evaluations were conducted. Stage 4: Significant narrative (DM x WK) effects were determined within group (SZ and CT).

Most of our data were not normally distributed, thus, Mann–Whitney *U* test comparisons were conducted to determine whether there was significant group and narrative differences. Bonferroni adjustment to P level of 0.05 was applied per parameter, whenever necessary, considering the number of variables analyzed to avoid possible familywise error rate (Bender and Lange, 2001; Albers, 2019). Thus, after Bonferroni correction, the level of significance varied according to the number of variables within each parameter (parameters: (a) $p = 0.008$; (b) $p = 0.05$; (c) $p = 0.025$; (d) $p = 0.017$; (e) $p = 0.025$; and (f) $p = 0.013$). Eta squared (η^2) was calculated (based on Z values obtained for Mann Whitney 2 independent samples test) and used to quantify effect sizes whenever group differences reached significance at level of 0.05. According to Cohen's (1988) suggested interpretation of effect size magnitude, η^2 values are considered small ($\eta^2 < 0.01$), medium ($0.01 < \eta^2 < 0.25$), and large ($\eta^2 > 0.25$). Spearman' rho correlation coefficient was used to calculate correlations between linguistic variables with significant group differences at the level of 0.05 and the scores of psychometric scales. After Bonferroni adjustment, P level of significance was set at 0.01.

4.3. Experiment 1

4.3.1. Participants and narrative samples

As presented in section 4.1, the basis for this experiment was a corpus of interview narratives previously collected by Dra. Natalia Bezerra Mota. The group of subjects with SZ consisted of outpatients of a local mental clinic (Ambulatório de Pesquisas em Psiquiatria IC (HUOL), Federal University of Rio Grande do Norte) and inpatients of a local mental hospital (Enfermaria de Psiquiatria Hospital João Machado (HUM), Natal/Rio Grande do Norte). CT subjects were recruited in their working

places (Natal/Rio Grande do Norte). Exclusion criteria was based on the cause of psychosis being caused by neurological disorder or induced by psychotropic substances, on lack of any dream memory, and on refusal to participate in the experiment. All participants were voluntarily recruited and signed a consent form.

Participants were independently diagnosed by the standard Structured Clinical Interview for DSM-IV rating SCID (Portuguese version), composing two groups of participants: subjects with SZ and CT subjects, with them all having been examined for major changes in state and level of consciousness (e.g., drowsiness), for signs of autopsychic and allopsychic disorientation (e.g., inability to remember name, age, spatial localization), and for reduced mnemonic and cognitive capacity. During the interviews, the "Positive and Negative Scale" (PANSS) and the "Brief Psychiatric Rating Scale" (BPRS) were applied to all participants to quantify symptoms at the time of the interview, including psychosis (see Mota et al., 2014).

This corpus of narratives consists of reports from 20 patients diagnosed with schizophrenia, medicated and out of the acute psychotic phase at the onset of the study, and 20 non-psychotic individuals with depression (N=5), generalized anxiety disorder (N=2), one past episode of post-traumatic stress disorder (N=1), various symptoms of mood/anxiety disorder without reaching diagnostic criteria (N=11), plus one healthy individual.[3] Of the group of patients with schizophrenia, 85% were under typical antipsychotic medication and 25% were under atypical antipsychotic medication, 15% were taking a mood stabilizer, and 25% were taking benzodiazepine. Of the non-psychotic CT group, 15% were taking benzodiazepine, and 20% were taking antidepressants. Socio-demographic and psychiatric information is given in Table 3.

[3] It has been correctly pointed out that including people with depression and anxiety in the control group might be a limitation of our study. However, we would like to emphasize that other studies have included individuals with anxiety and depression in the control group (Docherty et al., 2013) arguing for an advantage in comparing patients with schizophrenia and non-psychotic mixed control subjects, based on data showing that patients with schizophrenia can also have depression and anxiety. In fact, it has been reported that 1Person pronoun usage distinguished patients with schizophrenia from the group of individuals showing non-psychotic symptoms, such as depression and anxiety, and the group of healthy individuals (Fineberg et al., 2016). Moreover, a study of social media written-texts comparing mixed SZ and CT groups (both groups containing subjects with depression and anxiety), showed that depression and anxiety did not have significant effect on syntactic complexity. In other words, these non-psychotic symptoms did not affect the performance of the SZ group in terms of structural impoverishment (Moreira e Silva, 2020).

Demographic Characteristics		Subjects with SZ	CT subjects	*P* values (SZ x CT)
Age (years)		34.79 ± 9.60	35.05 ± 11.21	0.978
Sex	Male Female	(80%) (20%)	(45%) (55%)	0.022
Years of Education		6.85 ± 4.37	9.80 ± 4.35	0.052
Marital status	Married Previously Married Never Married	(20%) (25%) (55%)	(65%) (10%) (25%)	0.016
Psychiatric Assessment				
Scales	PANSS BPRS	69 ± 16.59 16.40 ± 7.26	36.15 ± 6.43 3.95 ± 3.72	< 0.001 < 0.001
Medication status	YES NO	100% 0	26% 74%	< 0.001
Age of Onset		22.5 ± 7.67	36.8 ± 7.96	
Disease Duration		12 ± 8.3	1.24 ± 1.4	

Table 3: Participants' background information. Mean and standard deviation of continuous variables - age (in years), years of education, total score of PANSS and BPRS, age of onset, and disease duration -, and percentage frequency of categorical variables - sex, marital status, and medication status (yes or no) for the groups studied. *P* values of Mann-Whitney *U* test or Chi-square test between SZ and CT groups.

The sample of narratives of the present analysis is composed by transcribed interviews of the subjects with SZ and CT subjects of Mota et al. (2014): 40 DM reports (20 of the SZ group and 20 of the CT group), and 40 WK reports (20 of the SZ group and 20 of the CT group) of different sizes. The DM reports were elicited by the prompting request "Please report a recent dream", and the WK reports by the prompting request "Please report your waking activities immediately before that dream".

4.3.2. Results

Stage 1: between-group analyses of DM and of WK narratives

The SZ group, compared to the CT group, produced significant smaller number of words in the DM narrative ($p < 0.001$); however, no significant difference in the number of words was found in WK narratives ($p = 0.640$).

Mann-Whitney *U* comparisons showed significant differences of sentence count, matrix sentence, truncated sentence non-anomalous, pronoun count and null pronoun in DM narratives only (see Table 4). After Bonferroni adjustment, sentence count and truncated non-anomalous sentences were not significant. The effect size magnitude (η^2) values reported in Table 4 correspond to medium effect.

Between-Group Differences in Dream Narratives Exp.1 (n = 40)

Parameter	Variable	SZ Mean (SD)	CT Mean (SD)	Mann-Whitney U	Z	p^a	Effect size (η^2)
(a) Type of sentence	SC	23.02 (3.5)	20.55 (1.9)	107.000	-2.516	0.011[b]	0.16
	MS	16.65 (2.9)	13.74 (2.3)	84.000	-3.138	0.001[b]	0.25
	ES	6.37 (3.1)	6.81 (2.0)	178.000	-0.595	0.565[b]	
	TS	1.49 (1.3)	1.32 (0.9)	197.500	-0.068	0.947[b]	
	TS+A	1.43 (1.3)	0.94 (0.9)	160.000	-1.086	0.289[b]	
	TS-A	0.06 (0.2)	0.38 (0.4)	109.000	-2.958	0.013[b]	0.22
(b) Total of Pronouns	PC	17.35 (5.3)	15.18 (2.5)	124.000	-2.056	0.040[b]	0.11
(c) Phonological Form	NP	10.15 (5.3)	7.28 (2.4)	115.500	-2.286	0.021[b]	0.13
	OP	7.20 (2.8)	7.9 (2.1)	160.000	-1.082	0.289[b]	
(d) Person Feature	1P	10.32 (4.2)	9.05 (3.3)	175.500	-0.663	0.512[b]	
	2P	0.64 (0.8)	0.65 (0.6)	172.500	-0.769	0.461[b]	
	3P	5.96 (3.3)	5.42 (2.3)	187.000	-0.352	0.738[b]	
(e) Null 3P Referentiality	N3P+R	2.65 (2.2)	2.04 (1.2)	183.000	-0.461	0.659[b]	
	N3P-R	2.16 (2.2)	2.03 (1.3)	189.000	-0.298	0.779[b]	
(f) 3P Referential Anomaly	N3PR+A	0.90 (1.3)	0.53 (0.6)	189.000	-0.315	0.779[b]	
	N3PR-A	1.75 (2.2)	1.52 (1.0)	170.500	-0.801	0.429[b]	
	O3PR+A	0.39 (0.6)	0.40 (1.3)	170.000	-1.031	0.429[b]	
	O3PR-A	0.87 (1.4)	0.95 (0.9)	156.500	-1.225	0.242[b]	

*Mean difference significant at the 0.05 level.
a. One-tailed *p*-values.
b. Not corrected for ties.

Table 4: Mann-Whitney *U* comparisons between-group in production in dream narratives. Variables with significant difference are highlighted. P values marked in red indicate significance after Bonferroni adjustment.

On the other hand, there were significant differences of 3Person pronoun, null 3Person referential pronoun and null 3Person referentially non-anomalous pronoun in WK narratives only (see Table 5). After Bonferroni adjustment, null 3Person

referentially non-anomalous pronouns were not significant. The effect size magnitude (η^2 values) reported in Table 5 correspond to medium effect.

Between-Group Differences in Waking Narratives Exp.1 (n = 40)

Parameter	Variable	SZ Mean (SD)	CT Mean (SD)	Mann-Whitney U	Z	p^a	Effect size (η^2)
(a) Type of sentence	SC	23.29 (3.6)	21.59 (5.8)	149.000	-1.380	0.174[b]	
	MS	18.21 (4.7)	16.84 (6.2)	150.500	-1.339	0.183[b]	
	ES	5.08 (3.4)	4.72 (3.2)	193.000	-0.189	0.862[b]	
	TS	1.39 (1.5)	1.32 (1.5)	199.500	-0.014	0.989[b]	
	TS+A	1.03 (1.3)	1.06 (1.5)	200.000	0.000	1.000[b]	
	TS-A	0.36 (0.7)	0.26 (0.6)	183.000	-0.605	0.659[b]	
(b) Total of Pronouns	PC	17.96 (4.7)	16.72 (6.8)	173.500	-0.717	0.478[b]	
(c) Phonological Form	NP	12.26 (6.4)	11.05 (7.2)	167.000	-0.893	0.383[b]	
	OP	5.71 (3.4)	5.67 (3.8)	193.000	-0.190	0.862[b]	
(d) Person Feature	1P	11.94 (6.4)	13.69 (7.3)	160.500	-1.069	0.289[b]	
	2P	0.24 (0.5)	0.45 (0.7)	171.000	-0.943	0.445[b]	
	3P	5.58 (3.5)	2.58 (2.2)	86.000	-3.087	0.002[b]	0.24
(e) Null 3P Referentiality	N3P+R	3.24 (3.8)	0.84 (1.3)	101.500	-2.711	0.007[b]	0.19
	N3P-R	1.22 (1.4)	0.71 (0.9)	163.500	-1.036	0.327[b]	
(f) 3P Referential Anomaly	N3PR+A	0.87 (1.6)	0.24 (.4)	177.000	-0.748	0.547[b]	
	N3PR-A	2.37 (3.2)	0.60 (1.0)	117.500	-2.307	0.024[b]	0.14
	O3PR+A	0.38 (0.8)	0.34 (0.9)	183.500	-0.639	0.659[b]	
	O3PR-A	0.73 (1.2)	0.68 (0.9)	200.000	0.000	1.000[b]	

*Mean difference significant at the 0.05 level.
a. One-tailed *p*-values.
b. Not corrected for ties.

Table 5: Mann-Whitney *U* comparisons between-group in production in waking narratives. Variables with significant difference are highlighted. P values marked in red indicate significance after Bonferroni adjustment.

DM narratives of the SZ group, compared to the CT group, showed significant higher proportion of sentence count (Figure 4 (a)) and matrix sentences (Figure 4 (b)), lower proportion of truncated non-anomalous sentences (Figure 4 (c)), and higher proportion of pronoun count (Figure 4 (d)) and of null pronouns (Figure 4 (e)).

Dream narratives

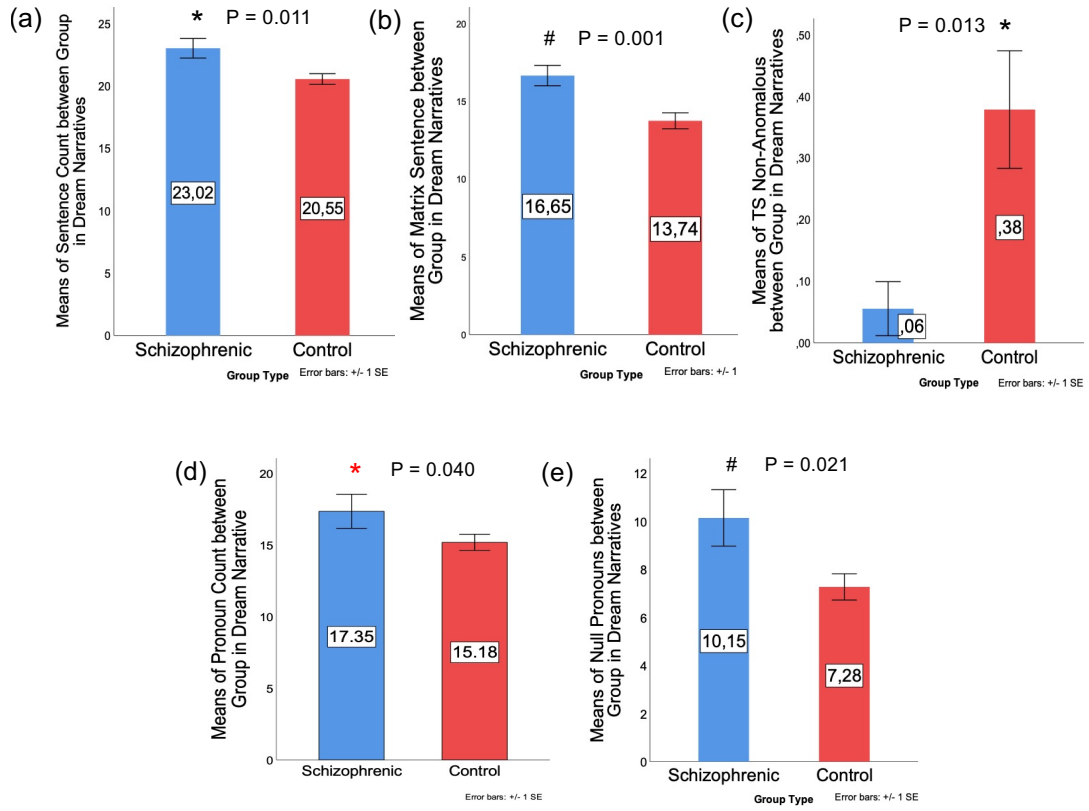


Figure 4: Means of variables with significant group differences in dream narratives: (a) sentence count, (b) matrix sentences, (c) truncated sentences non-anomalous, (d) pronoun count, and (e) null pronouns. Sentence and pronoun variables were calculated based on the percentage ratio of the total number of words in the dream narratives. (∗) P is significant at the 0.05 level, and (#) P is significant after Bonferroni correction. Note that, as parameter (b) consists of one variable only, no adjustment to the level of significance was necessary for the pronoun count variable, thus, it was kept at 0.05.

In WK narratives, we found significantly higher proportion of 3Person pronouns (Figure 5 (a)), of null 3Person referential pronouns (Figure 5 (b)), and of null 3Person referentially non-anomalous pronouns (Figure 5 (c)) in the SZ group than in the CT group.

Waking narratives

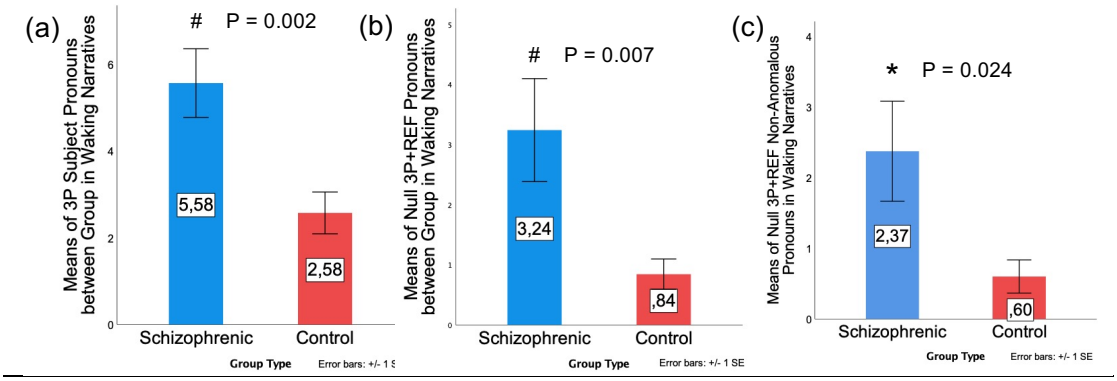


Figure 5: Means of variables with significant group differences in waking narratives: (a) 3Person pronoun, (b) null 3Person referential pronoun, and (c) null 3Person referentially non-anomalous pronoun. Pronoun variables were calculated based on the percentage ratio of the total number of words in the waking narratives. (∗) P is significant at the 0.05 level, and (#) P is significant after Bonferroni correction.

Stage 2: between-group analyses of the sum of narratives

There was significant group difference in number of words (p = 0.003), with the SZ group producing fewer words than the CT group.

Results from Stage 2 analysis replicated the results of Stage 1 obtained in DM narratives only, i.e., only the variables with significant group difference in DM narratives (sentence count, matrix sentence, truncated sentence non-anomalous, pronoun count, and null pronoun) kept their significance (see Table 6). After Bonferroni adjustment, the difference of truncated non-anomalous sentences was not significant. The effect size magnitude (η^2 values) reported in Table 6 for sentence count and matrix sentences correspond to large effect, while for truncated non-anomalous sentences, pronouns count, and null pronouns, to medium effect size.

Although no significant differences of 3Person, null 3Person referential, and null 3Person referentially non-anomalous pronouns were found in stage 2, these variables kept the trend of WK narratives, where group differences reached significant P levels.

Between-Group Differences in the Sum of Narratives (Exp.1 / n = 40)

Parameter	Variable	SZ Mean (SD)	CT Mean (SD)	Mann-Whitney U	Z	p^a	Effect size (η^2)
	SC	23.15 (2.7)	20.61 (1.9)	76.000	-3.354	0.000[b]	0.28

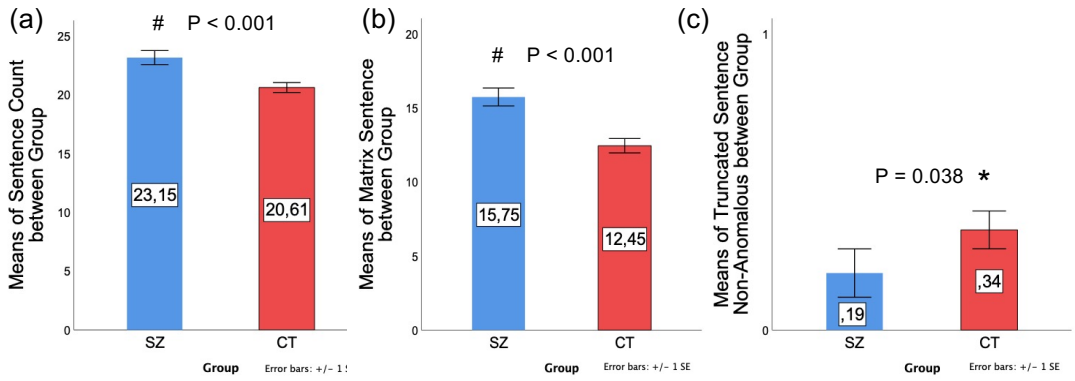
(a) Type of sentence	MS	15.75 (2.7)	12.45 (2.2)	54.000	-3.949	0.000[b]	0.39
	ES	5.70 (2.0)	5.77 (1.6)	191.000	-0.243	0.820[b]	
	TS	1.47 (1.1)	1.32 (.8)	189.000	-0.298	0.779[b]	
	TS+A	1.27 (1.1)	0.98 (0.7)	178.000	-0.596	0.565[b]	
	TS-A	0.19 (0.4)	0.34 (0.3)	123.000	-2.204	0.038[b]	0.12
(b) Total of Pronouns	PC	17.74 (4.0)	15.27 (2.1)	110.000	-2.435	0.014[b]	0.15
(c) Phonological Form	NP	11.03 (4.6)	7.85 (2.4)	103.000	-2.624	0.008[b]	0.18
	OP	6.71 (2.4)	7.42 (1.8)	169.000	-0.839	0.414[b]	
(d) Person Feature	1P	10.92 (3.8)	9.98 (2.4)	185.000	-0.406	0.698[b]	
	2P	0.49 (0.6)	0.58 (0.5)	171.000	-0.798	0.445[b]	
	3P	6.01 (3.1)	4.67 (1.8)	154.000	-1.245	0.221[b]	
(e) Null 3P Referentiality	N3P+R	2.99 (2.4)	1.67 (0.9)	140.000	-1.625	0.108[b]	
	N3P-R	1.80 (1.7)	1.74 (1.2)	190.000	-0.271	0.799[b]	
	N3PR+A	0.96 (1.1)	0.46 (0.5)	171.000	-0.802	0.445[b]	
(f) 3P Referential Anomaly	N3PR-A	2.04 (2.2.)	1.22 (0.7)	172.000	-0.758	0.461[b]	
	O3PR+A	0.39 (.6)	0.37 (1.0)	175.500	-0.748	0.512[b]	
	O3PR-A	0.87 (1.1)	0.88 (0.7)	183.000	-0.465	0.659[b]	

*Mean difference significant at the 0.05 level.
a. One-tailed *p*-values.
b. Not corrected for ties.

Table 6: Mann-Whitney *U* comparisons between-group in production in the sum of narratives. Variables with significant differences are highlighted. P values marked in red indicate significance after Bonferroni adjustment.

The SZ group SZ compared to the CT group, produced significantly higher proportion of sentence count (Figure 6 (a)) and matrix sentences (Figure 6 (b)), lower proportion of truncated non-anomalous sentences (Figure 6 (c)), and higher proportion of pronoun count (Figure 6 (d)) and null pronouns (Figure 6 (e)).

Sum of narratives



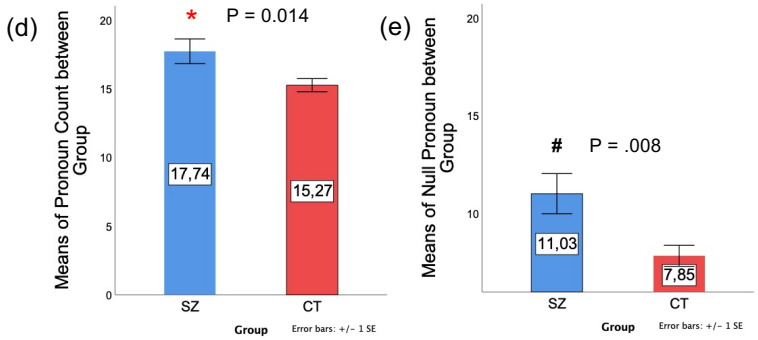


Figure 6: Means of variables with significant group differences in the sum of narratives: (a) sentence count, (b) matrix sentences, (c) truncated sentence non-anomalous, (d) pronoun count, and (e) null pronouns. Sentence and pronoun variables were calculated based on the percentage ratio of the total number of words in both narratives together. (∗) P is significant at the 0.05 level, and (#) P is significant after Bonferroni correction. Note that, as parameter (b) consists of one variable only, no adjustment to the level of significance was necessary for the pronoun count variable, thus, it was kept at 0.05.

Stage 3: Correlations

There were moderate significant correlations between the five linguistic variables with significant group effect (sentence count, matrix sentences, truncated non-anomalous sentences, pronoun count, and null pronoun) and BPRS and PANSS psychometric scales scores, as shown in Table 7.

Spearman's rho Correlations (Exp.1 / n=40)

		SC	MS	TS-A	PC	NP
BPRS	Cor. Coef.	0.332*	0.445**	-0.209	0.323*	0.280*
	Sig. (1-tailed)	0.018	0.002	0.098	0.021	0.040
Total PANSS	Cor. Coef.	0.360*	0.516**	-0.250	0.315*	0.340*
	Sig. (1-tailed)	0.011	0.000	0.060	0.024	0.016
Positive PANSS	Cor. Coef.	0.507**	0.554**	-0.310*	0.488**	0.454**
	Sig. (1-tailed)	0.000	0.000	0.026	0.001	0.002
Negative PANSS	Cor. Coef.	0.298*	0.534**	-0.290*	0.280*	0.427**
	Sig. (1-tailed)	0.031	0.000	0.035	0.040	0.003
General PANSS	Cor. Coef.	0.253	0.378**	-0.170	0.180	0.188
	Sig. (1-tailed)	0.058	0.008	0.147	0.134	0.123

**. Correlation is significant at the 0.01 level (1-tailed).
*. Correlation is significant at the 0.05 level (1-tailed).

Table 7: Spearman's rho correlations of variables with significant group difference (sentence count, matrix sentence, truncated non-anomalous sentence, pronoun count and null pronoun) and the scores of BPRS and PANNS (Total, Positive, Negative, and General)**.** Significant correlations are highlighted.

Matrix sentences showed more significant correlations compared to the other 4 linguistic variables. It correlated with the BPRS scores, and with the PANNS total,

positive, negative, and general scores, while sentence count correlated with the PANNS positive scores, null pronouns correlated with the PANSS positive and negative scores, and pronoun count correlated with the PANNS positive scores only. There was no significant correlation between truncated non-anomalous sentences and the scores of the psychometric scales.

Stage 4: between-narrative analysis within group

Although both groups produced more words in DM than in WK narratives, there was significant narrative difference of the total number of words within the CT group only (CT subjects: $p < 0.001$, and subjects with SZ: $p = 0.398$).

Subjects with schizophrenia

Statistical analysis within the SZ group showed no significant narrative difference of the variables quantified in the present study (see Table 8).

Within-Group Differences in Production of Subjects with Schizophrenia (Exp.1 / n = 40)

Parameter	Variable	DM Mean (SD)	WK Mean (SD)	Mann-Whitney U	Z	p^a
(a) Type of sentence	SC	23.02 (3.5)	23.29 (3.6)	195.000	-0.135	0.904[b]
	MS	16.65 (2.9)	18.21 (4.7)	154.500	-1.231	0.221[b]
	ES	6.37 (3.10	5.08 (3.4)	142.000	-1.569	0.121[b]
	TS	1.49 (1.3)	1.39 (1.5)	185.000	-0.413	0.698[b]
	TS+A	1.43 (1.3)	1.03 (1.3)	156.000	-1.223	0.242[b]
	TS-A	0.06 (0.2)	.36 (0.7)	157.000	-1.665	0.253[b]
(b) Total of Pronouns	PC	17.35 (5.3)	17.96 (4.7)	192.500	-0.203	0.841[b]
(c) Phonological Form	NP	10.15 (5.2)	12.26 (6.4)	161.500	-1.041	0.301[b]
	OP	7.20 (2.8)	5.71 (3.4)	160.500	-1.069	0.289[b]
(d) Person Feature	1P	10.32 (4.2)	11.94 (6.4)	165.500	-0.933	0.355[b]
	2P	0.64 (.8)	0.24 (.5)	142.000	-1.804	0.121[b]
	3P	5.96 (3.3)	5.58 (3.5)	186.500	-.365	0.718[b]
(e) Null 3P Referentiality	N3P+R	2.65 (2.2)	3.24 (3.8)	199.500	-0.014	0.989[b]
	N3P-R	2.16 (2.2)	1.22 (1.4)	142.000	-1.586	0.121[b]
(f) 3P Referential Anomaly	N3PR+A	0.90 (1.3)	0.87 (1.6)	183.500	-0.504	0.659[b]
	N3PR-A	1.75 (2.2)	2.37 (3.2)	186.000	-0.384	0.718[b]
	O3PR+A	0.39 (0.6)	0.38 (0.8)	183.500	-0.551	0.659[b]
	O3PR-A	0.87 (1.4)	0.73 (1.2)	195.500	-0.135	0.904[b]

*Mean difference significant at the 0.05 level.
a. One-tailed *p*-values.
b. Not corrected for ties.

Table 8: Mann-Whitney *U* comparisons within the group of subjects with schizophrenia, with narrative type as grouping variable.

Control subjects

Contrastingly, within the CT group, significant narrative differences were found. As Table 9 shows, there was significant differences at the sentence level, with significant narrative difference of matrix sentences and of embedded sentences, and at the pronoun level, with significant narrative difference of null pronouns, 1Person pronouns, 3Person pronouns, null 3Person referential pronouns, null 3Person non-referential pronouns, and null 3Person referentially non-anomalous pronouns. After Bonferroni adjustment (parameter (a): $p = 0.008$), the differences in matrix sentences and embedded sentences were not significant. The effect size magnitude (η^2) values reported on Table 9 for 3Person, null 3Person referential, null 3Person non-referential, and null 3Person referentially non-anomalous pronouns correspond to large effect; for null pronouns, and 1Person pronouns, to medium effect; and, for matrix sentences and embedded sentences, to small effect size.

Within-Group Differences in Production of Control Subjects (Exp.1 / n = 40)

Parameter	Variable	DM Mean (SD)	WK Mean (SD)	Mann-Whitney U	Z	*p*[a]	Effect size (η^2)
(a) Type of sentence	SC	20.55 (1.9)	21.59 (5.8)	178.500	-0.582	0.565[b]	
	MS	13.74 (2.3)	16.84 (6.2)	120.500	-2.151	0.030[b]	0.12
	ES	6.81 (2.0)	4.72 (3.2)	119.000	-2.191	0.028[b]	0.12
	TS	1.32 (0.9)	1.32 (1.5)	181.500	-0.502	0.620[b]	
	TS+A	0.94 (0.9)	1.06 (1.5)	169.000	-0.853	0.414[b]	
	TS-A	0.38 (0.4)	0.26 (0.6)	178.500	-0.582	0.565[b]	
(b) Total of Pronouns	PC	15.18 (2.5)	16.72 (6.8)	158.000	-1.136	0.265[b]	
(c) Phonological Form	NP	7.28 (2.4)	11.05 (7.2)	111.500	-2.394	0.015[b]	0.15
	OP	7.90 (2.1)	5.67 (3.8)	133.000	-1.813	0.072[b]	
(d) Person Feature	1P	9.05 (3.3)	13.69 (7.3)	112.000	-2.380	0.017[b]	0.15
	2P	0.65 (0.6)	0.45 (0.7)	149.000	-1.447	0.174[b]	
	3P	5.42 (2.3)	2.58 (2.2)	61.000	-3.762	0.000[b]	0.36
	N3P+R	2.04 (1.2)	.84 (1.3)	76.000	-3.390	0.001[b]	0.29

(e) Null 3P Referentiality	N3P-R	2.03 (1.3)	0.71 (0.9)	74.500	-3.431	0.000[b]	0.30
(f) 3P Referential Anomaly	N3PR+A	0.53 (0.6)	0.24 (0.4)	141.000	-1.748	0.114[b]	
	N3PR-A	1.52 (1.0)	0.60 (1.0)	78.000	-3.345	0.001[b]	0.29
	O3PR+A	0.40 (1.3)	0.34 (0.9)	192.500	-0.306	0.841[b]	
	O3PR-A	0.95 (0.9)	0.68 (0.9)	153.000	-1.323	0.211[b]	

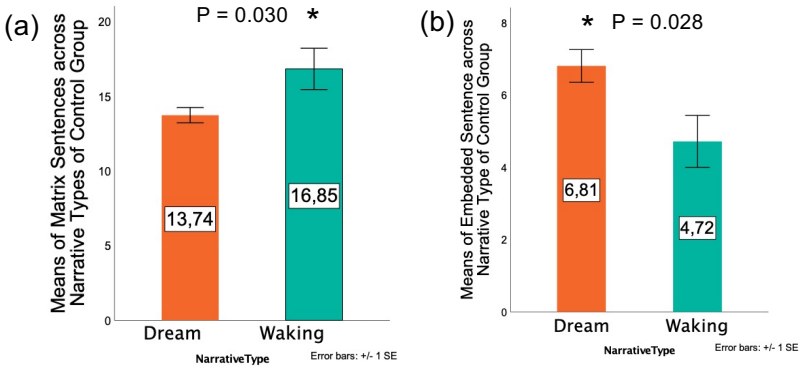
*Mean difference significant at the 0.05 level.
a. One-tailed *p*-values.
b. Not corrected for ties.

Table 9: Mann-Whitney *U* comparisons within control group, with narrative type as grouping variable. Variables with significant difference are highlighted. P values marked in red indicate significance after Bonferroni adjustment.

As Figure 7 shows, at the sentence level, the CT group produced significant lower proportion of matrix sentences (Figure 7 (a)) and higher proportion of embedded sentences (Figure 7 (b)) in DM than in WK narratives.

At the pronoun level, the CT group produced significantly lower proportions of null (Figure 7 (c)) and 1Person (Figure 7 (d)), and higher proportion of 3Person (Figure 7 (e)) pronouns in DM than in WK narratives.

At the pronoun referential level, the CT group produced significant higher proportion of null 3Person referential (Figure 7 (f)), null 3Person non-referential (Figure 7 (g)), and null 3Person referential non-anomalous (Figure 7 (h)) pronouns in DM than in WK narratives.



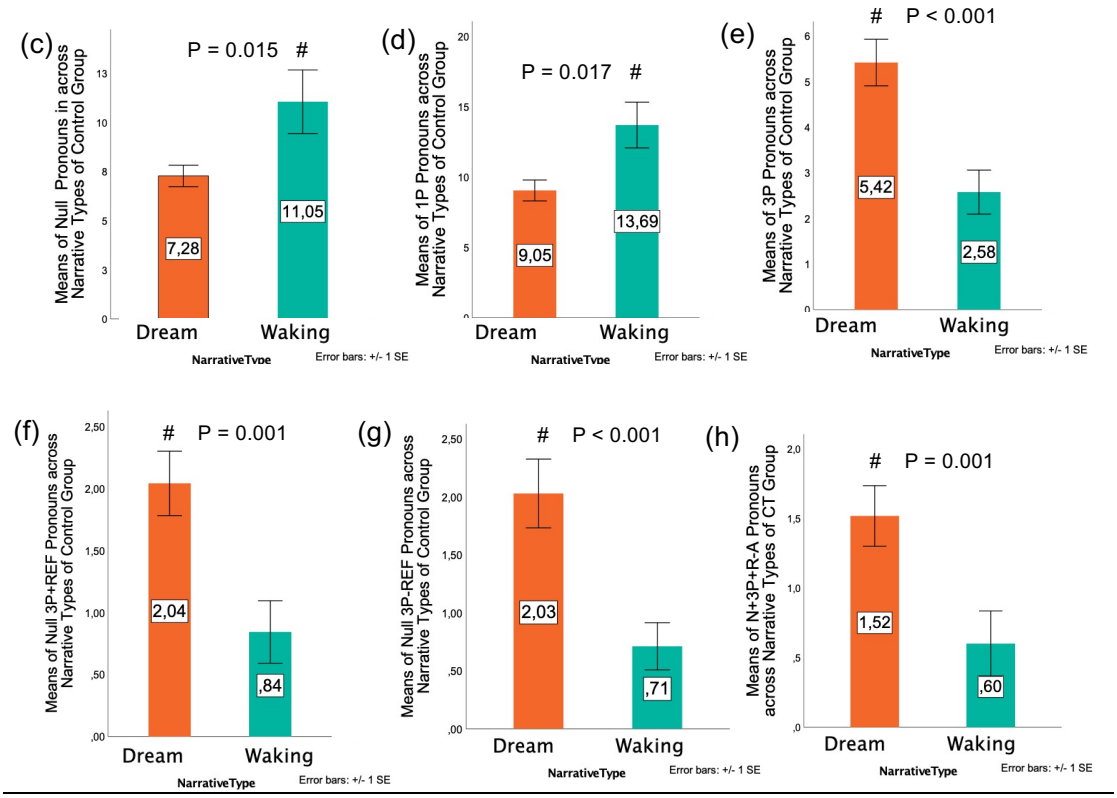


Figure 7: Means of variables with significant narrative differences within control group: (a) matrix and (b) embedded sentences, and (c) of null, (d) 1Person, (e) 3Person, (f) null 3Person referential, (g) null 3Person non-referential, and (h) null 3Person referential non-anomalous pronouns produced by CT subjects across narrative types. Sentence and Pronoun variables were calculated based on the percentage ratio of the total number of words. (∗) P is significant at the 0.05 level, and (#) P is significant after Bonferroni correction.

4.3.2.1. Summary of the results obtained in experiment 1

The main findings of Exp. 1 are the significant differences in proportions of matrix sentences, truncated non-anomalous sentences, and null pronouns found in DM narratives, which kept their significant group difference when both DM and WK narratives were summed up. Significant differences in the production of 3Person, null 3Person referential, and null 3Person referentially non-anomalous pronouns were found in WK narratives only, although, in the sum of narratives, they kept the same trend, with the SZ group showing higher means. Table 9 summarizes the results of between-group comparisons, as well as the significant correlations with the psychometric scores of Exp.1.

Linguistic variables with significant differen	DM	WK	DM+WK	Significant Correlation
Higher proportion of sentences in SZ	p= 0.011		p= 0.001#	PANSS positive
Higher proportion of matrix sentences in SZ	p= 0.001#		p < 0.001#	BPRS and PANSS total, positive, negative and general
Lower proportion of non-anomalous truncated sentences in SZ	p= 0.013		p= 0.038	
Higher proportion of pronoun count in SZ	p= 0.040#		p= 0.014#	PANSS positive
Higher proportion of null pronouns in SZ	p= 0.021#		p= 0.008#	PANSS positive and negative
Higher proportion of 3P pronouns in SZ		p= 0.002#		
Higher proportion of null 3P referential pronouns in SZ		p= 0.007#		
Higher proportion of null 3P referentially non-anomalous pronouns in SZ		p= 0.024		

Table 10: Summary of between-group significant differences of the linguistic variables obtained in dream, in waking, and in the sum of narratives, and the significant correlations found between these linguistic variables and the scores obtained in BPRS and PNSS. (#) Significant P values after Bonferroni adjustment.

There were significant narrative differences within the CT group only. Table 11 summarizes the significant differences between narrative effects of linguistic variables of Exp.1.

Linguistic variables with significant difference	SZ	CT
Lower proportion of matrix sentences in DM		p = 0.030
Higher proportion of embedded sentences in DM		p = 0.028
Lower proportion of null pronouns in DM		p = 0.015#
Lower proportion of 1P pronouns in DM		p = 0.017#
Higher proportion of 3P pronouns in DM		p < 0.001#
Higher proportion of null 3P referential pronouns in DM		p = 0.001#
Higher proportion of null 3P non-referential pronouns in DM		p < 0.001#
Higher proportion of null 3P referentially non-anomalous pronouns in DM		p = 0.001#

Table 11: Summary of within-group results found between dream and waking narratives in Exp.1. (#) Significant P values after Bonferroni adjustment.

4.4. Experiment 2

4.4.1. Participants and narrative samples

As mentioned in 4.1, the corpus of narratives of our second experiment consists of the complete transcripts of the interviews of both the SZ and the CT groups collected by Mota et al. (2017) for the purpose of a graph-theoretical analysis.

All subjects with SZ were recruited during first clinical contact for recent-onset psychosis in a local public child psychiatric clinic (CAPSI-Natal/RN) and were interviewed during regular psychiatric anamnesis. After the interview, they were psychometrically evaluated using PANSS and BPRS. Disorder and diagnosis were established 6 months after the interview by an interdisciplinary team, according to DSM IV criteria (Applying SCID). Of the SZ group, 55% of the subjects were under typical antipsychotic medication and 82% under atypical antipsychotic medication, 9% were taking mood stabilizers, 9% were taking benzodiazepine, and 9% were taking antidepressants. Exclusion criteria was based on the psychosis being drug-related or caused by neurological disorders.

Matched healthy CT subjects were recruited in local schools and interviewed during regular school hours in public local schools (Natal/RN). Exclusion criteria was based on not having any psychiatric symptom or diagnosis.

All participants were asked to produce a DM report, then a WK report of their previous day. Next, they were instructed to imagine and report a story about an image displayed on a computer screen.[4] All reports were limited to 30 sec. This means that whenever participants stopped talking before reaching the 30 sec. limit, the interviewer prompted them to keep talking until the time limit was reached.

Our final sample consisted of DM and WK narratives produced by 31 subjects, 11 of which were diagnosed with SZ and 20 healthy CT subjects. Socio-demographic information of all 31 subjects and the psychiatric information of the group of subjects with SZ are given in Table 12.

[4] Participants were shown three types of affective images: highly negative, highly positive, and neutral.

Demographic Characteristics		Subjects with SZ	CT subjects	*P values* (SZ x CT)
Age (years)		14.64 ± 2.69	15.80 ± 3.30	0.476
Sex	Male Female	(82%) (18%)	(55%) (45%)	0.135
Years of Education		5.73 ± 2.45	8.35 ± 2.54	0.016
Psychiatric Assessment				
Scales	BPRS PANSS	16.73 ± 5.88 69.27 ± 13.91		
Disease Duration (days)		339.36 ± 244.80		

Table 12: Participants' background information. Mean and standard deviation of continuous variables - age (in years), years of education, total score of PANSS and BPRS, and disease duration (in days) -, and percentage frequency of sex for the groups studied. *P* values of Mann-Whitney *U* test or Chi-square test between SZ and CT groups.

All DM and WK narratives investigated in Mota et al. (2017), except for one narrative of a CT subject whose transcript was not available, were analyzed in the present study. Although we tagged and statistically analyzed all image reports, we will not report the results in the present study, for the results did not add to the present discussion.

All examined narratives were syntactically annotated and statistically analyzed according to the established parameters (see subsection 4.2.1).

4.4.2. Results

Stage 1: Between-group analysis of dream and of waking narratives

The analyses of the DM and of the WK narratives produced by the SZ group in Exp.2 showed significantly fewer words compared to the narratives produced by the CT group (DM: $p = 0.003$, and WK: $p = 0.016$).

Mann-Whitney *U* comparisons of DM narrative data showed no significant group difference (Table 13).

Between-Group Differences in Dream Narratives (Exp.2 / n = 31)						
Parameter	Variable	SZ Mean (SD)	CT Mean (SD)	Mann-Whitney U	Z	p^a
(a) Type of sentence	SC	21.40 (6.0)	22.20 (4.7)	83.500	-1.095	0.279[b]
	MS	17.08 (5.7)	16.20 (4.6)	109.500	-0.021	0.984[b]
	ES	4.32 (3.2)	6.00 (3.1)	81.000	-1.200	0.244[b]
	TS	4.07 (9.3)	1.07 (1.2)	108.000	-0.088	0.951[b]
	TS+A	3.84 (9.3)	0.56 (.9)	101.500	-0.410	0.730[b]
	TS-A	0.22 (.7)	0.50 (1.0)	94.000	-0.958	0.528[b]
(b) Total of Pronouns	PC	15.24 (4.9)	14.27 (4.7)	91.500	-0.764	0.451[b]
(c) Phonological Form	NP	7.85 (5.2)	6.64 (3.6)	90.500	-0.805	0.427[b]
	OP	7.39 (5.0)	7.63 (3.5)	105.500	-0.186	0.855[b]
(d) Person Feature	1P	10.99 (4.8)	9.50 (5.0)	89.500	-0.847	0.403[b]
	2P	1.14 (1.7)	0.05 (0.2)	73.500	-2.353	0.133[b]
	3P	3.11 (2.7)	4.71 (4.2)	85.500	-1.018	0.317[b]
(e) Null 3P Referentiality	N3P+R	2.30 (2.6)	1.72 (2.1)	100.500	-0.412	0.699[b]
	N3P-R	0.43 (1.0)	1.50 (2.4)	72.000	-1.717	0.123[b]
(f) 3P Referential Anomaly	N3PR+A	0.61 (2.0)	0	100.000	-1.348	0.699[b]
	N3PR-A	1.69 (2.2)	1.72 (2.1)	105.000	-0.219	0.855[b]
	O3PR+A	0	0.06 (0.3)	104.500	-0.742	0.823[b]
	O3PR-A	0.38 (1.3)	1.44 (2.0)	68.000	-2.027	0.087[b]

*Mean difference significant at the 0.05 level.
a. One-tailed *p*-values.
b. Not corrected for ties.

Table 13: Mann-Whitney *U* comparisons between-group in dream narratives.

The analysis of WK narratives, on the other hand, showed significant group differences of 1Person pronouns, 3Person pronouns, and null 3Person referential pronouns (Table 14). After Bonferroni adjustment, however, the difference in 3Person pronouns and null 3Person referential pronouns were not significant. The effect size magnitude (η^2) values reported in Table 14 for 1Person and 3Person pronouns correspond to medium effect, and, for null 3Person referential pronouns, to large effect size.

Between-Group Differences in Waking Narratives (Exp.2 / n = 31)							
Parameter	Variable	SZ Mean (SD)	CT Mean (SD)	Mann-Whitney U	Z	p^a	Effect size (η^2)
	SC	23.17 (5.9)	24.43 (8.2)	97.000	-0.537	0.611[b]	

(a) Type of sentence	MS	20.80 (7.0)	21.55 (9.0)	105.000	-0.207	0.855[b]	
	ES	2.37 (3.2)	2.89 (2.5)	91.500	-0.781	0.451[b]	
	TS	3.10 (6.3)	0.71 (1.3)	85.000	-1.243	0.317[b]	
	TS+A	2.85 (6.3)	0.57 (1.2)	82.000	-1.442	0.261[b]	
	TS-A	0.26 (0.9)	0.13 (0.6)	105.000	-0.485	0.855[b]	
(b) Total of Pronouns	PC	16.54 (4.4)	21.29 (9.1)	68.000	-1.736	0.087[b]	
(c) Phonological Form	NP	11.22 (5.1)	15.90 (11.2)	83.500	-1.095	0.279[b]	
	OP	5.32 (5.2)	5.39 (3.9)	99.000	-0.456	0.670[b]	
(d) Person Feature	1P	11.95 (5.9)	19.87 (9.0)	48.500	-2.540	0.009[b]	0.22
	2P	0.28 (.9)	0	100.000	-1.348	0.699[b]	
	3P	4.32 (4.1)	1.42 (1.9)	54.000	-2.402	0.020[b]	0.19
(e) Null 3P Referentiality	N3P+R	3.08 (4.2)	0.31 (1.0)	58.000	-2.791	0.032[b]	0.26
	N3P-R	1.24 (1.8)	0.82 (1.3)	100.500	-0.458	0.699[b]	
(f) 3P Referential Anomaly	N3PR+A	1.44 (2.6)	0.11 (0.5)	84.000	-1.842	0.298[b]	
	N3PR-A	1.64 (2.5)	0.20 (0.6)	77.000	-1.975	0.183[b]	
	O3PR+A	0	0	110.000	0.000	1.000[b]	
	O3PR-A	0	0.29 (1.0)	99.000	-1.066	0.670[b]	

*Mean difference significant at the 0.05 level.

a. One-tailed *p*-values.

b. Not corrected for ties.

Table 14: Mann-Whitney *U* comparisons between-group in waking narratives. Variables with significant effect are highlighted. P values marked in red indicate significance after Bonferroni adjustment.

Waking Narratives

WK narratives of the SZ group, compared to the ones of the CT group, showed significant lower proportion of 1Person pronouns (Figure 8 (a)), and significant higher proportion of 3Person pronouns (Figure 8 (b)) and null 3Person referential pronouns (Figure 8 (c)).

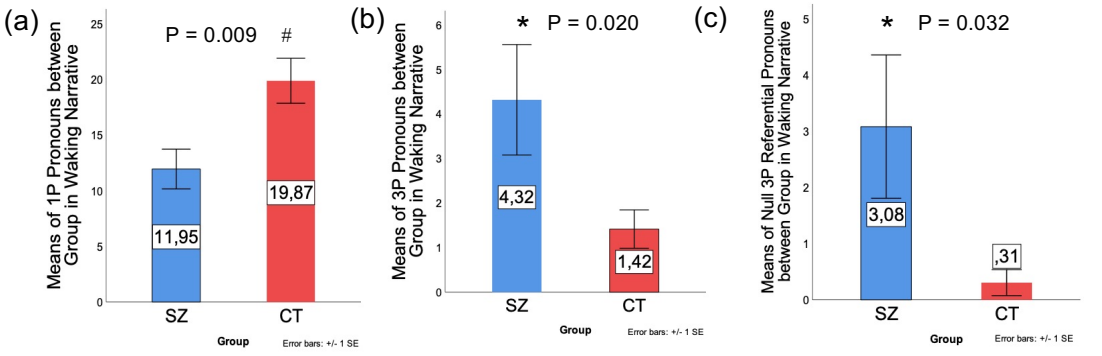


Figure 8: Means of variables with significant group differences in waking narratives: (a) 1Person, (b) 3Person, and (c) null 3Person referential pronouns. Pronoun variables were calculated based on the

percentage ratio of the total number of words in waking narratives. (∗) P is significant at the 0.05 level, and (#) P is significant after Bonferroni correction.

Stage 2: Between-group analysis of the sum of narratives

Compared to the CT group, the SZ group produced significantly smaller number of words (p = 0.005). There was no significant group difference of any linguistic variable when both narratives were analyzed as one (Table 15), but 1Person, 3Person, and null 3Person referential pronouns, which reached significant group differences in WK narratives, kept the same trends, with the SZ group producing fewer 1Person, and more 3Person and null 3Person referential pronouns than CT group.

Between-Group Differences in the Sum of Narratives (Exp.2 / n = 31)

Parameter	Variable	SZ Mean (SD)	CT Mean (SD)	Mann-Whitney U	Z	p[a]
(a) Type of sentence	SC	22.38 (4.1)	23.19 (3.5)	100.000	-0.413	0.699[b]
	MS	18.93 (4.7)	18.39 (4.2)	105.000	-0.206	0.855[b]
	ES	3.45 (2.8)	4.80 (2.1)	75.000	-1.445	0.157[b]
	TS	3.46 (5.8)	0.86 (0.9)	88.000	-0.936	0.381[b]
	TS+A	3.3 (5.9)	0.58 (0.7)	90.000	-0.877	0.427[b]
	TS-A	0.20 (0.4)	0.28 (0.5)	103.500	-0.366	0.792[b]
(b) Total of Pronouns	PC	15.91 (1.9)	17.31 (4.4)	95.000	-0.619	0.555[b]
(c) Phonological Form	NP	9.38 (3.1)	10.70 (4.8)	92.500	-0.723	0.476[b]
	OP	6.53 (3.4)	6.62 (2.7)	107.000	-0.124	0.919[b]
(d) Person Feature	1P	11.62 (3.4)	14.11 (4.6)	73.000	-1.528	0.133[b]
	2P	0.72 (1.2)	0.03 (0.1)	73.500	-2.353	0.133[b]
	3P	3.56 (2.9)	3.17 (2.3)	101.000	-0.372	0.730[b]
(e) Null 3P Referentiality	N3P+R	2.68 (3.1)	1.08 (1.1)	80.000	-1.267	0.227[b]
	N3P-R	1.76 (1.6)	1.28 (1.3)	94.000	-0.676	0.528[b]
(f) 3P Referential Anomaly	N3PR+A	1.05 (2.2)	0.06 (0.3)	84.000	-1.842	0.298[b]
	N3PR-A	1.63 (1.5)	1.01 (1.0)	85.000	-1.056	0.317[b]
	O3PR+A	0 (0)	0.04 (0.2)	104.500	-0.742	0.823[b]
	O3PR-A	0.17 (0.6)	0.85 (1.2)	65.000	-2.172	0.066[b]

*Mean difference significant at the 0.05 level.

a. One-tailed p-values.

b. Not corrected for ties.

Table 15: Mann-Whitney U comparisons between-group in the sum of narratives.

Stage 3: Correlations

In Exp.2, the investigation of possible correlations between linguistic variables and psychopathological symptoms assessed by PANSS and BPRS considered only the 11 subjects with diagnosis of schizophrenia, since the CT subjects of Exp.2 were not evaluated in terms of psychopathological symptoms. Also, considering that there was no significant group difference of the linguistic variables in the sum of narratives, the correlation analysis considered only the linguistic variables with significant group difference in stage 1 analysis of WK narratives: 1Person pronouns, 3Person pronouns, and null 3Person referential pronouns.

Spearman's rho Correlations (Exp.2/ n=11)				
		1P	3P	N+3P+R
BPRS	Cor. Coef.	0.201	0.030	0.085
	Sig. (1-tailed)	.0554	0.930	0.804
Total PANSS	Cor. Coef.	-0.178	0.264	0.220
	Sig. (1-tailed)	0.601	0.432	0.516
Positive PANSS	Cor. Coef.	-0.244	0.242	0.295
	Sig. (1-tailed)	0.469	0.474	0.379
Negative PANSS	Cor. Coef.	-0.314	0.478	0.339
	Sig. (1-tailed)	0.346	0.137	0.307
General PANSS	Cor. Coef.	-0.174	-0.080	-0.144
	Sig. (1-tailed)	0.610	0.815	0.673

**. Correlation is significant at the 0.01 level (1-tailed).
*. Correlation is significant at the 0.05 level (1-tailed).

Table 16: Correlations between variables with significant group difference in Exp.2 (1P = 1Person pronouns, 3P = 3Person pronouns, N+3P+R = null 3Person referential pronouns) and the scores of the psychometric scales (BPRS and PANSS).

As Table 16 above shows, there was no correlation between the scores of the psychometric scales and the linguistic variables with significant group differences in Exp.2.

Stage 4: Between-narrative analysis within group

Although the SZ group and the CT group produced more words in DM than in WK narratives, there was no significant narrative difference in number of words within either group (SZ: $p = 1.000$), CT: $p = 0.091$).

Mann-Whitney *U* comparisons within the SZ group showed no significant narrative difference of the variables quantified in the present study (Table 17).

Within-Group Differences in Production of Subjects with Schizophrenia Exp.2 (n = 22)

Parameter	Variable	DM Mean (SD)	WK Mean (SD)	Mann-Whitney U	Z	*p*[a]
(a) Type of sentence	SC	21.40 (6.0)	23.17 (5.9)	46.000	-0.953	0.365[b]
	MS	17.08 (5.7)	20.80 (7.0)	36.000	-1.612	0.116[b]
	ES	4.32 (3.2)	2.37 (3.2)	39.000	-1.462	0.171[b]
	TS	4.07 (9.3)	3.10 (6.3)	59.000	-0.108	0.949[b]
	TS+A	3.84 (9.3)	2.85 (6.3)	58.000	-0.184	0.898[b]
	TS-A	0.22 (0.7)	0.26 (0.9)	60.000	-0.066	1.000[b]
(b) Total of Pronouns	PC	15.24 (4.9)	16.54 (4.4)	56.500	-0.264	0.797[b]
(c) Phonological Form	NP	7.85 (5.2)	11.22 (5.1)	36.000	-1.612	0.116[b]
	OP	7.39 (5.0)	5.32 (5.2)	44.500	-1.057	0.300[b]
(d) Person Feature	1P	10.99 (4.8)	11.95 (5.9)	51.000	-0.624	0.562[b]
	2P	1.14 (1.7)	0.28 (0.9)	44.000	-1.475	0.300[b]
	3P	3.11 (2.7)	4.32 (4.1)	58.500	-0.133	0.898[b]
(e) Null 3P Referentiality	N3P+R	2.30 (2.6)	3.08 (4.2)	55.500	-0.345	0.748[b]
	N3P-R	.43 (1.0)	1.24 (1.8)	47.500	-1.088	0.401[b]
(f) 3P Referential Anomaly	N3PR+A	0.61 (2.0)	1.44 (2.6)	50.000	-1.025	0.519[b]
	N3PR-A	1.69 (2.2)	1.64 (2.5)	59.000	-.111	0.949[b]
	O3PR+A	0	0	60.500	0.000	1.000[b]
	O3PR-A	0.38 (1.3)	0	55.000	-1.000	0.748[b]

*Mean difference significant at the 0.05 level.
a. One-tailed *p*-values.
b. Not corrected for ties.

Table 17: Mann-Whitney *U* comparisons within schizophrenia group, with narrative type as grouping variable.

Within the CT group, there were significant narrative differences of linguistic variables in Exp.2 (Table 18). After Bonferroni adjustment, however, matrix sentence and overt 3Person referentially non-anomalous pronouns were not significant. The effect size magnitude (η^2) values reported in Table 18 for 1Person pronouns correspond to large effect. While the values reported for matrix sentences, embedded sentences, pronoun count, null pronouns, 3Person pronouns, null 3Person referentially non-anomalous and overt 3Person referentially non-anomalous pronouns correspond to medium effect size.

Within-Group Differences in Production of Control Subjects (Exp.2 / n = 40)

Parameter	Variable	DM Mean (SD)	WK Mean (SD)	Mann-Whitney U	Z	p^a	Effect size (η^2)
(a) Type of sentence	SC	22.20 (4.7)	24.43 (8.2)	169.500	-0.826	0.414[b]	
	MS	16.20 (4.6)	21.55 (9.0)	116.500	-2.259	0.023[b]	0.13
	ES	6.00 (3.1)	2.89 (2.5)	85.000	-3.119	0.001[b]	0.25
	TS	1.07 (1.2)	0.71 (1.3)	157.000	-1.314	0.253[b]	
	TS+A	0.56 (0.9)	0.57 (1.2)	180.500	-0.670	0.602[b]	
	TS-A	0.50 (1.0)	0.13 (0.6)	161.500	-1.676	0.301[b]	
(b) Total of Pronouns	PC	14.27 (4.7)	21.29 (9.1)	92.000	-2.923	0.003[b]	0.22
(c) Phonological Form	NP	6.64 (3.6)	15.90 (11.2)	85.500	-3.098	0.001[b]	0.25
	OP	7.63 (3.5)	5.39 (3.9)	129.000	-1.922	0.056[b]	
(d) Person Feature	1P	9.50 (5.0)	19.87 (9.0)	54.000	-3.950	0.000[b]	0.40
	2P	0.05 (.2)	0	190.000	-1.000	0.799[b]	
	3P	4.71 (4.2)	1.42 (1.9)	88.500	-3.083	0.002[b]	0.24
(e) Null 3P Referentiality	N3P+R	1.72 (2.1)	0.31 (1.0)	111.000	-2.893	0.015[b]	0.21
	N3P-R	1.50 (2.4)	0.82 (1.3)	164.000	-1.053	0.341[b]	
(f) 3P Referential Anomaly	N3PR+A	0	0.11 (.5)	190.000	-1.000	0.799[b]	
	N3PR-A	1.72 (2.1)	0.20 (.6)	106.000	-3.055	0.010[b]	0.23
	O3PR+A	0.06 (.3)	0	190.000	-1.000	0.799[b]	
	O3PR-A	1.44 (2.0)	0.29 (1.0)	122.000	-2.603	0.035[b]	0.17

*Mean difference significant at the 0.05 level.

a. One-tailed *p*-values.

b. Not corrected for ties.

Table 18: Mann-Whitney *U* comparisons within control group, with narrative type as grouping variable. Variables with significant group effect are highlighted. P values marked in red indicate significance after Bonferroni.

As Figure 9 shows, at the sentence level, the CT group produced significantly lower proportion of matrix sentences (Figure 9 (a)) and a higher proportion of embedded sentences (Figure 9 (b) in DM than in WK narratives.

At the pronoun level, the CT group produced a significantly lower proportion of pronoun count (Figure 9 (c)), null pronouns (Figure 9 (d)) and 1Person pronouns (Figure 9 (e)), and a significantly higher proportion of null 3Person referential pronouns (Figure 9 (f)), null 3Person referentially non-anomalous pronouns (Figure 9 (g)) and overt 3Person referentially non-anomalous pronouns (Figure 9 (h)) in DM than in WK narratives.

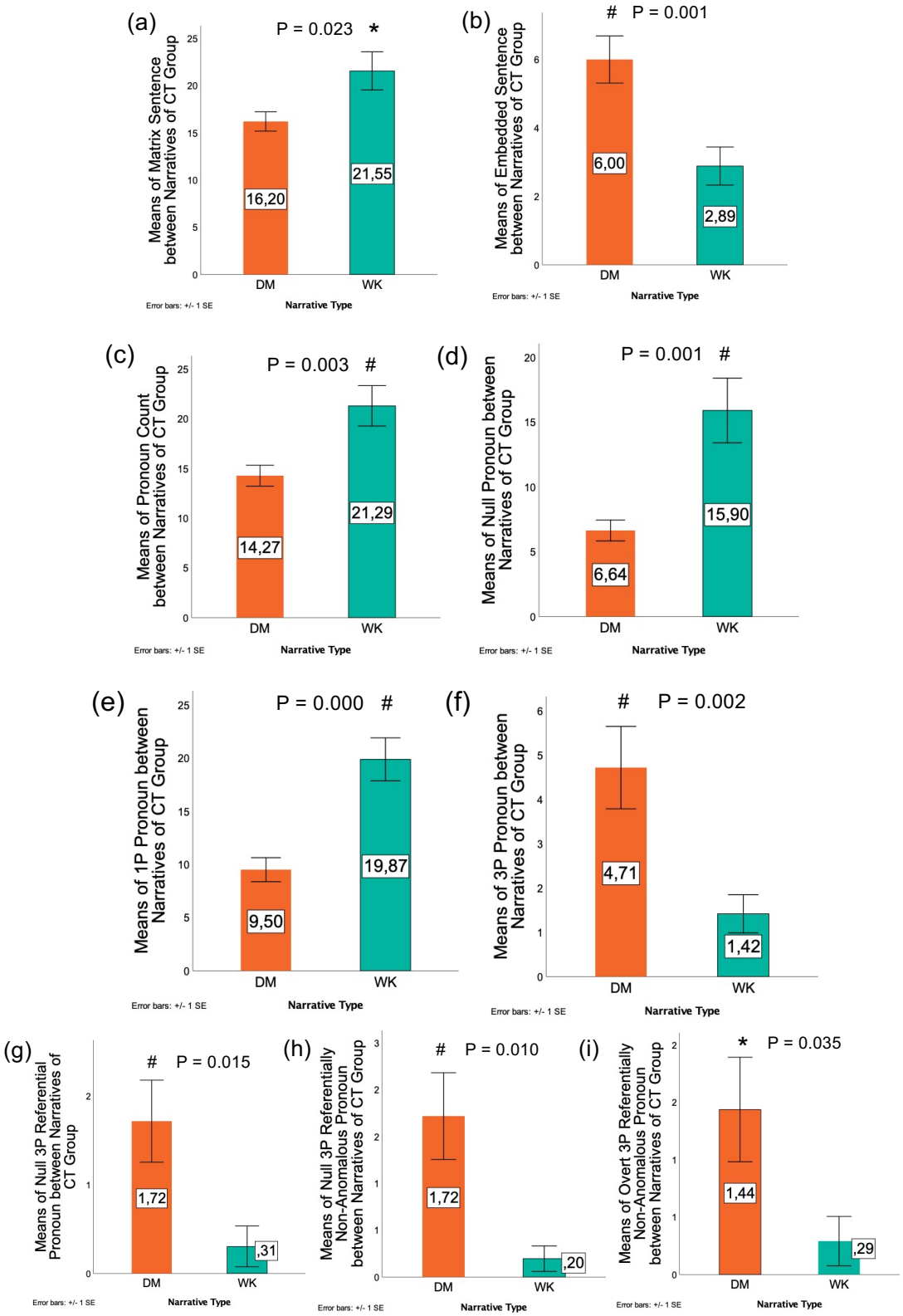


Figure 9: Means of variables with significant narrative difference within control group: (a) matrix and (b) embedded sentences, (c) pronoun count, (d) null pronouns, (e) 1Person, (f) 3Person, (g) null 3Person referential, (h) null 3Person referential non-anomalous, and (i) overt 3Person referential non-anomalous pronouns produced by group of CT subjects across narrative types. Sentence and pronoun

variables were calculated based on the percentage ratio of the total number of words per dream and waking narratives. (∗) P is significant at the 0.05 level, and (#) P is significant after Bonferroni correction.

4.4.2.1. Summary of the results obtained in experiment 2

The main findings of Exp.2 are the significant differences in proportions of 1Person, 3Person, and null 3Person referential pronouns found in WK narratives. No significant differences were found in DM narratives. When both narratives were summed up, the variables with significant differences in WK narratives were not significant although they kept the same trend. Table 19 summarizes the significant group differences obtained across narrative types in Exp.2.

Linguistic variables with significant difference	**DM**	**WK**
Lower proportion of 1P pronouns in SZ		$p = 0.009^{\#}$
Higher proportion of 3P pronouns in SZ		$p = 0.020$
Higher proportion of null 3Person referential pronouns in SZ		$p = 0.032$

Table 19: Summary of between-group results found in Exp.2

Similar to the within-group results of Exp.1, in Exp.2, only the CT group showed significant differences between narrative types. Table 20 summarizes the significant narrative differences within groups.

Linguistic variables with significant difference	**SZ**	**CT**
Lower proportion of matrix sentences in DM		$p = 0.023$
Higher proportion of embedded sentences in DM		$p = 0.001^{\#}$
Lower proportion of pronouns in DM		$p = 0.003^{\#}$
Lower proportion of null pronouns in DM		$p = 0.001^{\#}$
Lower proportion of 1P pronouns in DM		$p < 0.001^{\#}$
Higher proportion of 3P pronouns in DM		$p = 0.002^{\#}$
Higher proportion of null 3P referential pronouns in DM		$p = 0.015^{\#}$
Higher proportion of null 3P referentially non-anomalous pronouns in DM		$p = 0.010^{\#}$
Higher proportion of overt 3P referentially non-anomalous pronouns in DM		$p = 0.035$

Table 20: Summary of within-group results found in Exp.2

4.5. Discussion

This study was set to explore the use of subject pronouns in finite sentences produced by subjects with SZ compared to CT subjects, in particular the use of referentially anomalous null and overt pronouns, and to examine, additionally, structural deficiency at the sentence level, considering the types of sentences and sentential truncation. Our main findings on both experiments are summarized in Table 21 below: compared to the CT group, the SZ group used significantly more null pronouns and matrix sentences. Also, as our observations indicate, there are significantly fewer truncated non-anomalous sentences and more 3Person pronouns, particularly null 3Person referential ones in the narratives of the SZ group. We also found significantly fewer 1Person pronouns in WK narratives of the SZ group. There was no significant difference in terms of 3Person referential anomalies, but the SZ group, compared to the CT group, produced more null 3Person referentially anomalous pronouns in all narratives.

Performance of subjects with SZ versus CT subjects across narratives and experiments

	Exp.1			Exp.2		
	DM	WK	Sum	DM	WK	Sum
SC	+*	+	+#	(–)	(–)	(–)
MS	+#	+	+#	+	(–)	+
ES	(–)	+	(–)	(–)	(–)	(–)
TS	+	+	+	+	+	+
TS+A	+	(–)	+	+	+	+
TS-A	(–)*	+	(–)*	(–)	+	(–)
PC	+#	+	+#	+	(–)	(–)
NP	+#	+	+#	+	(–)	(–)
OP	(–)	+	(–)	(–)	(–)	(–)
1P	+	(–)	+	+	(–)#	(–)
2P	(–)	(–)	(–)	+	(+)	+
3P	+	+#	+	(–)	+*	+
N3P+R	+	+#	+	+	+*	+
N3P-R	+	+	+	(–)	+	+
N3PR+A	+	+	+	+	+	+
N3PR-A	+	+*	+	(–)	+	+
O3PR+A	(–)	+	+	(–)	(–)	(–)
O3PR-A	(–)	+	(–)	(–)	(–)	(–)

Table 21: Performance of subjects with SZ in all linguistic variables compared to CT subjects. "+" indicates higher means and "(–)" indicate lower means of the group of subjects with SZ compared to CT

subjects. Significant group differences are in red and marked with an asterisk (∗) when P level is at 0.05, and hash (#) indicates significance after Bonferroni adjustment. Performances that did not reach significant P level but showed the same tendency of the ones that did are highlighted. Variables with no significant group difference but in which the performance of the subjects with SZ showed the same tendency across all narratives are also highlighted.

To better address these results, we will discuss them considering our five predictions, starting by prediction number one (P1), which focuses on structure deficiency at the sentence level. Differences in the obtained results of DM and WK narratives, as well as the issue of the different protocols adopted in the experiments, will be addressed separately.

According to our P.1, narratives of the SZ group would show overuse of reduced and anomalous structures, compared to that of the CT group, measured in terms of the production of more matrix and less embedded sentences, and more truncated anomalous sentences. P.1 was only partially supported, since group differences did not reach significance across all comparisons. Nevertheless, the results obtained strongly suggest that subjects with SZ tend to produce more simpler syntactic structures (i.e., significantly more matrix sentences) and show reduced ability to make grammatical use of elision (i.e., significantly fewer truncated non-anomalous sentences). Although narratives of subjects with SZ showed fewer embedded sentences and more truncated anomalous sentences, the between-group differences were not significant.

Our results, thus, are in line with reports of reduced syntactic complexity (Morice and Ingram, 1982; Morice and McNicol, 1985 and 1986; Fraser, 1986; DeLisi, 2001; Çokal et al., 2018 among others) and more syntactic errors (Hoffman and Sledge, 1988; DeLisi, 2001, Moro et al., 2015) in narratives produced by subjects with SZ. The results are also compatible with Hinzen and Rosselló's (2015) hypothesis that SZ symptoms are caused by an underlying impairment in the ability to build complex grammatical structures and complex relations between propositions.

As the bellow DM narrative sample of a subject with SZ[5] shows, the decrease in grammatical complexity and increase in agrammatical structures correlate to a reduced ability to express coherent meaning.

- *Exp.1: DM sample - SZ group*

Int.: Please, tell me this dream that you had?

Part.: (?) was (?). (?) explained (?). Once I was (?) when I lived in the village up there. I have lived there, alright. And then I heard (?). I liked to lay down outside in the balcony. I heard someone walking in slippers. Then, I stood up. (I) went home.

In this fragment, the majority of the sentences are built out of simple (i.e., matrix sentences) and agrammatical structures (i.e., truncated anomalous sentences). As indicated by (?), it is not possible to infer the missing arguments of the predicates headed by "was" and "explained". The second occurrence of "was" and "heard" are missing one of their arguments as well. Also, the meaning of the embedded clause "when I lived in the village up there" is compromised by the lack of a complete matrix clause. Altogether, these truncations hinder the comprehension of what is being said.

Hinzen and Rosselló argue that the underlying syntactic impairment is distinctive of patients with SZ with severe thought disorder and delusions. We did not control for the specificity of schizophrenia symptoms; however, we found significant moderate correlations between reduced syntactic complexity, measured by more use of simpler structures, and all symptoms of schizophrenia quantified by the BRPS, PANSS and all PANSS subscales.

As discussed in chapter 2, several studies have reported syntactic impairment in schizophrenia; however, different measures of syntactic complexity, different tasks, and different groups of participants have been adopted. Çokal et al. (2018), for example, found significant group differences in syntactic complexity, measured by the

[5] Int.: Por favor, me conte esse sonho que você teve?
Part.: [$^{MS(TS+A)}$ *pro*$^{N+R}$ era] [$^{MS(TS+A)}$ *pro*$^{N+R}$ explicava] [$^{MS(TS+A)}$ uma vez eu$^{O+1P+R-A}$ estava [$^{ES(TS+A)}$ quando eu$^{O+1P+R-A}$ morava na vila em cima]] [^{MS} eu$^{O+1P+R-A}$ já morei lá] né e aí [$^{MS(TS+A)}$ eu$^{O+1P+R-A}$ escutei] [^{MS} eu$^{O+1P+R-A}$ gostava de [^{ES} me deitar do lado de fora na varanda]] [^{MS} eu$^{O+1P+R-A}$ escutei [^{ES} uma pessoa andando de chinela]] aí [^{MS} eu$^{O+1P+R-A}$ me levantei] [^{MS} *pro*$^{N+1P+R-A}$ fui para casa]

ratio number of embedded and dependent clauses, between narratives of thought-disordered SZ patients compared to first-degree relatives of SZ patients, and to neurotypical CT, but no significant difference was found between the narratives of the two groups of SZ patients (with and without thought disorder), or between non-thought-disordered SZ patients and both the CT groups and the group of first-degree relatives of SZ patients. They also reported no significant group effect of syntactic errors, which included truncated sentences and other errors such as agreement and tense violations. Çokal et al. (2019) reported that, in a comprehension task of embedded clauses (factive and non-factive), the performance of thought-disordered SZ patients was significantly worse compared to all other groups in both conditions. In these experiments, thought disorder was characterized based on the participants' answers to question 2 of the PANSS positive, which measures "Conceptual Disorganization". SZ patients who scored 3 or less were assigned to the non-thought-disordered group, and those who scored 4 or more were assigned to thought-disordered group. Working memory was not assessed in these experiments.

In its turn, Moro et al. (2015) reported that subjects with SZ were unable to detect structure violations but could detect semantic contradiction, which was interpreted as suggesting that syntactic knowledge is impaired in SZ, while semantic composition abilities are not compromised. Working memory, as assessed by the n-back task[6], showed no correlation with syntactic anomaly detection measures. There was, however, significant anticorrelation between syntactic anomaly detection measures in the long sentence condition and PANSS positive scores, which led the researchers to conduct yet another correlation analysis, with the scores of question 2 of the PANSS positive scale. This time a more significant anticorrelation was found with detection of syntactic anomaly measures in the long sentence condition, suggesting that thought disorder is related with the inability to detect syntactic anomalies in long sentences.

[6] The n-back task is one of the most adopted paradigms for measures of cognitive control and working memory storage capacity. The task involves the recall of a digit, or another stimulus previously presented.

Following Moro et al.'s steps, we conducted a correlation analysis for the PANSS P2 "Conceptual Disorganization" item.[7] The results show significant correlations between P2 scores and sentence count ($p = 0.004$), and matrix sentences ($p < 0.001$), and significant anticorrelation with truncated non-anomalous sentences ($p = 0.005$) of Exp.1. These findings corroborate our previously reported results, according to which the production of simple structures relates to all schizophrenia symptoms, but they add important information by showing that not only do measures of Conceptual Disorganization (i.e., thought disorder) increase the production of simple structure, but that they also decrease the grammatical use of ellipsis (i.e., regular use of non-anomalous truncation). Thus, it seems that structural deficiency, measured by the overuse of simple structures, is associated with schizophrenia symptoms in general, including thought disorder, but, when measured by the grammatical use of ellipsis, it is specifically associated with thought disorder.

The literature is filled with reports in which a decrease in grammatical complexity is associated with impaired working memory in SZ (Docherty et al. 1996b; Bagner et al. 2003; Forbes et al. 2009; Docherty 2012b). However, more experiments, adopting different paradigms, are necessary to fully understand correlations between working memory and syntactic complexity, especially because studies focusing on syntactic complexity in schizophrenia (Moro et al. 2015) found no correlations between specific syntactic anomaly detection and working memory abilities.[8] Since we did not measure working memory, we cannot go deeper into this possible association, but we will return to this issue when discussing our findings about pronouns.

Let us now focus on the differences found with respect to the types of narratives. Mota et al. showed that DM reports were especially informative of SZ diagnosis. The recall of DM, compared to WK memories, had greater impact on narrative productions

[7] Due to the size of our samples subdividing the SZ group would leave us with very small samples of patients. Based on PANSS P2 scores, in Exp.1, only 4 of the SZ subjects, and, in Exp.2, only 2 of the SZ subjects fit the thought disorder criteria.

[8] Working memory is a highly complex construct involving the maintenance and processing of different sources of information. It has been argued that working memory for syntactic information is not the same as the one for verbal items, and that the existing paradigms do not really measure working memory for syntactic information (Waters and Caplan, 1996; Caplan and Waters, 1999; DeDe et al. 2004; Caplan et al., 2007). Thus, it might be the case that the lack of association between working memory and detection of syntactic anomaly in Moro et al. (2015) is a task-related issue.

of both groups, although to a much greater degree in DM narratives of CT group (see Figure 10). DM graphs generated by SZ narratives are rather less complex compared to the highly convoluted DM graphs generated by CT narratives. WK graphs of both groups, on the other hand, present little recursiveness, arguably reflecting the sequential chronological nature of such reports.

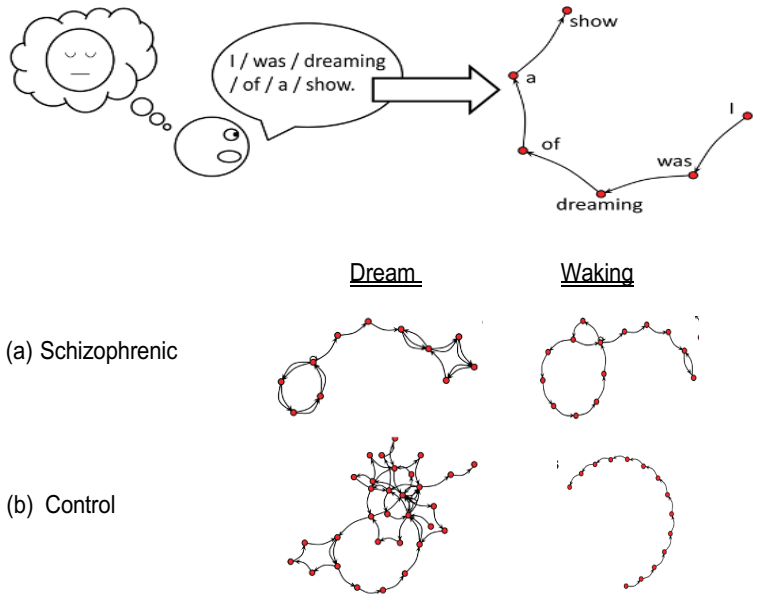


Figure 10: Speech-graphs of dream and waking narratives of (a) schizophrenic and (b) control participants. Adapted from Mota et al. (2014:2).

The similarities of SZ DM and WK graphs observed in Figure 10 (a) reflect the non-significant narrative effect of Speech Graph Attributes (SGA) found within the SZ group. On the other hand, DM and WK narratives of CT participants generated highly different graphs (see Figure 10 (b)). The same trend was found in the parameters adopted in the present study: within the SZ group, we found no significant differences between DM and WK narratives, whereas for the CT group, there were significant narrative effects of linguistic variables. Overall, CT subjects showed increased usage of embedded sentences and of 3Person pronouns, especially null referentially non-anomalous ones, and a decreased usage of null and of 1Person pronouns when reporting DM memories (see Tables 11 and 20).

Between-group analysis of the parameters adopted by us did not show agreeing results compared to Mota et al. analysis of SGA measures. Contrasting to Mota et al.'s

analysis, which show significant group effect of SGA in DM narratives only, our analysis showed that, not only DM, but also WK memory reports had different effects on the narrative productions of SZ subjects compared to CTs. In fact, in our analysis, only WK narratives showed significant group effects in both experiments.

Of note, both ours and Mota et al.'s analyses focus on speech cohesion; however, the present analysis aimed at the syntactic cohesion, while the graph-theoretical analysis aimed at the semantic cohesion. The SGA analysis is highly informative at the lexical cohesion level, whereas our analysis aims at combinatorial cohesion. Thus, even if the SGA analysis of WK narratives is not informative for the purpose of psychiatric diagnosis, the results of our analysis, showing significant overuse of 3Person pronouns, is especially informative of syntactic cohesion.

Also, differently from Mota et al., we only found significant group differences in DM narratives of Exp.1. The lack of significant group effect in our analysis of DM narratives of Exp.2 cannot be explained in terms of different levels of analysis. Thus, we are left with the following question: why did our analysis show significant group effects in one corpus of DM narratives but not in the other? Let us consider two possible alternatives, both of which concern the different protocols adopted in Exp.1 and 2: first, the 30sec time-limit of narrative samples used in experiment 2 does not provide us with enough speech material to contrast the linguistic features we were interested in; second, both the difference in age between participants and the difference in chronification between subjects with schizophrenia of experiment 1 and experiment 2 is responsible for the discrepancies observed.

Corroborating evidence for the lack of enough speech material provided by the 30sec. time-limited samples comes from the protocol developed by Docherty et al. (1994) and adopted by colleagues (Docherty et al. 1996a, 1998, 2005, 2012b; St-Hilaire et al., 2008; Rubino et al. 2011 among others). According to this protocol, 10-minute speech samples are necessary to provide a sufficient amount of speech for the analysis of communication failures, which include structural and referential failures. Tovar et al. (2019a), which also relied on free speech, used the first 5 pages of SZ patients interview reports, resulting in a mean number of 888,6 words. In the present study, the mean number of words in DM narratives of Exp.2 was 53,2 (SD = 26.2), compared to

the mean of 207,8 (SD = 152.7) in Exp.1.[9] This difference in number of words had a direct impact on sentence count. As indicated in Table 20, differently from Exp.1, SZ subjects produced a smaller proportion of sentence count in all narratives of Exp.2. Thus, it seems that DM narratives, which were highly informative of structural deficiency at sentence level in Exp. 1, were directly affected by the small number of words of Exp.2.

In discussing the possibility that the lack of group effect in DM narratives of Exp.2 is associated with subjects' younger age, we should highlight that, according to the continuity hypothesis, typically-developing children internalize the complex linguistic system of their local language before the age at which they start receiving formal education (Crain et al., 2017). In fact, language acquisition studies show that by the age of 3, children are just like adults in their abilities to produce and understand sentences, to judge the truth or falsity of sentences, and to understand the relations between sentences (Crain and Thornton, 1998 and 2015) (see section 3.4.1). Exp.2 participants were well above 3 years of age (age means of 14.64 ± 2.69 for SZ group, and 15.80 ± 3.30 for CT group). Also, between-narrative analysis within both SZ and CT groups shows the same trend across experiments (i.e., no significant narrative differences within SZ, and pretty much the same differences within CT, as shown in Tables 10 and 19). However, we must acknowledge that the observed delay in language acquisition, in pre-schizophrenic population, at the ages of 7, 11 and 16 years (Crow, 1996, 1997, 2000) might further impact the language abilities of SZ individuals as they get older. So, it is highly possible that the computational system (see section 3.1) of SZ patients deteriorates over the years. Thus, although it is unlikely that the lack of group effect found in DM narratives of Exp.2 is related to the participants' younger age, we would like to raise the hypothesis that the group effect found in DM narratives of Exp.1

[9] Means of number of words per groups across narratives and experiments

Words	SZ DM Mean (SD)	CT DM Mean (SD)	SZ WK Mean (SD)	CT WK Mean (SD)	SZ Sum Mean (SD)	CT Sum Mean (SD)
Exp.1	129.1(89.3)	286.5(163.9)	37.6(25.1)	61.8(23.1)	226.7(131.8)	417.7(234.5)
Exp.2	37.6(25.1)	61.8(23.1)	34.6(15.1)	49.7(17.4)	72.1(29.5)	111.4(35.1)

might be related to a putative higher degree of impaired grammar in the SZ subjects of Exp.1.

Now let us move on to our three predictions aiming at the usage of pronouns.

Our P.2 is that SZ narratives would show overuse of pronouns in general. Although we found a tendency of SZ subjects to use more pronouns, compared to CTs, especially when reporting DM memories, the group difference was not significant across all comparisons. Thus, P.1 was only partially fulfilled.

Our results are in line with findings of quantitative studies examining lexical characteristics of SZ language, showing overuse of pronouns in SZ narratives compared to CTs (Buck et a. 2015; Hong et al., 2015; Birnbaum et al., 2017; Zomick et al. 2019; Bae et al. 2021 among others). Differences in terms of pronoun person and number features are also reported. Automated analyses of Reddit social media show that, compared to CTs, SZ posts contain more 1PersonSG (Zomick et al., 2019), more 3PersonPL (Bae et al., 2021), more 2Person, and fewer 1PersonPL and 3PersonSG pronouns (Zomick et a. 2019; Bae et al., 2021).[10]

We also found significant moderate correlation between pronoun count and positive symptoms of SZ (see Table 7), but the association with thought disorder (p = 0.016), was not as significant. Thus, our data indicates that the overuse of personal pronouns is associated with positive symptoms of SZ in general.

P.3 predicts that SZ narratives would show higher use of 1Person pronouns compared to CTs. DM and WK narratives are anchored in the speaker's perspective, thus, an increase in the use of 1Person would be expected in both types of narratives. However, our results showed differences in terms of 1Person pronouns across narratives. SZ DM narratives showed more 1Person pronouns, but no significant group difference was found. SZ WK narratives, on the other hand, showed lower proportion of 1Person pronouns compared to CTs, and group difference reached significant P level in Exp.2. Thus, we conclude that P.3 was not supported.

Our results contrast with reports of overuse of self-referential words, especially 1Person pronouns in SZ narratives (Bersudsky, 2005; Strous et al., 2009; Buck et al.,

[10] It is important to highlight that, in the present study, there was only a handful of plural personal pronouns and most of them were used with generic meaning, thus, number feature was not computed.

2015a; Fineberg et al., 2015; Birnbaum et al., 2017). Nevertheless, less use of 1Person pronouns was found in first-person essays of SZ patients, compared to CTs. In fact, compared to CTs, SZ patients and subjects with family history of SZ produced fewer 1PersonSG and more 3PersonPL pronouns when writing about their own lives (Deutsch-Link, 2016). Contrastingly, Strous et al.'s (2009) analysis of written essays found overuse of 1PersonSG and less of 3PersonSG in SZ essays compared to CTs. However, differently from Deutsch-Link's essays, Strous's participants were asked to write about an important person in their lives. Thus, the different results of 1Person pronouns reported in these experiments could be related to the essay topic. In line with this rationale, we suggest that the contradicting results found in our analysis of DM and WK narratives can be explained in terms of the type of reports. A closer inspection of our data indicates that both groups show a tendency to use more 1Person pronouns in WK reports compared to DM reports (see Tables 4 and 5 for Exp.1 means, and Tables 13 and 14 for Exp.2 means), but this tendency is much stronger in the CT group, especially in Exp.2, where the group difference reached a significant level.

Although no prediction was made regarding the use of 3Person pronouns, we did find overuse of 3Person pronouns by SZ subjects, with WK narratives of Exp.1 showing significant group difference. Agreeing results are reported by Birnbaum et al. (2017), who found greater use of 3Person pronouns in tweeter posts of self-disclosed SZ participants. Strous et al. (2009), however, reported less use of 3Person pronouns in SZ essays about someone important in the writer's life. Interestingly, in first-person account of events, SZ essays used more 3Person, and when the essay focused on a third-person, SZ subjects used less 3Person, compared to CTs. Thus, it seems that, in terms of person feature, the usage of pronouns is related to the type of narrative analyzed, with SZ subjects' use of pronouns being not as directed to the narrative privileged focus as that of the CT group.

According to our fourth prediction (P.4), SZ subjects would use more null pronouns compared to CT ones. Our analysis shows that SZ subjects do tend to produce higher proportions of null pronouns, compared to CT ones. However, P.4 was only partially supported, since significant group differences were only found in the DM narratives of Exp.1.

We also found that null pronouns were significantly associated with SZ positive and negative symptoms (see Table 7), measured by PANSS positive and negative scores respectively. However, they were less significantly correlated with thought disorder, as measured by PANSS P2 ($p = 0.017$). Thus, our data support the hypothesis that the use of null pronouns in SZ is significantly associated with positive symptoms of SZ in general.

The observed overuse of null pronouns found in our samples is in direct contrast with the ongoing reduction of null subject pronouns in CBP (see section 3.2.2.2). According to the literature, there has been a consistent change towards the use of overt subject pronouns, particularly referential ones. Duarte et al. (2021) reports that, in a sample of interviews with CBP native speakers analyzed in 1995, 29% of all pronominal subjects were null, whereas, in a sample of interviews collected in 2009/2010, null subjects accounted for 20% of all pronominal subjects. For the sake of comparison, we consider the number of pronouns in our samples in terms of frequency. The result of this further analysis shows that 45% of all pronominal subjects found in Exp.1 were null, and, in Exp.2, 57% were null.

This unexpected result can be partially explained in terms of the dialogic nature of our data. Our narrative samples were all initiated by a prompting request "Please report a recent a dream" or "Please report your waking activities", and participants were prompted to continue talking whenever necessary to complete the 30sec time-limit. Thus, a certain frequency of null pronouns might have occurred in matrix sentences immediately following prompting utterances. As discussed in chapter 3, Simões (1999) argued that at least part of the 55.5% of null pronouns produced by children acquiring Brazilian Portuguese could be attributed to the discourse nature of the data (see section 3.2.2.3), in which the subject referent was easily found within the immediate context, as well as in the interviewers' prompting questions.

Our results also indicate a tendency of more null 3Person pronouns (both referential and non-referential) in SZ narratives, compared to CTs. However, significant group differences were found in relation to null 3Person referential pronouns of WK narratives only.

Duarte et al. (2021) reports that of all 3Person referential pronouns found in the 1995 sample, 39% were null, and, in the 2009/10 sample, 28% were null pronouns. In terms of frequency, our results showed that of the total number of 3Person referential pronouns in the sum of narratives of Exp.1, 60% were null, and, in Exp.2, 68% were null. Interestingly, in CT narratives, 56% of all 3Person referential pronouns were null in Exp.1, and 58% in Exp.2, which is close to the frequency of null pronouns found in children acquiring CBP. Whereas SZ narratives showed 66% of null 3Person referential pronouns in Exp.1, and 86% in Exp.2.

Thus, the dialogic nature of our data could in part explain the overall higher proportion of null pronouns found in our samples of narrative; however, it does not explain the higher frequency, nor the higher proportion of null 3Person referential pronouns found in SZ narratives.

As discussed in chapter 3, unlike other null-subject romance languages, CBP is a partial null subject language, where null subjects are not only less frequent compared to overt ones, but also their distribution is highly restricted (see section 3.2.2.2). For instance, in CBP, differently from consistent null-subject languages (e.g., Italian and European Portuguese), null 3Person subjects require a sentential antecedent in order to get a referential interpretation, as attested by the ungrammaticality of the utterance in (1).

(1) **pro* comprou um carro novo.
bought-3PSG a new car
"She/he bought a new car." (adapted from Nunes 2019: 3)

Although not allowed in matrix clauses in out of the blue contexts, they are acceptable in dialogue contexts, such as example (2) shows (Figueredo Silva, 2017).

(2) A. Cadê a Maria?
where the Mary
B. *pro* saiu.
left

A. “Where is Mary?”

B. “She left”. (adapted from Figueredo Silva, 2017: 197)

As discussed in chapter 3, null 3Person referential pronouns, in CBP, are more frequent in embedded contexts in a c-command relation with the antecedent (41%) (Duarte et al., 2021). Given the higher rate of matrix (one-clause) independent sentences and the low-rate of embedded sentences, most of the null 3Person referential pronouns found in our samples of SZ narratives arguably occurred in the context of independent matrix clauses. According to Duarte et al.’ (2021) the frequency of null 3Person referential pronouns in all types of independent matrix clauses is 29%, but when the antecedent is distant and there are intervening sentences with different subjects, the frequency drops to 14.5%. The frequency of null 3Person pronouns found in SZ samples of both experiments (Exp.1 = 66%; Exp.2 = 86%) are by far higher than what is reported by Duarte et al. Thus, the higher proportion of null 3Person referential pronouns found in our samples of SZ narratives not only shows that the use of null subjects by SZ subjects was not in accordance with what is observed in CBP, but also suggests problems in the referential use of null pronominal forms.

P.5 predicted that SZ subjects would produce more 3Person referentially anomalous pronouns, especially overt (strong) ones compared to CTs; however, no significant group difference was found. Thus, P.5 was not supported. We did observe, however, more anomalous 3Person pronouns in SZ narratives, but this trend was only constant across all narrative types and experiments in terms of null (weak) pronouns.

The lack of significant results in terms of referential anomaly maybe partially associated with the dialogic nature of our data. Studies reporting referential anomalies (Rochester and Martin, 1979; Çokal et al. 2018; Sevilla et al. 2018 among others) adopted narrative tasks where a given set of characters should be referenced (e.g., recounting fairytales and stories based on comic strips), which highly constrained the referential process. In contrast, in the task of reporting dream and waking events of one’s life, referentiality was restricted by the interviewer prompting questions. Also, in our samples, there are many cases in which it is not possible to be 100% sure whether or not the pronoun is anomalous, especially in the cases where the prompting questions

were not available. In such cases, we chose not to consider pronoun anomaly in order to avoid false positives.

Notwithstanding, the consistent tendency in terms of null, but not overt, 3Person referentially anomalous pronouns in SZ narratives, compared to CTs, is opposite to findings of first and second language acquisition studies. As shown in chapter 3, children under 6 years of age show non-adult linguistic behavior in terms of strong but not weak pronouns (Solan and Ortiz, 1987; Grolla, 2005; Hartman et al., 2012), and bilinguals show different linguistic behavior compared to monolinguals in terms of overt but not null pronouns (Sorace, 2016; Slabakova et al. 2017).

We suggest that the results showing a more anomalous use of null 3Person pronouns in SZ compared to CT narratives might reflect the greater number of null pronouns found in our data, likely characterizing a ceiling effect. In fact, a closer look into the occurrences of null compared to overt 3Person pronouns showed significantly higher proportions of the null pronouns in all narratives across experiments (Exp.1: $p < 0.001$ in both SZ and CT narratives; Exp.2: $p = 0.012$ in SZ narratives, and $p < 0.004$ in CTs).[11] As for the absence of significant differences in terms of anomalous use of overt 3Person pronouns, although our sample of narratives is very informative, they elicited only very few overt 3Person pronouns.

A handful of studies comparing SZ and CT narrative productions were conducted in null-subject languages (Hebrew by Bersudsky et al. (2005) and Strous et al. (2009), and Spanish by Sevilla et al. (2018) and Tovar et al. (2019a)). To the best of our knowledge, Tovar et al. (2019a) was the first study to report on null pronouns in SZ. However, they did not compare their usage between SZ and CT groups. Instead, they examined clinical interviews of thought-disordered SZ native speakers of Spanish, showing that they made significantly more errors in covert (i.e., null referential) compared to overt pronouns. A closer look into our samples of SZ narratives also

[11]Means of 3Person overt and null pronouns produced by SZ and CT groups across experiments

3Person pronouns	Null in SZ Mean (SD)	Null in CT Mean (SD)	Overt in SZ Mean (SD)	Overt in CT Mean (SD)
Exp.1	4.79 (3.0)	3.41 (1.2)	1.27 (1.2)	1.26(1.1)
Exp.2	3.39 (3.0)	2.28 (1.6)	.17 (.6)	.90 (1.1)

showed more anomalous null 3Person pronouns compared to overt ones; however, overt/null differences in terms of proportion of anomaly did not reach significance in either Exp.1 (p = 0.055) or Exp.2 (p = 0.080).

At this point in our discussion, we would like to argue that the reason for the higher proportion of null pronouns in our samples of SZ narratives is associated with the fact that these are less specified elements in terms of internal structure. As discussed in chapter 3 (see section 3.2.1), pronouns are internally structured elements, consisting of a bundle of formal features (Cardinaletti and Stark, 1999; Harley and Ritter, 2002; Déchaine and Wiltschko, 2002). Moreover, null/weak pronouns are structurally deficient and less referential compared to overt/strong pronouns (Cardinaletti and Stark's 1995, 1999). Consequently, when the language allows for the usage of null pronouns, it follows that SZ speakers make more use of these referentially deficient elements. In other words, we are suggesting that our results showing higher proportion of null 3Person referential pronouns in SZ corroborate findings of poorly specified use of personal pronouns in SZ (Rochester and Martin, 1979; Barch and Berenbaum, 1996; Docherty et al., 2003). The rationale is that when parametric variation allows it, the SZ subject's tendency to use less specified nominal elements manifests in the overuse of null pronouns, which arguably could lead to anomalies in the use of null/weak pronouns.

Corroborating evidence that the linguistic behavior of atypical adults follows parametric variation comes from a study comparing the use of null versus overt subject pronouns in Alzheimer's patients speakers of Italian (a null subject language) and English (a non-null subject language) in a sentence repetition task (Bencini et al., 2010). Differently from Italian matching CT subjects, Italian speakers with Alzheimer's disease omitted sentential subjects when repeating complex sentences, while English speakers with Alzheimer's disease did not omit subjects at all.

Recently, the long-observed difficulty with pronouns in SZ (Rochester and Martin, 1979; McKenna and Oh, 2005 among others) has been proposed to be related to a deeper problem, especially in association with thought disorder, involving both referentiality and definiteness (Hinzen, 2017). It follows that definite noun phases (NPs) are more structured compared to indefinites, thus, lower rate and more anomalies

in the use of definite NPs, compared to indefinite ones, are observed. Sevilla et al. (2018) reported that referential anomalies in definite and pronominal phrases, but not indefinite and non-pronominal ones, were distinctive of thought-disordered SZ. Çokal et al. (2018) reported that the production of definite NPs significantly predicted and distinguished non-thought-disordered SZ from thought-disordered SZ, with patients with thought disorder producing lower rate of definite NP.

Tovar et al.'s (2019a) results are specially important to our study. They found that the proportion of anomalous definite compared to indefinite NPs showed no difference within SZ narratives. Yet, although the proportion of anomalous full NPs compared to that of pronouns were higher, when 1Person and 2Person pronouns were taken out of the comparison, the proportion of anomalous 3Person pronouns was significantly higher than that of anomalous full NPs. Tovar et al. argued that the issue with pronouns might in fact be a deeper problem affecting functional categories, and that their finding of more anomalous null referential pronouns compared to overt ones reinforces this hypothesis.

Differently from our study in which SZ narratives were compared to that of CTs, Tovar et al. analyzed linguist anomalies within thought-disordered SZ narratives. However, both our results point to problems in realizing definiteness in acts of reference. On the one hand, Tovar et al.'s found more errors in null referential pronouns compared to overt ones, and more anomalous 3Person pronouns compared to full NPs in the narratives of thought-disordered SZ. On the other hand, we found overuse of null pronouns in general, and of null 3Person referential pronouns, with more anomalies in the use of null 3Person referential pronouns across all SZ narratives, compared to CTs. Thus, our results also point to a deeper problem possibly associated with the production of complex structures.

Interestingly, Tovar et al. reports that of the linguistic levels analyzed in their study, the NP level was the more affected, while the morphosyntax (i.e., sentence) level was the least affected. They attributed the relative preservation of morphosyntactic aspects found in SZ patients with severe though disorder to learned patterns in procedural memory (Ullman, 2004, 2008). We did not measure anomalies at the sentence level directly, but our observation that SZ speakers have a reduced ability to

generate grammatical sentential structures with ellipsis indicates anomalies at the sentential domain. I addition, our samples of SZ narratives, although showing relative fluency, consist mostly of one-clause sentences, which implies the higher use of rather simpler structures, which can also be understood as reflecting the use of procedural routines learned prior to SZ onset.[12]

Following Tovar et al.'s rationale, we understand that the significant overuse of simpler sentences and of null referential pronouns found in our samples might be related to problems with functional categories. One the one hand, the inability to build complex grammatical structures and complex relations between propositions in SZ (Hinzen and Rosselló, 2015) causes SZ patients to overuse simpler sentences. On the other hand, the allegedly reduced ability to build complex structures causes the overuse of structurally deficient pronouns, when the language allows for their use, which in turn leads to referential anomalies in the use of null pronouns.

We set out this investigation by assuming, based on studies on first- and second-language acquisition, as well as studies on atypical populations, that we would find more overt anomalous pronouns in SZ narratives compared to CTs. However, our analysis indicates that SZ subjects show a strong tendency of overuse structurally deficient elements (null pronouns) and simpler sentences. As discussed in chapter 3, children acquiring CBP use quantitively more null pronouns than adults; however, they use null subjects qualitatively in the same way as adult speakers of CBP (see section 3.2.2.3). Also, although young children prefer to use the weaker pronominal form available in their language (Varlokosta et al., 2015), crosslinguistic data show that children's interpretations of null/weak pronouns is as accurate as that of typical adults (see section 3.4.1), so is the use of null subjects by second language learners compared to that of monolinguals.

The linguistic behaviors of SZ subjects and neurotypical children are not the same in terms of null pronouns. Thus, we cannot readily attribute the observed overuse of null pronouns in SZ to working memory overload (although, SZ subjects might face working memory issues). Instead, in terms of memory, we understand that together the overuse of null 3Person referential pronouns and the preference for simpler sentences

[12] See Lightfoot (2012) on acquisition of matrix vs. embedded clauses.

over complex ones might be better explained in terms of procedural and declarative memory systems, both of which are essential in the learning and processing of linguistic information (Ullman, 2001, 2004).

Walenski et al.'s (2010) findings of greater deficits in SZ patients, compared to CT subjects, in producing past tense of regular and novel verbs, but not of irregular verbs, indicates problems in grammatical processing with relative sparing lexical knowledge. The conclusion put forward in Walenski et al. is that SZ involves problems with processing of grammatical information, but lexical processing, at least for routines learned before the SZ onset, is spared. While we cannot go deeper into this matter with the current results, we want to point out that according to the declarative/procedural model (Ullman, 2001, 2004, 2020), procedural memory is involved in the learning of grammatical knowledge that is fundamental to the real-time computation of linguistic information, and declarative memory is involved in memorizing structured chunks of linguistic information, and possibly explicit and implicit rules. Interestingly, the learning and knowledge of functional categories and morphemes are more related to the procedural memory system, while nouns and other open-class words are more related to the declarative memory system (Ullman, 2020).

In sum, based on our results, we would like to suggest that the alleged problems with functional categories in SZ might lead to impoverished syntactic structures that cannot be used in syntactic embedding, and to the anomalous use of referential pronouns, which, depending on parametric variation, manifests itself in terms of null or overt forms. We understand that our results pointing to problems at the grammatical level of organization might possibly be related to impairments in procedural memory. when dealing with real-time computations. This hypothesis should be further examined, especially given that not all investigations on syntactic impairment find correlations with working memory.

5
Conclusions and remarks

The present dissertation consists of an exploratory investigation, especially motivated by the challenge of contributing to the linguistic profile of schizophrenia, focusing on the types of sentences and types of pronouns in sentential subject position.

Language impairments in schizophrenia have been attested in a plethora of studies, with use of different experiment techniques, within different areas of knowledge. People with diagnosis of schizophrenia present deficits in production and comprehension at several linguistic levels (see chapter 2). Today, the real challenge in this area of research is to provide a detailed description and formal analysis of the linguistic profile of schizophrenia, which must include fine grained structural analyses, so as to determine whether the language impairments observed are language-specific or the result of other cognitive deficits (Kuperberg, 2010).

At the structural level, reduced syntactic complexity (Morice and Ingram, 1982; Morice and McNicol, 1985, 1986; Hoffman and Sledge, 1988), deficits in syntactic comprehension (Moro et al., 2015; Çokal et al., 2019), and referential anomalies in the use of definite DPs, especially in the use of 3Person pronouns (Docherty et al. 1996, Docherty et al., 2003; Sevilla et al., 2018; Çokal et al, 2018; Tovar et al., 2019a) have been verified in schizophrenia. Hence, following the path of the studies on referential and syntactic deficits, but aiming at contributing to a crosslinguistic profile of language in schizophrenia, we examined structural deficiency at the pronominal and sentential levels in spontaneous narratives produced by native speakers of Colloquial Brazilian Portuguese (CBP) diagnosed with schizophrenia.

Our research was specially set to investigate referential anomalies in null and overt pronouns, considering possible rate differences between them, verifying sentential structure as well (elliptical/truncated, simple and recursive (self-embedded) structures). We were especially interested in examining whether semantic/pragmatic anomalies in 3Person pronoun use, such as difficulty in establishing pronoun-antecedent/referent dependencies, and syntactic anomalies at the sentential level, such as ungrammatical ellipsis and overuse of simple sentences, could be given a unified explanation in terms of deficits at functional structural layers.

Under the Generative Grammar approach to human language, studies on parametric variation within nominals pay special attention to (a) how pronominal-antecedent relationships are built by Grammar, and (b) the division of labor between different types of personal pronouns, particularly the division between weak/null and strong/overt pronouns (see chapter 3).

In the so-called null subject languages, even though there is a preference for a deictic reading of overt/strong pronouns and for a bound reading of null/weak pronouns, null/weak pronouns are not grammatically restricted. In partial null-subject languages (e.g., CBP), however, null/weak pronouns are grammatically restricted: null 3Person pronouns are not allowed to have a deictic/referential reading. This allowed us to raise two possible explanations for the misuse of null referential pronouns observed in Spanish-speakers with schizophrenia (Tovar et al., 2019a): (a) null pronouns are overused as a strategy to avoid complex derivational processes, and (b) due to the lack of morphosyntactic features, when given a deictic reading, null pronouns lead to higher rates of errors.

Our analysis of two corpora of dream and waking reports of people diagnosed with schizophrenia – including patients with only one and more than one psychotic episodes (main difference between experiments 1 e 2) – and matching non-psychotic subjects, indicates intergroup differences both at the pronominal and sentential levels.

In accordance with findings reported by previous studies, the analyzed data shows that subjects with schizophrenia produced more pronouns and simpler sentences. And, although the results differed across narrative types and experiments (see chapter 4), altogether, we found that subjects with schizophrenia, compared to control subjects, produced (i) a higher rate of matrix sentences, (ii) a higher rate of null pronouns and (iii) a higher rate of null 3Person referential pronouns. Also, subjects with schizophrenia showed a tendency to produce more anomalous null 3Person pronouns across all narratives. All of which indicate the use of less structure, both at pronoun and sentence levels.

Of note, the higher rate (and frequency) of null 3Person referential pronouns found in the narratives of subjects with schizophrenia, compared to that of control subjects, is not in accordance with what is observed in adult speakers of CBP (Duarte,

2021) or in children acquiring the language (Simões, 1999), both of which demonstrate that the usage of null pronouns in schizophrenia does not conform with what is observed in neurotypical language development (see chapter 3). Moreover, since null pronouns are highly restricted in CBP (see chapter 3), the higher proportion of null 3Person referential pronouns in the context of matrix sentences (i.e., with deictic use) indicates that referential use of null pronouns by speakers with schizophrenia does not conform with the grammatical, syntactic and semantic restrictions observed in CBP. Differently from Spanish, where the deictic use of null pronouns violates a preference, in CBP, it signalizes a grammatical violation. Hence, our results suggest that schizophrenia leads to inobservance of grammatical constraints in the use of pronouns.

In short, our results indicate that grammar, in the face of schizophrenia, shows impairments at the structural level. We interpret these results as suggesting that schizophrenia leads to syntactic deficits at the functional layers of nominal and sentential structures, resulting in impoverished structures (see Tovar et al, 2019a for similar suggestion). These deficits, depending on parametric variation, are manifested in the use of anomalous null/overt pronominal forms.

The fact that speakers with schizophrenia allow for deictic uses of null pronouns even in languages where referential null pronouns are restricted to bound readings (the case of CBP) suggests that the observed structural deficiency is universal in schizophrenia. That is, although parametric variation affects how structural deficiency is manifested, this is a universal aspect of the grammar of the schizophrenic population.

We believe that our work contributes to the research on schizophrenia-specific linguistic profile by providing evidence, from a partial pro-drop language, that schizophrenia affects the grammar of pronouns. Thus, our work highlights the importance of crosslinguistic data and formal analysis in deepening our understanding of syndrome-specific language features.

Importantly, our results suggest that language acquisition in the schizophrenic population does not develop at the same rate as in neurotypical children (Crow, 1997), while adding to that, the observation that it does not follow the path of language acquisition observed in other neuroatypical populations (e.g., autism and SLI).

In addition, the observations of our investigation align with studies showing the impact of both the nature (e.g., dialogical vs. retelling) and the context (e.g., dream vs. waking reports) of the narrative task in eliciting the linguistic material necessary for the intended analysis.

As for associations between structural deficiency in schizophrenia and memory, there is a need for further investigations (as already suggested in Çokal et al. 2018 Tovar et al. 2019), preferably in terms of procedural memory systems (Ullman, 2001).

When Crow's characterization of schizophrenia as a price humans pay for having language is taken into consideration, our findings, added to results already available in the literature, seem rather paradoxical, as pointed out to me by Juan Uriagereka (p.c.). If schizophrenia leads to loss of grammatical information, how can it be a price we pay for having language? This paradox is nonetheless superficial. Crow's observation is about evolution and emergence of language. What recent investigations, including ours, indicate is that once language is already installed in a person's brain/mind, schizophrenia reduces its ability. Putting it all together, we understand that language emergence in humans has made us prone to schizophrenia, which can actually reduce our language abilities.

There are three main limitations to this study. First, the different protocols adopted across experiments, which might have affected the analysis of dream narratives. Second, SZ patients were not grouped according to specific diagnosis, thus, no distinction between specific language symptoms (e.g., thought disorder versus non-disorder) could be drawn from our study. Third, participants were not evaluated in terms of working memory, executive function, or ToM, thus, our data cannot be interpreted in terms of these cognitive abilities. These limitations can be overcome in the future by adopting a unified protocol in the following lines: (i) larger samples, (ii) a more extensive amount of speech for the extraction of the linguistic material necessary for structural analyses; (iii) grouping patients according to specific language symptoms, and (iv) assessing participants' other cognitive abilities, such as working memory, executive function and ToM.

Let us end, however, by observing that, despite these limitations, our research points to the importance of crosslinguistic data, in observance of parametric variations

among languages, in investigations on the linguist profile of schizophrenia. In general, our observations are in line with results from other languages, particularly Moro et al.'s (2015) findings on difficulties in computing syntactic locality (e.g., Wh-movement – which cannot be investigated in languages that do not allow Wh-movement (e.g., Chinese), and with Tovar at al.'s findings on preference for null pronouns, which cannot be clearly observed in non-pro-drop languages (e.g., English). We, thus, concur with Çokal et al.'s (2018) suggestion that further studies should focus on languages that differ in terms of functional categories (e.g., repertoire of pronouns and complementizers).

We believe that interdisciplinary investigations, combining areas of study such as formal linguistics, neurocognitive psychology, and neuroscience are the only way to fully understand human grammar in face of neurodiversity.

6
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