Interdisciplinary Linguistic and Psychiatric Research on Language Disorders

Volume Editors
Vlasta Erdeljac
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Zagreb 2019.

ed. Vlasta Erdeljac and Martina Sekulić Sović
INTERDISCIPLINARY LINGUISTIC AND PSYCHIATRIC RESEARCH
ON LANGUAGE DISORDERS

Urednice / Editors
Prof. dr. sc. Vlasta Erdeljac i dr. sc. Martina Sekulić Sović

Izdavači / Publishers
FF-press i Klinika za psihijatriju Vrapče

Godina tiskanog izdanja: 2019.
Godina elektroničkog izdanja: 2020."

Grafička priprema / Page layout
Tvrtko Molnar, Banian ITC

Lektor / Copy editor
Alexander D. Hoyt

Oblikovanje korica / Cover design
Ana Vujasić, Banian ITC

ISBN 978-953-175-831-4 (tiskano izdanje)
ISBN 978-953-175-873-4 (elektroničko izdanje)

https://doi.org/10.17234/9789531758314

CIP zapis dostupan je u računalnome katalogu Nacionalne i sveučilišne knjižnice u Zagrebu pod brojem 001046562.

Objavljivanje ove knjige potpomognuto je sredstvima projekta
Clinical linguistics: Psycholinguistic parameters in lexical-semantic processing in patients with schizophrenia
i sredstvima Klinike za psihijatriju Vrapče.

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Preface

https://doi.org/10.17234/9789531758314.00

Interdisciplinary Linguistic and Psychiatric Research on Language Disorders is a special issue containing studies and discussions presented at the International Scientific Workshop on Clinical Linguistics. The workshop was organized as a part of a project entitled *Clinical linguistics: Psycholinguistic parameters in lexical-semantic processing in patients with schizophrenia*, funded by the University of Zagreb, under the guidance of Professor Vlasta Erdeljac, PhD, Department of Linguistics, Faculty of Humanities and Social Sciences, University of Zagreb. The Workshop was held at the Education Centre of the University Psychiatric Hospital Vrapče on 20 November 2018.

The book consists of eight chapters. Chapter 1 provides insight into the theoretical background of psycholinguistic studies in schizophrenia with an emphasis on first-episode and early-course psychosis in schizophrenia-spectrum disorders. It also gives an overview of the psycholinguistic parameters used in the experimental studies in schizophrenia mentioned in the following chapters. The next two chapters provide empirical evidence of language disorders with a focus on the correlation between neuropsychological domains and language dysfunctions. Chapter 2 deals with limitations in language functioning (the comprehension of passives) in individuals with intellectual disabilities (adults with Down syndrome and Williams syndrome). In order to identify neuropsychological correlates underlying verbal fluency deficits in schizophrenia, chapter 3 explains how executive dysfunctions are associated with verbal fluency performance. The following chapters outline studies on lexical-semantic processing in schizophrenia. Chapter 4 gives an overview of a study which examines the language processing of lexical-semantic category boundaries in first-episode psychosis. Chapter 5 presents a study of the lexical-semantic animacy feature and taxonomy relations (hyponym–hypernym relations) in first-episode and early-course psychosis. Chapter 6 examines the effect of lexical semantic features of imageability and frequency on language association and production in subjects with first-episode and early-course schizophrenia-spectrum psychosis. The last chapter on lexical-semantic processing in psychosis and schizophrenia, chapter 7, presents a study on the processing of the lexical-semantic typicality feature based on verbal category fluency in schizophrenia subjects. Chapter 8 reviews the main approaches to the understanding of semantic knowledge with special emphasis on a recently developed approach to operationalizing conceptual representations that relies on the relevance of perceptual information. It presents the novel approach of describing word meaning in schizophrenia in the form of profiles of sensory experience across different sensory modalities.

The aim of this book was to offer some possible language elements as indicators which could improve the diagnostic value of tests for the early detection and follow-up of illness in subjects with high risk for psychosis, first-episode psychosis, and schizophrenia. There is a need for precise measurement instruments which could enable the identification of persons with a greater risk for psychosis, as some cognitive deficits in schizophrenia can be revealed before the onset of the illness. Experts in the field have invested great effort into designing fine-grained scoring procedures for assessing the measurement of the multiple cognitive processes underlying fluency performance on which the language processing of different types of deficits is based. Still, it is unclear which independent components are necessary to describe language processing in psychiatric cases in different tasks of language. This book is a pioneering work, especially when one considers its various linguistic-psychiatric interdisciplinary studies on the Croatian language, as well as its studies conducted by our colleagues abroad who are experts in the same field of research. Our goal was to present the results of current studies and to elucidate the path that future systematic studies in related topics should take.

The Editors

Acknowledgments

https://doi.org/10.17234/9789531758314.01

With great respect and fondness, we remember Professor Vlado Jukić, director of the University Psychiatric Hospital Vrapče, who left this world early in 2019, during the realization of the project that resulted in this book. We owe special gratitude to Professor Jukić above all because of his readiness to organize and financially support a collaborative project between the Department of Linguistics at the Faculty of Humanities and Social Science in Zagreb and the University Psychiatric Hospital Vrapče, there by showing his personal understanding of the necessity to breach new topics of research in areas of contact between psychiatry and linguistics.

We thank the reviewers of every article published in this book, but especially the editor-in-chief, Jana Willer Gold, for her pedantic reading of all the texts and her constructive comments and suggestions.

The role of the psycholinguistic characteristics of words in the assessment of language processing of patients with psychosis, ultra-high risk of psychosis, or schizophrenia

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https://doi.org/10.17234/9789531758314.02

1. Psychosis and schizophrenia-spectrum disorders

Psychosis is an umbrella term used to describe disorders in which one's ability to adequately test reality is compromised because of changes in perception and thoughts as well as in affective responses, all of which leads to impaired functioning on multiple levels. The most common features in all psychotic disorders include delusions and hallucinations (often referred to as positive symptoms), but clinical presentation can vary significantly among individuals diagnosed with the same disorder, and even in the same individual over time, making the process of differential diagnosis in certain cases extremely complex.

Delusions are fixed false beliefs that resist change even when the individual is confronted with compelling contrary evidence; the most common are persecutory delusions (the belief that someone wants to harm or hurt the person, or is plotting against them) and referential delusions (the belief that random things/individuals have special meaning for the affected person). Other types of delusions can also be part of the clinical presentation (e.g. erotomanic, grandiose, somatic, and nihilistic delusions), and these can further be divided into bizarre and non-bizarre delusions.

Hallucinations are changes in perception that take place in the absence of any external stimulus and can affect any perceptual modality (visual, auditory, olfactory, gustatory, and somatic). Not only are delusions and hallucinations linked to psychosis, but other symptoms and symptom domains as well, such as disorganized thinking and speech, changes in motor behavior, and negative symptoms (e.g. flat affect, anhedonia, alogia, and amotivation). Certain symptom domains are seen more often in specific psychotic disorders (e.g. negative symptoms in schizophrenia), a fact that can be used in the process of reaching definitive diagnostic differentiation.

The disorder most commonly mentioned in the context of the psychosis spectrum is schizophrenia, which is often seen as the paradigmatic psychotic disorder. However, the spectrum also includes disorders such as schizoaffective disorder, schizophreniform disorder, delusional disorder, schizotypal disorder, and brief psychotic disorders. Psychosis symptoms can also be present in other psychiatric disorders (e.g. bipolar affective disorder, depression, and personality disorders) and can be induced by various psychoactive substances and medications or by various medical conditions (e.g. autoimmune, endocrine, and metabolic disorders, tumors, etc.).

A diagnosis of a psychotic disorder is primarily based on a detailed patient history and examination of mental status (whether by means of structured questionnaires or semi-structured and/or unstructured interviews). As of yet, there are no widely accepted "objective" neuroimaging or laboratory tests used to diagnose schizophrenia or other psychotic disorders (although such tests are used to diagnose medical conditions that potentially induce psychotic symptoms).

2. Schizophrenia

Schizophrenia (SCZ) is a psychotic disorder with a reported prevalence varying between 0.4% and 1% and is among those mental disorders with the greatest impact on the duration and quality of life as well as on the work and social functioning of those affected (Sadock, Sadock, & Ruiz, 2015, p. 301; Bhugra, 2005; Mcgrath, Saha, Chant, & Welham, 2008; Desai, Lawson, Barner, & Rascati, 2013). The male to female rate ratio of SCZ is reported to be 1.4:1 (Desai et al., 2013), while the peak incidence in males is seen at an earlier age (15–25) than in females (25–35) (Sadock et al. 2015, p. 301; Mcgovern & Cope, 1987). Women, however, show a bimodal distribution, and have a second peak of SCZ onset in middle age (Messias, Chen, & Eaton, 2007). Men are reported to experience more negative symptoms, and the outcome for women is considered to be generally more favorable.

Although we referred in the previous paragraph to SCZ as a psychotic disorder, today it is considered to be a group of related disorders with possibly varying clinical presentations, underlying pathological mechanisms, and outcomes. One of the major, still unmet challenges in SCZ research today is therefore the identification of valid sub-types (both clinically and in relation to a number of different objective indicators).

2.1. Etiology

Even though the etiology of SCZ has been studied since its initial conceptualization in the nineteenth century, no definitive model of its underlying pathology has emerged, which might at least partially be the result of its above-mentioned heterogeneity. We know from research carried out to date that there is a strong genetic component of the disorder, informing us of the risk to relatives of those affected, and recently, a number of additional candidate gene loci linked to SCZ have been identified (Schizophrenia Working Group, 2014), driving forward research on the genetics of the schizophrenia spectrum. The rate of concordance in monozygotic twins is reported to be between 33% and 50%, and heritability in SZC spectrum disorders is 73% (Sadock et al. 2015, p. 303; Hilker et al., 2018). Even if we take the higher rate of concordance (50%) in monozygotic twins as true, it still indicates that SCZ vulnerability depends on more than just genetic loading.

The first studies on the neuropathology of SCZ failed to show clear signs of brain changes, causing the disorder to be classified as functional, but subsequent research indicated that there is a loss of brain volume, possibly stemming from excessive synaptic pruning during adolescence. In addition to changes observed in the prefrontal cortex, the limbic system, the thalamus, and some other specific regions of the brain, reduced symmetry was also reported. This is believed to originate during fetal life and to disrupt brain lateralization (Sadock et al. 2015, p. 304).

Probably the most widely accepted theory is the dopamine theory of SCZ (and psychosis in general), which argues that dysregulation of the dopamine system causes most symptoms of the disorder (particularly its positive and negative symptoms). This has been supported by the effectiveness of dopamine antagonists in the treatment of SCZ (for treating positive symptoms) and that of all of the currently available antipsychotic medications that regulate dopamine neurotransmission. Dopamine theory has survived many modifications, with changes in focus among different elements (dopamine production, release, receptor changes), and even after it was challenged by other hypotheses explaining the emergence of psychosis at different levels, it continues to be seen as the "final common pathway" to psychosis (Howes & Kapur, 2009). The Glutamate and GABA systems dysregulation hypotheses postulate changes in excitation/inhibition, which have been confirmed by a number of studies and computer models of the disruptions seen in SCZ. Those changes have been linked to, among other things, working memory problems observed in the SCZ population (Starc et al., 2017). Neuroimaging studies of schizophrenia have also helped us to move from focusing on a specific brain region(s) to seeing it characterized by changes in widely distributed networks and functions (Yang et al., 2014).

Many other theories on the etiology of SCZ and psychosis exist, possibly explaining other important elements of its underlying pathology (e.g. the infection hypothesis, based on, among other facts, a high incidence of SCZ after prenatal exposure to influenza), but listing all of them goes beyond the scope of this article. It is important to note, however, that there are also a number of psychological theories of SCZ (e.g. the double-bind concept) that have descriptive value and can help us understand individual symbolic meaning behind some of the symptoms, which helps in the treatment process when using psychological interventions for SCZ patients.

2.2. Clinical presentation and diagnostic criteria

No symptom is considered to be pathognomonic for schizophrenia, as all symptoms and signs reported in SCZ can also be seen in other psychiatric disorders. This, combined with the fact that we still do not have an objective diagnostic instrument, illustrates the difficulty in making an early diagnosis of SCZ and the importance of observations made over prolonged periods in order to capture all aspects of this psychopathology and its changes over time. Current conceptualizations of the schizophrenia spectrum recognize the existence of subtle, non-specific premorbid signs and symptoms progressing through the prodromal stage into frank psychosis. Patients who go on to develop schizophrenia-spectrum disorder may have been more introverted and socially retracted, and research has shown that cognitive changes may be among the first signs in those who go on to be diagnosed with SCZ (Häfner et al., 1992). Even with clear prodromal signs and symptoms predating the first episode of psychosis, we still consider prodromes to be a retrospective concept, clearly defined as part of SCZ only after the actual onset of the illness.

Keeping in mind that SCZ is a longitudinal concept without clear pathognomonic symptoms, we expect it to be present with a number of different signs and symptoms, changing over time, which we usually divide into different symptom domains. The clinical presentation of a patient with schizophrenia can range all the way from a disorganized, agitated, and bizarre patient to one who is seemingly inconspicuous, silent, and immobile. Two domains that have been part of all previous and current conceptualizations of psychosis and SCZ are positive and negative symptoms. Positive symptoms have occasionally additionally been divided into "core" positive symptoms reflecting perceptual disturbances and thought content (delusions and hallucinations), and formal thought disorder that reflects changes not in the content but rather in the organization of thoughts and speech. Disorders of the form of thought can be objectively assessed through a patient's speech and writing, and they include looseness of association, tangentiality, echolalia, verbigeration, derailment, and incoherence (with word salad being at its extreme point), as well as mutism. The thought process, on the other hand, can be inferred from a patient's behavior as well as speech or writing, and includes thought blocking and control, thought broadcasting, poverty of thought content, changes in abstract thinking, idiosyncratic associations, and perseveration.

Negative symptoms, which include flat affect, anhedonia, amotivation, and poverty of speech (alogia), usually raise less flags than positive symptoms early in the course of the disorder and are usually less prominent in other psychotic disorders than in SCZ. On the other hand, compared to some other symptoms, negative symptoms are linked to significant reductions in functioning and poor prognosis. In addition to these two symptom domains, we also identify mood changes, excitement, and the cognitive dimension. Symptoms in SCZ can be evaluated using unstructured, semi-structured, or structured interviews, and there are a number of questionnaires and scales which are used in research and clinical practice. One of the most widely used scales to assess the severity of symptoms is the Positive and Negative Syndrome Scale (PANSS), a 30-item scale in which each item is rated from 1 to 7 based on the severity of a specific phenomenon/symptom.

Changes in cognition in SCZ have been a particular focus of numerous studies and are now seen as central features of the disorder. Occasionally, cognition changes are even considered as candidates for trait markers of SCZ. Cognitive impairments precede the onset of psychosis and are relatively stable from the first episode of psychosis throughout the course of the disorder; in addition, they predict the level of social functioning (Häfner et al., 1992; Brewer et al., 2005). A number of studies of SCZ patients have found changes in attention, working memory, executive functioning, speed of processing, verbal comprehension, learning and memory, problem solving, and social cognition (Nuechterlein et al., 2004), with overall intelligence, executive functioning, and verbal memory being identified as especially influencing their social functioning (Green, Kern, Braff, & Mintz, 2000; Leeson, Barnes, Hutton, Ron, & Joyce, 2009). A wide array of cognitive impairments reflect the disruption of cortico-cerebellar-thalamic circuits, leading to what was termed "cognitive dysmetria" (Andreasen, Paradiso, & Oleary, 1998).

Diagnosing SCZ is done according to accepted classification systems, two of the most widely currently accepted and used being the 10th revision of the *International Statistical Classification of Diseases and Related Health Problems* (ICD-10) (World Health Organization, 1992) and the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013). In essence, a person can be diagnosed if he/she meets a specified number of specific criteria with regard to symptoms, their duration, and reduction in functioning. According to DSM-5, in order for a diagnosis to be made, two symptoms from a list including delusions, hallucinations, disorganized speech (e.g. incoherence), disorganized behavior, and negative symptoms need to be present for most of the time during a one-month period (at least one of these two symptoms needs to be delusions, hallucinations, or disorganized speech). In addition to reduction of functioning, signs of the disturbance must also persist for at least six months (including the above-mentioned one-month period). ICD-10, on the other hand, places more emphasis on specific symptoms, previously called first-rank symptoms. In order to be diagnosed with SCZ according to ICD-10, a person should have for most of the time during a one-month period one clear symptom from each of the following groups: (I) thought broadcasting, thought echo, thought insertion; (II) delusions of control, influence, or passivity; (III) voices commenting on the person's behavior or discussing that person among themselves; (IV) persistent delusions that are culturally inappropriate. The person can also be diagnosed if they have two less clear symptoms from two different above-mentioned groups, or symptoms from at least two other groups of symptoms (persistent hallucinations of any modality followed by delusions without affective content, changes in the train of thought resulting in incoherence or neologisms, catatonic behavior, negative symptoms, and significant changes in behavior and social functioning).

It is clear that the differences between these classification systems, whether we choose to see them as major or discreet, point to the problem of validity of the diagnosis of schizophrenia, which has implications in research but also clinical practice.

3. First-episode psychosis (FEP)

The past few decades have seen a rise in attempts at clarifying the complexity of SCZ as a heterogeneous syndrome and at identifying markers of its subtypes and predictors of different illness courses and outcomes. One of the most important "helper" concepts on that road is that of clinical staging, acting as a more refined way of diagnosing disorders across a timeline in hopes of allowing for early intervention at earlier stages of a disorder (Mcgorry et al., 2006). Staging rests on the idea of progressive reduction in functionality that comes with illness chronicity and assumes that early interventions might prove to be more effective and less harmful, and might be able to delay chronic phases. In order for staging to be meaningful, it is important that we achieve a broader knowledge of the etiology and course of a specific disorder, as well as of different risk and protective factors, markers and predictors, as well as their relationships, all of which seems to be mostly lacking in the case of schizophrenia and psychosis-spectrum disorders. It is thought that clinical staging might help in mapping various biological, cognitive, and other markers to a specific illness stage, thus also contributing to the validation of illness subtypes and possibly even separate clinical entities (Mcgorry, Killackey & Yung, 2008).

When trying to formalize the stages of SCZ and define the extremes on the timeline, on one end of this line we usually position the chronic residual stage, and on the other the ultra-high-risk states, a concept that proves more difficult to define and operationalize. Authors have long talked about prepsychotic stages that precede frank psychosis, and we have already briefly mentioned the concept of prodromes earlier in this text. Prodromes include non-specific behavioral symptoms that can progress into subthreshold positive symptoms, sometimes years before actual symptoms of psychosis appear. Even with a number of initiatives trying to establish valid markers for states of clinical high risk for psychosis and predictors of transitioning into psychosis, which would help in defining certain symptoms as prodromal, we still talk about the prodromal phase as a retrospective concept, only after the onset of actual psychosis.

It might seem that, compared to prodromes, first-episode psychosis (FEP) must be something easier to define, as it rests on the appearance of the objectifiable actual psychotic symptoms that we listed earlier in this text. However, the clinical and research reality tends to deviate from that assumption. We can expect FEP to be conceptualized in terms of (i) first contact with psychiatric services and treatment (understandably an unreliable concept, given that symptoms can be present for years before treatment starts), (ii) duration of use of antipsychotics, and (iii) duration of psychosis (Breitborde, Srihari, & Woods, 2009). In order to avoid pitfalls, the suggestion has been made that FEP should be re-conceptualized as early-course psychosis or recent-onset psychosis in terms of duration of psychosis, a definition that offers the promise of best construct validity. Given that most functional deterioration takes place in the first five years, the five-year point has often been used to mark the end of FEP or early-course psychosis, although one has to be mindful of significant individual variation in the course of the illness.

We are again using the umbrella term of psychosis, which reflects the fact that FEP can have various trajectories and outcomes, from differentiation into SCZ, affective psychosis, or other psychotic disorders, to full remission without subsequent episodes. ICD-10 recognizes variations in the clinical presentation of acute psychotic disorder (F23), describing them as polymorphic without SCZ symptoms (F23.0), polymorphic with SCZ symptoms (F23.1), schizophrenia-like (F23.2), predominantly delusional (F23.3), other specified (F23.8), or unspecified brief (reactive) (F23.9). There is little predictive value in these diagnoses, and so the diagnosis of schizophrenia-like acute FEP does not necessarily mean the person diagnosed with it will progress to actual SCZ. The variation of presentations, along with the fact that FEP can progress in the direction of affective psychosis, also means that patients in an acute psychotic episode can be treated with a number of other medication classes in addition to antipsychotics (e.g. antidepressants, mood stabilizers). It is reported that from around 16% (up to about one third) of those with FEP will not have another episode and might show good long-term recovery. Around one third (up to 43%) will have repeated episodes after FEP and an unremitted course of illness with increased impairment, while the rest will have multiple episodes over their lifetimes with partial or full remissions between episodes and varying patterns (Shepherd, Watt, Falloon, & Smeeton, 1989; Messias, Chen, & Eaton, 2007). We currently have no valid instrument to help us identify which FEP patient will fall into which category, and as mentioned previously, even our diagnoses depend on long-term observations of the clinical course.

Two points need to be emphasized and follow from what was presented about FEP. First, because of the progressive and deteriorating nature of "chronic" psychotic disorders (specifically those from the schizophrenia spectrum), it is vital to promote the early detection of psychosis and implement early interventions, and one of the ways to do that is to identify usable markers that might be shown to even precede the onset of manifest psychotic symptoms. Secondly, given the differences in the symptoms we see and the wide variety of possible outcomes (in terms of remission and level of functioning, but also clinical presentation changes), it is important to identify different predictors that might help us tailor interventions and individualize our approach to individuals with FEP. Both these markers and predictors could prove to be useful tools in our attempts to finally elucidate processes that underlie heterogeneous disorders like SCZ, their subtypes, and symptoms.

4. Lexical-semantic deficits in schizophrenia

As language disturbances are thought to be one of the most prominent characteristics of psychosis, and hence schizophrenia, from the beginning of their defining, they maintain the position of an important diagnostic criterion. Abnormalities of language production, such as derailment, tangentiality, poverty of speech, illogicality or incoherence, are commonly understood in terms of formal thought disorder (FTD) (Barrera et al., 2005, Kircher et al., 2018). FTD refers to a clinical description of a range of language production deficits which can be described as inadequacy of language production and alterations in the thought process (Kircheret al., 2018). The symptoms of FTD are most often categorized as being either positive or negative. Positive symptoms involve an increased amount of produced speech, including the production of neologisms, idiosyncratic associations, etc., while negative symptoms include deficits in speech and thought production. FTD occurs in a range of neuropsychiatric disorders, but chronic positive FTD is held as a diagnostic marker for schizophrenia and an indicator for high-risk psychosis (Kircher et al., 2018).

FTD is observed through traditional clinical scales and encompasses a variety of symptoms. Besides the aforementioned division into positive and negative symptoms, other categorizations include subjective vs. objective and qualitative vs. quantitative forms of the disorder. As these subdivisions present a heterogeneity of symptoms, different manifestations of the syndrome could represent different aspects of cognitive dysfunctions (Cavelti et al., 2018), and overall FTD diagnostics could obscure correlations between specific symptoms (Sumner et al., 2018). Lewandowski et al. (2018) remark that there is cognitive heterogeneity both within and between diagnostic categories, since patients across diagnoses share similar cognitive deficits, and patients with shared clinical and diagnostic features may exhibit different cognitive abnormalities. This heterogeneity presents problems for the study of cognitive dysfunctions in psychosis and should be further distinguished, with novel strategies and different approaches. Furthermore, these differences accentuate the importance of studies of first-episode and early-course psychosis along with longitudinal studies, as they could further enlighten the heterogeneity of symptoms accompanied with different cognitive or language deficits. First-episode and early-onset diagnoses, along with language and cognitive studies, could, if accompanied by longitudinal studies, distinguish subgroups of this heterogenic diagnosis which could reveal underlying processes in schizophrenia, and psychosis in general, and could become a valuable tool as a predictor for a particular course of the illness and its phases.

Brown and Kuperberg (2015) list four ways in which language disturbances are important in schizophrenia: language abnormalities manifest in symptoms of psychosis itself (particularly in positive FTD and auditory verbal hallucinations); language dysfunction is a core consequence of schizophrenia and is more strongly compromised in relation to other cognitive abilities; language production deficits often extend to perceptual processing of speech, i.e. comprehension; and language dysfunctions have been linked to functional and social impairments. Cavelti et al. (2018, citing Kircher, 2008; Strik et al., 2008) conclude that disturbances in the connectivity of the language network may be the underlying neurobiological cause of FTD language deficits. Hence, language deficits in schizophrenia may be tied exclusively to the semantic memory or may include other mechanisms of language processing. They may be due to a combination of deficits, the consequence of either a general deficit or a specific deficit.

The semantic memory is a long-term memory system containing organized knowledge about words and their meanings, referents, and relations (Tulving, 1972). It is considered to be organized into a network of associated concepts represented by nodes of interconnected links which indicate semantic relationships between them (Minzenberg, 2002, Collins and Loftus, 1975). Language processing deficits in schizophrenia may be tied exclusively to the semantic memory, but they also might include search and retrieval processes connected with executive functions and working memory processes. Although it is yet unclear which domains interact with which processes, both play a significant role in manipulating semantic memory concepts in language processing, in goal-directed processing, cognitive inhibition, flexibility, planning, etc. (Orellana and Slachevsky, 2013).

Studies have shown that, in schizophrenia, the semantic memory is preserved, meaning that the concepts and their features are not degraded as in category-specific deficits, but that access to them is disrupted (Allen et al., 1993, Elvevåg et al., 2002).

In 1938, Cameron (McKenna & Oh, 2005) described an overinclusion of objects in categories by schizophrenia patients as compared to healthy controls. Lawrence et al. (2007) presented similar results, concluding that overinclusion is the result of an inability to preserve boundaries of categories, which leads to indistinct and broadened category boundaries. Other studies have reached similar results (Chen et al., 1994; Brébion et al., 2004; 2010; Kreher et al., 2008), while Elvevåg et al. (2002) did not find qualitative differences between schizophrenia patients and a healthy control group, but they did find slower reaction times in the patient group.

On account of hyperpriming results on priming tasks in schizophrenia patients, Spitzer (1993) concluded that patients have an increased amount of spreading activation in the semantic memory. In explaining hyperpriming in schizophrenia patients, Maher (1983) claimed that activating a concept activates concepts associated with the first activated concept, which in its foundation constitutes the theory of spreading activation. The increased spreading activation theory was validated with other studies, in addition to priming tests, by analyzing association production in schizophrenia patients' discourse (Maher et al., 2005), fluency tests (Johnson and Shean, 1993), categorization tests (Brébion et al., 2010, Kreher et al., 2008), etc.

Maher (1983) proposed that, along with the increase in spreading activation, inhibition processes in language processing are decreased in schizophrenia, resulting in the intrusion of activated, and not inhibited, associations (Leeson et al., 2005). In an ERP priming study, Kreher et al. (2008) also concluded that their results of heightened activation in a shorter time frame in the semantic memory of schizophrenia subjects, in comparison to healthy control subjects, could be the result of increased automatic activation and/or a deficiency of inhibition. Moritz et al. (2001), in a study on the processing of dominant and inferior meanings of homographs, also conclude that there is a lack of inhibition in schizophrenia patients compared to healthy control subjects.

Leeson et al. (2005) note that inhibition mechanisms play a significant role in both the increased spreading activation and disorganization theories. While, according to the spreading activation theory, inhibition seems to decrease in schizophrenia, resulting in heightened activation of the semantic memory and the activation of inappropriate concepts which would have been inhibited, the disorganized semantic memory theory suggests that inhibition is heightened as closely related activated concepts are inhibited and activation spreads to more distantly related concepts. Furthermore, inhibition is not the only executive function domain which seems to be affected in schizophrenia. Although abnormalities in both the semantic memory and the working memory or executive function have shown to predict clinical language disturbances (Kuperberg 2010), conclusions on their specific roles in language processing deficits in schizophrenia require further, more exhaustive studies.

On account of these theoretical approaches, Kuperberg et al. (2010) concluded that schizophrenia patients rely on semantic associations in language processing, which leads to the disruption of the balance of necessary processes and the generation of inappropriate meanings on a higher level. With further studies, Kuperberg et al. (2019) diverged research on schizophrenia language deficits towards controlled and automatic processes and top-down and bottom-up processing. Because patients with schizophrenia do not show heightened direct priming results, and on account of neural studies and highly automatic priming studies with 0 SOA, Kuperberg et al. (2019) concluded that increased automatic (indirect) priming occurs because of noisier lexical representations, i.e. nodes that describe the connections between the form and the meaning of words. While automatic spreading activation theory does not account for why schizophrenia patients mostly do not show heightened direct priming, Kuperberget al. (2019) suggest that automatic activity can spread in a bottom-up direct pathway from a prime word form representation to indirectly related representations, without them being meditated by a directly related representation, because the lexical representation encodes mappings between the word form and the semantic features (which do not need to be pre-activated) and are connected to indirectly related representations, hence “noisier lexical representations.” These assumptions are based on the fact that, under automatic conditions at 0 SOA, it is suspected that there will not be enough time for pre-activation on the semantic level.

In a meta-analysis of studies concerning thought-disordered subjects, Sumner et al. (2018) conclude that there are few studies which investigate correlations between behavioral and functional neuroimaging measures in thought disorder, although there is behavioral evidence for executive dysfunctions in thought disorder. Even though neuroimaging studies mostly concern the analysis of a general symptom of attention and working memory, some neural correlates of thought disorder can be interpreted as executive function deficits, such as attentional selection (Pessoa, 2009) or cognitive integration (Duff and Brown-Schmidt, 2012). Accordingly, some cognitive evidence is indicative of combinatory semantic and executive dysfunctions in thought disorder (Leeson et al., 2005), as mentioned above.

5. The psycholinguistic characteristics of words in the assessment of language processing

Any use of language (both in production and in perception), whether in healthy individuals or in individuals with some form of linguistic difficulty, necessarily involves access to information about the world that is stored in the form of lexical concepts and categories in the human mind. People shape mental concepts of categories of objects that enable them to respond appropriately to new objects they encounter. Concepts, their categorical organization, levels of hierarchical taxonomy, and ways of storing and retrieving information from lexical memory are the most commonly investigated psychological and neurolinguistic phenomena, especially in linguistic pathology (Levelt, 1993; Murphy, 2002; Murphy, 2010; Levin & Pinker, 1992). The understanding and description of the mechanisms of language processing are primarily associated with semantic memory. Semantic memory is the term for long-term memory in which conceptual information (both semantic and lexical), as well as facts about the world, are presented. It refers to the part of long-term memory that processes ideas and concepts that do not derive from personal experience (as opposed to episodic memory) but which includes generally known facts acquired during one's life. This depository of signs, i.e. concepts or words and their characteristics, is thus found within the long-term memory, specifically within the semantic part of the declarative memory. Semantic memory derives from episodic memory inasmuch as new facts or concepts are learned based on experiences, while episodic memory is considered to intensify semantic memory. Semantic memory can also be defined as "a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, about relations among them, and about rules, formulas, and algorithms for the manipulation of these symbols, concepts, and relations" (Tulving, 1972, p. 386).

In order to understand the process of retrieving information from semantic memory in the language processing of persons with psychosis, ultra-high risk of psychosis (UHR), or schizophrenia, verbal fluency is used as a clinical test and as a basic tool. Verbal fluency can be semantic (the meaning relations of words within a category) and phonological (the connection between a word and its initial phoneme). Semantic verbal fluency is identified as a possible predictor of psychosis, neurocognitive deviations, and abnormalities and irregularities prevalent both in first-episode psychosis and in UHR patients. On the one hand, difficulties in semantic fluency may indicate problems in the very organization and storage of semantic information in the mental lexicon (category organization, levels of hierarchical taxonomy), but they may also indicate problems with the retrieval of information from lexical memory. Studies of UHR patients indicate impairment in selection, i.e. problems with selecting among alternatives during language processing, but not problems with retrieval from semantic memory. UHR patients have a lower mean value of total semantic fluency than help seeker controls. In young UHR patients, this effect is significant for each individual semantic category (e.g. animals, fruit), but not for phonological fluency. In patients with schizophrenia, semantic verbal fluency is also more impaired than phonological fluency. Difficult (poor) verbal fluency in schizophrenia may be an expression two separate problems in semantic processing – either the semantic memory has been damaged, or there is inefficient access to the semantic memory, which is actually normal.

The results of research on people at high risk of psychosis and non-psychotic help-seeking young adults, which confirmed significant differences on semantic fluency tests, suggest that semantic deficiencies occur during the prodromal phase and precede clinical expression, i.e. the full onset of psychosis. The very fact that verbal fluency (semantic categories) is impaired in patients at high risk for psychosis can be used to improve the predictability of the illness's development in high-risk patients, or in the possible transition to psychosis.

Therefore, some cognitive impairment in schizophrenia can be detected before the onset of the illness itself and thus can help identify people with high risk for psychosis. Recently great efforts have been invested in the development of fine-grained procedures for evaluating the measurement of multiple cognitive processes underlying performance. However, it is still unclear what independent components are needed to describe in detail the linguistic processing involved in a task of fluency.

Our goal in this book is to offer some of the possible linguistic elements (lexical characteristics) that could serve to improve the diagnostic value of early detection and illness monitoring tests in people with high risk for psychosis, first-episode psychosis, and schizophrenia.

Lexical units may be tightly or loosely connected in the mental lexicon, but their place in the semantic network is determined by the very fact that they share some of the same characteristics with other lexical units or their representations. Numerous linguistic and extralinguistic factors affect the storage and processing of language facts during spoken use. On the lexical level of language use, three basic types of parameters are most commonly said to be responsible for success in the use of words (Desrochers and Thompson, 2009; Desrochers et al., 2010). The first group consists of intrinsic characteristics of words that can be determined directly from their surface structure (e.g. the length of the words expressed in the number of phonemes, phones, letters, or syllables; part of speech; morphological characteristics, etc.). In the second group are parameters that depend on the target word's relationship to the wider corpus, i.e. contextual characteristics (the size of the phonological neighbourhood of the word, the word's frequency of use in the text, etc.). The third group of variables that affect the speed and accuracy of retrieving words from the mental lexicon during their active and passive use is constituted by so-called psycholinguistic characteristics, those which depend on the personal experience of the language user (e.g., the concreteness, subjective frequency, familiarity, and imageability of the word, the user's upon acquiring the word, etc.) and are calculated on the basis of the subjective assessment of a speakers of some language. We believe that precisely the psychological characteristics of the word could be a new element that would enable us to improve the diagnostic value of early detection and illness monitoring tests in people with high risk for psychosis, first-episode psychosis, and schizophrenia. Furthermore, we will address in particular those lexical characteristics that have been examined in some of the experimental studies presented in this book as well as characteristics that would be worth including in future studies.

5.1. Imageability and concreteness

Imageability is a psychological variable that addresses the ease at which a respondent creates a visual or auditory image of a reference that corresponds to a word; in other words, it is a lexical parameter that indicates how well a word leads to a mental image or sensory experience (Erdeljac, 2009; Erdeljac et al., 2014). The value of this characteristic is determined along a scale, so that a higher or lower degree of conceivability is attributed to individual concepts, and it is placed on the semantic level of language processing (Erdeljac et al., 2014). Imageability is commonly used in evaluating the effect of meaning on memory and word recognition. Imageability is often closely linked to concreteness, even to the extent that some authors either do not distinguish between these two lexical measures or they consciously equate them (Tyler and Moss, 1997; Paivio, 2010). But although for many words these parameters are in high correlation, there are data on subjective estimates that describe the same word as highly concrete while having low imageability. There are numerous studies which, taking into account this fact, prove that imageability is often a better predictor of the process of language performance than concreteness.

The key differences between the lexical-semantic systems of abstractness and concreteness consist in the fact that concrete words are adopted through sensory experience with physical objects, while abstract concepts are adopted through their use in sentences and in their mutual relations with other concepts within the language (Noppeney & Price, 2004). With concrete concepts, the representational form varies depending on the modality in which it is represented (in visual, auditory, tactile, or gustatory form), while abstract concepts are formed u propozicijski. In addition, concrete concepts present a direct link with entities in the physical world and have a fixed frame of meaning, while abstract concepts are largely determined linguistic context. In accordance with these assumptions, concreteness is associated with perceptual characteristics, and abstractness with verbally learned information. People with deviations in language processing perform linguistic tasks more successfully with words that refer to concrete concepts than to those which refer to abstract concepts – they retrieve them more quickly and accurately from lexical memory (the mental lexicon), associate them more easily with other similar words, more successfully detect different types of semantic relations among them, and remember their meanings longer. Both concrete and abstract words are represented in the verbal system, while only concrete words are semantically coded in the non-verbal system (as they correspond to easily imageable representations). Precisely because representations of concrete words are in both systems, such words are easier to retrieve and are more accessible in the lexical memory (Erdeljac et al., 2014, pp. 41–42). Thus, abstract and concrete words are encoded differently in our mind: concrete words have both verbal and visual representations, while abstract words are only verbal/linguistic. While functionally separate, there is also a certain level of interconnectedness between the two systems, so that the activation of a representation in one system can activate the appropriate representation in the other. Concrete/Imageable words are more accessible precisely because the systems are connected, and both can be activated simultaneously (Tyler et al. 2002:476).

5.2 Subjective frequency, age of acquisition, and familiarity of words

Subjective frequency refers to how often, according to the subjective assessment of native speakers of a given language, a word is used or heard in daily communication. The frequency of words can be evaluated in two ways: objectively or subjectively. The objective frequency of a word refers to the sum of the occurrences of a word in text corpora, while the subjective frequency of a word is the result of the assessment of native speakers on a Likert scale (Desrochers & Thompson, 2009).

A comparison of objective and subjective frequency norms showed a high correlation, so both modalities of assessment can be regarded as powerful predictors of ease and speed of responses in different types of language tasks (Fernández-Fuertes & Thompson, 2010). In research on the processing of written (visual) and spoken (auditory) words, subjective frequency is a better predictor than objective frequency (Balota et al., 2001). Furthermore, the influence of lexical frequency on the speed of naming is confirmed, and words that are used or heard more often are easier to retrieve from lexical memory than low-frequency words. The frequency effect is undoubtedly situated at the level of phonological coding because it influences the time it takes to activate and select the target lexeme; this effect can be explained by lowering the threshold for the activation of the lexeme, which is low for frequent words and high for low-frequency words (Jescheniak & Levelt, 1994).

Word frequency and age of acquisition are mutually very intertwined variables. The age of acquiring a word is defined as the period during which a person was able to understand a particular word if someone used it, even if he or she did not know how to use, read, or write that word at that time. It can be assumed that words adopted at an earlier/younger age tend to be used more often in adulthood by that speaker, but also that precisely the high frequency words (those used daily) are actually acquired earlier. These variables, it has been shown, are so mutually dependent that it is not easy to separate their effects. Age of acquisition has long been a neglected variable in lexical processing research, and its influences have been attributed to the frequency of words, which is easier to prove experimentally and to objectively observe (Barry et al., 2001).

Studies designed to observe the effects of word frequency and age of acquisition demonstrated the justification of the separation of these two characteristics of words, as it was confirmed that these two factors have different effects on the latency of response in different visual word processing tasks. It has been confirmed, for example, that age of acquisition affects naming latency, while word frequency is not confirmed in such types of tasks (Cortese & Schock, 2012; Wilson, Cuetos, Davies, & Burani, 2013).

Therefore, the subjective word frequency, as well as age of acquisition, are important variables that influence the processing of words. The greater frequency of a word and earlier acquisition of the word enable the speaker to retrieve and produce them more quickly. The processing of high-frequency words in tasks involving naming, as well as lexical and semantic decision-making, is faster than the processing of low-frequency words. It has been shown that frequency also plays a role in memorizing tasks such that low-frequency words are more difficult to invoke subsequently, but also that they lead to better results in tasks involving subsequent recognition. Subjective word frequency is a variable that correlates highly with many other characteristics – except with age of acquisition, it is also linked to word length, similarity to other words, etc.

The characteristics of word frequency and age of acquisition are also closely linked to knowledge of the word (the characteristic of familiarity). Familiarity refers to how often some object or concept is present in the experience of a speaker of a language. The familiarity of a word, or rather, of a concept, has been shown to have a significant impact on the speed of naming in healthy individuals as well as in those with some form of linguistic difficulty (aphasic patients). Images representing familiar objects retrieve the appropriate words from lexical memory more quickly than those representing unusual objects (Cuetos et al., 1999). Although this effect has not been found consistently in all studies investigating the determinants of image naming, in the literature, naming latency is considered an important possible linguistic processing predictor in pathology and should therefore be taken into account when this type of research is conducted (Alario et al., 2004; Barry et al., 1997).

It is assumed that familiarity affects the ease and speed of identifying objects and that this variable has an effect at the level of the link between visual recognition and the conceptual level (Cuetos et al., 1999). The effect of familiarity has been discovered at different levels of semantic processing in patients suffering from the semantic variant of primary progressive aphasia (Hirsh & Funnell, 1995). The assumption is that the structural visual representations of very familiar objects activate their corresponding semantic representations than is the case with representations of objects that are not well known (Boukadi et al., 2016).

5.3. Associative norms

Associations are considered a reflection of semantic memorization because they provide insight into the internal structure of concepts in language processing. Within the framework of psychology and linguistics, studies of associations were introduced as part of research on memory and language processing in connection with various pathologies. Associations reflect the way in which human knowledge is structured, the semantic representations of words, and the relationships among them (de Groot, 1989). Free-association tests (the listing of associations with a stimulus without further limitation, except limiting the quantity of data) are a means by which it is possible to construct maps of lexical knowledge of people who share linguistic and cultural background because similar experiences create associative structures that include representations of words and their connections, which are equated (Steyvers & Tenenbaum 2005).

Associations can be based either on the meaning or the form of the word, but also on simultaneous similarity on both of these levels of representation (semantic and phonological-acoustic). The characteristics of associative links can be twofold, i.e. they can be unlimited in number and an unspecified in order, so that a specific linguistic sign, word, or concept can activate an undetermined number of associations in any order. On the one hand, one can talk about so-called clang associations, which include an associative link between words on an acoustic-phonological basis (rhyme, number of syllables, accents, etc.), and on the other hand, these may be paradigmatic associations, which link words of great semantic similarity. Semantic similarity may relate to the closeness or overlap of certain characteristics, to the occurrence of another word, or interchangeability, while syntagmatic associations are those between words that are often appear together.

In studies on the structure and organization of semantic memory, associations provide information about the associative structures that reflect representations of words, and the testing of associations has been carried out since the very beginnings of interest in semantic memory (even Tulving concluded that tests of the association provide wide insight into semantic memory, 1972, p. 402).

Associative norms provide insight into the relative accessibility of (associatively) related words in the semantic memory and enable insight into the strength of the connections between certain words in the semantic memory. Such norms are useful in linguistic research: in the construction of a network of semantic memory, they reveal the structure of freely remembering in learning and in language processing; they reveal methods of searching within different semantic domains; they serve as a standard for comparison in psychological studies of healthy populations and those with linguistic pathologies; they can be used as a base for creating language materials or a foundation for manipulation in tasks with different variables of characteristics.

Memory search is considered an automated process based on the characteristics of stimuli and is carried out according to the laws of association. There are many different psycholinguistic models that attempt to describe semantic processing. In connectivist models, the semantic memory is presented as a network of connections that represent the characteristics of concepts, while concepts are marked at the nodes of those connections, and activation spreads when the searching towards these links reaches nodes that represent concepts. The internal organization of the semantic storage is determined by the abstract links between concepts and does not depend on the modality of the concepts or their characteristics. Another applicable model for the description of semantic processing is the *dual code theory* (Paivio, 1986), which envisages two repositories of different modalities (verbal and visual storage) and a different activation that depends on modality. In this model, information is activated from one or both of the repositories. With respect to internal semantic organization, the models of the organization are distinguished by domain-specific categorization, according to which the concepts, depending on their category, are processed in different regions partly according to their sensory modalities. Spreading activation theory, upon which most of the studies presented in this book are based, is unimodal: it does not presuppose specific repositories for certain modalities and argues that complex knowledge located in the semantic memory consists of nodes and connections between nodes, and that the knowledge of one concept consists of a whole network of nodes connecting the network via connections. In the spreading of activation, or in semantic processing, inhibition plays a special role.

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The effect of age on language in adults with intellectual disabilities: A comparison of passives in Down syndrome and Williams syndrome

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https://doi.org/10.17234/9789531758314.03

Abstract

Individuals with intellectual disabilities often show limitations in language functioning, commonly linked to their overall poor cognitive skills. However, despite the intellectual impairments and language delays, it is well established that language is more vulnerable in some populations, e.g. Down syndrome (DS), and relatively preserved in others, e.g. Williams syndrome (WS). Individuals with DS are also known to be at increased risk of cognitive decline due to the earlier onset of Alzheimer's dementia, although little is known about how aging affects language skills in this population. Individuals with WS, though with relatively developed language, are reported to never acquire some grammatical structures that appear late in typically developing (TD) individuals, such as passives of psychological verbs.

In an attempt to better understand how linguistic deficits in individuals with intellectual disabilities can be teased apart from the effects of general language delays, chronological age, and overall intellectual impairment, we compare the comprehension of passives in adults with DS (mean age: 38) and WS (mean age: 30). Passives are known to develop late in typical development and present difficulties for individuals with developmental disorders. This has been observed especially in their generally poorer performance on passives of psychological verbs than on passives of actional verbs.

Our results reveal divergent patterns of performance in our participants. Adults with WS performed no different from younger TD controls on actives and passives of both actional and psychological verbs. In contrast, adults with DS showed exceptionally poor performance on all sentence types, even on actives of actional verbs, considerably poorer than observed in the TD and WS groups. While the good performance of adults with WS might be due to individual variation, rather than continuous language development, we argue that the poor performance of participants with DS is due to an age-related decline of cognitive and language abilities, possibly linked to Alzheimer's-type dementia.

1. Introduction

Individuals with intellectual disabilities (IDs) by definition have significant limitations in intellectual functioning (i.e. reasoning, planning, solving problems, thinking abstractly, comprehending complex ideas, learning quickly, and learning from experience) and in adaptive behavior expressed in conceptual, social, and practical skills that originate before the age of 18 (AAIDD, 2010). Limitations in language functioning are not specifically noted in this definition; however, most individuals with IDs will have some language difficulties. This may be in the domain of vocabulary, where they may not be able to comprehend abstract terminology or appropriately express their thoughts and intentions; in the domain of phonology, where they may not be able to pronounce certain consonant clusters, making their speech unintelligible to others; in the domain of grammar, where they may not be able to rely on grammatical devices to mark the time or a duration of an event that has happened; in the domain of pragmatics, where they may not be able to use linguistic devices to specify referents involved in an event, or in the domain of semantics, where they may not comprehend subtle ambiguities in meaning. Limited competence in any of these domains may considerably affect these people's adaptive functioning, independent of intellectual skills such as planning or reasoning.

The question that has long intrigued researchers is whether a depressed level of language ability should be interpreted as a result of poor intellectual ability. However, the wide variability in both language and intellectual functioning of individuals with IDs makes this premise almost untestable. Still, it is well established that language is more vulnerable in some populations than in others, and while language is typically delayed in many populations, their ultimate linguistic achievement can be very different. Furthermore, it is now accepted that individuals with IDs rarely show flat profiles in their cognitive or language abilities: we see strengths and weaknesses in different domains. For instance, in Williams syndrome, visuo-spatial abilities can be severely affected, while verbal short-term memory is relatively spared (Mervis, 2006). In Down syndrome, verbal short-term memory is known to be severely deficient, and visuo-spatial abilities relatively strong (Abbeduto, Warren & Conners, 2007). It is also now known that some populations experience a decline in their cognitive skills as they age: individuals with Down syndrome are at an increased risk for Alzheimer's disease and show a tendency toward accelerated biological aging (e.g. Zigman & Lott, 2007). However, it is unclear how aging affects language skills in individuals with Down syndrome: some studies report a decline in language skills from around 40 years of age (e.g. Carter Young & Cramer, 1991), while others find no evidence for such a decline (e.g. Devenny & Krinsky-McHale, 1998; see Witecy & Penke, 2017, for a recent review).

In an attempt to better understand whether, and how, linguistic deficits in individuals with IDs can be teased apart from the effects of overall intellectual impairment and general language delays, here we compare the linguistic competence of two populations that have often been compared in the literature: Down syndrome (DS) and Williams syndrome (WS). They are etiologically distinct developmental disorders with distinct cognitive and language profiles, but language delays and IDs are common to both. In order to avoid the effects of language delay and differential rates of development, we focus on adults, whose language development is unquestionably complete, but, crucially, may now be subject to decline, at least in DS.

In the ensuing sections, we give an overview of the cognitive and language skills of individuals with WS and DS before presenting our small-scale study involving adults with these disorders. We focus on assessing the comprehension of passives, an aspect of grammar known to develop late in typically developing (TD) children and also to present difficulties for individuals with language and cognitive impairments.

2. Language and cognition in DS vs. WS

WS is a rare genetic disorder caused by the deletion of about 26 genes on the long arm of chromosome 7, affecting between 1 in 7,500 and 1 in 25,000 individuals (Ewart et al. 1993). The deletion of the crucial gene, Elastin, is associated with a number of medical conditions and a specific cognitive profile (see Royston, White & Howlin, 2019 for a review). Disparities are noted between different aspects of cognitive abilities: visuo-spatial construction skills may be particularly affected, along with sensory motor processing, executive function, and attention. Auditory memory, however, is relatively preserved (Mervis, 2006). WS has been hailed as an example of intact language and impaired cognition (Bellugi, Marks, Bihrle & Sabo, 1988). However, it is now accepted that the language of individuals with WS, while not intact, is a relative strength compared to other aspects of cognition affected by the syndrome (cf. Mervis, 2006). A number of studies have shown a command of various aspects of grammar at levels comparable to those in younger TD children functioning at equivalent levels of cognitive and verbal functioning: binding (Ring & Clahsen, 2005, Perovic & Wexler, 2007; 2018), passives of actional/agentive verbs (Clahsen & Almazan, 1998; Ring & Clahsen, 2005; Perovic & Wexler, 2006; 2010), wh-questions and relative clauses (Zukowski, 2001). However, there are indications that aspects of complex grammar known to develop late in typical populations (e.g. raising, Perovic & Wexler, 2007; passives of psychological verbs, Perovic & Wexler, 2010) may be further delayed or even unattainable.

DS is a chromosomal disorder caused by trisomy of chromosome 21. Affecting about 1 in 650–1000 live births worldwide (Bittles, Bower, Hussain & Glasson, 2007), it is one of the most common causes of ID. It is associated with significant health issues, hearing loss, and premature aging. It has long been known that individuals with DS over the age of 35–40 show neuropathological hallmarks of Alzheimer's disease (Malamud, 1972), such as amyloid plaques and neurofibrillary tangles. The role of chromosome 21 is crucial, as it contains a number of genes implicated in Alzheimer's, thus putting individuals with DS at particular risk, compared with individuals with other IDs (Lott & Dierssen, 2010). However, definitive signs of dementia do not appear until later, and it is unclear whether dementia presents differently in DS compared to the types of Alzheimer's dementia that appear in typical populations (e.g. Zigman & Lott, 2007; Zis & Strydom, 2018).

The cognitive profile of DS is characterized by disparities between different domains: impairments in auditory memory, attention, and executive function are common, but visuo-spatial abilities are typically less impaired, for instance (Abedduto et al, 2007). Language in DS has been reported to be more noticeably affected than cognitive abilities, which sets it apart from other populations with IDs (Perovic, 2006; Abedduto et al, 2007). There is, of course, wide individual variation in both language and intellectual abilities among people with DS (Karmiloff-Smith, Al-Janabi, D'Souza et al, 2016). However, disparities between measures of overall mental age (MA) and language measures have been reported in both children and adults with DS (e.g. Fowler, Gelman & Gleitman, 1994; Rondal & Comblain, 1996). This is most obvious in their command of morphosyntax.[1] Chapman, Seung, Schwartz & Kay-Raining Bird (1998) report that expressive language of 5- to 8-year-old children with DS, measured by mean length of utterance (MLU), was comparable to a TD 2-year-old child, while the MLU of adolescents (16- to 20-year-olds) was comparable to that of a TD 3-year-old child. Even if MLU improved in adolescence, grammatical morphology remained deficient. The results of these and numerous other studies bring into focus dissociations at the level of the language faculty itself: aspects of language functioning that seem most impaired in this population are those of the computational system, i.e. morphosyntax and phonology, in contrast to those associated with the general processing system, i.e. vocabulary and pragmatics. Studies typically show impairment in any of the areas of grammar studied (with the focus on English-speaking individuals): binding (Perovic 2001; 2006, Ring & Clahsen, 2005), passives of actional verbs (Bridges & Smith, 1984; Ring & Clahsen 2005; Joffe & Varlokosta, 2007), wh-questions (Joffe & Varlokosta, 2007).

1 There is evidence, however, that DS children's morphosyntactic abilities as measured in production studies are obscured by their very poor phonological abilities. See Christodoulou (2015), Christodoulou and Wexler (2016).

The effect of aging and possibly Alzheimer's disease on language abilities in DS has not been systematically investigated, despite interesting overlapping in the linguistic profiles. Research on Alzheimer's dementia in typical adults has uncovered a range of linguistic deficits, usually linked to impaired working memory. Semantic impairments are most commonly reported (e.g. Altmann & McClung, 2008), in addition to impairments in sentence comprehension (e.g. Rochon, Waters & Caplan, 2000) and production (e.g. Altmann, 2004). Crucially, grammatical difficulties are observed in both spontaneous speech and in experimental tasks, in the production of passives (e.g. Bates, Marchman, Harris, Wulfeck & Kritchevski, 1995), subject-verb agreement, and the production of closed-class words (auxiliaries, determiners, prepositions) (e.g. Altmann, Kempler & Anderson, 2001; though see Kavé, 2003), which are also typically impaired in individuals with DS.

Early studies investigating effects of age on language in DS seldom used methods common in the dementia research reviewed above: they either relied on proxy measures, such as reports by carers of individuals with DS (e.g. Carter Young & Kramer, 1991), or they focused on verbal IQ subscales, which usually assess receptive vocabulary only (e.g. Devenny & Krinsky-McHale, 1998), the aspect of language abilities that we know is often the strongest in individuals with DS. One study that focuses on pragmatic aspects of language functioning, however, does report a decline in these language skills. Relying on a behavioral checklist administered to caregivers of adults with DS, Nelson, Orme, Osann & Lott (2001) report problems in social conversational style, failure to grasp the meaning of spoken or written words, and difficulty interacting with others in those 40-year-olds with DS with confirmed neurological and MRI changes. This study also reports a decline in vocabulary comprehension, as measured by the Peabody Picture Vocabulary Scales, though grammatical abilities were not assessed.

The few studies that have investigated language skills in more detail report divergent results. Rondal & Comblain (1996) and Witecy & Penke (2017) report no age-related changes in cross-sectional studies of grammar comprehension in French and German children and adults with DS, respectively. Witecy and Penke's (2017) results on the comprehension of a range of sentences presented in the German version of the Test of Reception of Grammar (TROG) reveal difficulties with grammar typical of DS, with some of their participants (the younger group was aged 4;6–19;0; the older group, 20;8–40;3) unable to comprehend even simple sentences. Yet some studies report *improvement* with age in aspects of phonology, semantics, and grammar in German (Schaner & Wolles, 2004) and in Greek (Sanoudaki & Varlokosta, 2015). However, except for Rondal & Comblain, these studies do not include adults with DS over the age of 40, when signs of dementia are more likely to appear in this population, and do not include assessments designed to assess for presence of dementia.

Iacono, Torr & Wong (2010) included assessments of dementia as well as measures of receptive and expressive language in a large sample of 55 adults with DS in the relevant age range: 19–55 years. Once the data of ten of their participants, aged 39–58, with confirmed or suspected diagnoses of Alzheimer's dementia was removed, their analysis showed no age-related decline in receptive language, measured by a standardized test of vocabulary, morphology, and syntax, but pointed to a significant decline in expressive language, as measured by MLU. Note, however, that MLU is not a reliable measure of morphosyntax – a higher MLU does not automatically mean a more sophisticated use of grammatical morphemes in an individual whose vocabulary production may be more advanced than their grammar. Also, this study does not report their participants' results on the linguistic structures tested in the standardized measure of receptive morphology and syntax, making comparisons to other studies difficult.

2.3 Passives and their acquisition in typical development, Down syndrome, and Williams syndrome

The verbal passive ('Mary is kissed by John') is a construction known to pose difficulties for both TD children and those with developmental disorders. However, the comprehension of verbal passives is known to be affected by the type of verb used: children as young as four perform well on passives of actional/agentive verbs (e.g. *kiss, push*), whereas passives of psychological verbs (e.g. *see, love*, also referred to as non-actional and experiencer verbs) are difficult to comprehend even for 7-year-olds (e.g. Maratsos, Fox, Becker, & Chalkley, 1985). One well-known explanation for this pattern of performance is that it reveals an incomplete knowledge of the syntactic movement involved in the formation of passive (Borer & Wexler, 1987). These authors argue that children's good performance on passives of actional verbs is due to a particular strategy of interpreting these structures as adjectival passives. Adjectival passives (e.g. *The door is broken*) are distinct from verbal passives: they are formed independently of the syntactic mechanism needed for the formation of the verbal passive (see Hirsch & Wexler, 2006, for a review of studies on typical development, Perovic & Wexler, 2010, for a review on studies on atypical development, and Wexler, 2004, for a detailed theoretical advancement of his theory).

There is little systematic research investigating the full range of passive constructions in individuals with DS, which includes both actional and psychological verbs, the latter being a means of testing the full knowledge of passives in the literature on typical acquisition.

In the very first study on this topic, Bridges & Smith (1984) used an act-out task to test actives and long (long: including the 'by-phrase') *get* passives in 24 participants with DS, age range: 4–17. They report scores of between 70% and100% on actives, and only between 30% and 50% on the passives, comparable to TD 4-year-olds. Since *get* passives have characteristics of adjectival passives, and young children do much better on *get* than *be* passives, this poor performance is consistent with what we know about DS children not being able to use the adjectival interpretation to comprehend *be* verbal passives.

Bellugi, Bihrle, Jernigan, Trauner and Doherty (1990) report data from one of the first comparisons of language and cognitive abilities in DS and WS. Six adolescents in each group (mean age: DS group=15;4; WS group=14;4), matched on age and full IQ, showed a distinct pattern of performance: on long passives of actional verbs, participants with WS averaged about 90% correct, while those with DS performed at chance.

Clahsen & Almazan (1998) and Ring & Clahsen (2005) used a four-picture selection task to test comprehension of passives of actional verbs only, both short (without the 'by-phrase') and long, in teenagers with DS and WS, and in MA-matched younger controls. Participants with DS performed at chance on long and short passives, and just under 80% correct on actional actives. Participants with WS performed considerably better, with 90% correct on actives, and around 80% on long and short passives. Different patterns, however, were observed on the same task in Joffe & Varlokosta (2007) in the performance of younger children with WS and DS (aged 6–14, mean=8;9), compared to much younger MA-matched TD controls (aged 3;3–6;5, mean=4;4). Groups with WS and DS performed equally poorly overall, significantly worse than TD controls, but not significantly different from each other. All groups performed poorly on passives, though a surprisingly low performance on actives was recorded for all the participant groups: 55%, 64%, and 74% correct, for DS, WS, and TD, respectively, indicating that the task may have been too demanding even for the TD controls. Witecy and Penke (2017), mentioned in the previous section, also report chance performance of their child and adult participants on the four actional long passives tested in the German version of the standardized grammar comprehension test, TROG.

Eriks-Brophy, Goodluck & Stojanovic (2004) was the only study that tested both actional and psychological verbs in DS. Their participants were 8 individuals with DS aged 11–33, with vocabulary skills higher than usual on the scale (vocabulary age equivalent ranging between 6 and 12;11), prompting the authors to label them as high-functioning, although no IQ scores were reported. Two tasks were used to assess the comprehension of passives, act-out and Truth-Value-Judgment (TVJ), with 4 tokens of each construction: 2 'false'; 2 'true'. The participants' performance on actional actives was very good, at 97% and 84%

correct in the act-out task and the TVJ task, respectively. Their performance on long actional passives was considerably poorer, at 59% and 66% correct, and on long non-actional passives even poorer, at 41% and 34% correct. There was a disparity, however, in their performance on short non-actional passives on the act-out task, at 47%, vs. the considerably higher 85% on the TVJ task. The participants' performance on actives of non-actional verbs was 78% correct on the act-out task, and only 62% correct for the TVJ task. The poorer performance on the TVJ task could be explained by task effects: the task involved somewhat complicated and long stories, that were likely highly demanding on the participants' memory and inferencing skills, but since no comparison data are available from TD controls, it is difficult to interpret these results.

In addition to the studies above, which included comparisons of children with WS and DS, and only passives of actional verbs, two studies investigated passives of both actional and psychological verbs in WS. Karmiloff-Smith, Tyler, Voice, Sims, Udwin, Howlin & Davies (1998) tested comprehension of long but not short passives of psychological and actional verbs in eight teenagers and adults with WS, aged 14;9–4;8 (mean age=20;7). The authors report a 17-percent error rate on actives of actional verbs, a 17 percent error rate on passives of actional verbs, and a 33-percent error rate on actives and passives of psychological verbs combined. No breakdown of scores for actives and passives of psychological verbs is given however, and no details of the task and the verbs used, again making these results difficult to interpret.

Perovic & Wexler (2010) carried out the most comprehensive study of passives in WS to date, involving 26 children and teenagers with WS, aged 6–16 (mean age=11;6), and three groups of TD controls, matched separately on different measures of language and non-verbal reasoning to the WS group. Actives of actional and psychological verbs, and short and long passives of actional and psychological verbs were tested relying on a picture-selection task – the methodology used in the majority of studies reviewed previously – which was developed and used in one of the largest studies on passives in typical development, that of Hirsch & Wexler (2006). The results show a strong performance on actives and actional short and long passives in the WS group, no different from three TD control groups. However, their performance on passives of psychological verbs, both long and short, was extremely poor, and significantly worse than any of the TD control groups': only 18 percent correct for PLP, and 33 percent correct for PSP. Interestingly, 5 out of 26 children with WS in this sample performed well on passives of both actional and psychological verbs. These children did not perform unusually well on the standardized measure of language and cognition; however, they were among the oldest in the sample: aged 12, 13, 14;4, 15, and 16;6. Note that there were an additional 8 children in the sample aged 12 and above who did not perform well on psychological passives; and none of the younger children showed good performance on psychological passives (though they may have done so on actional passives). It is unclear whether this is a simple instance of individual variation, or whether age has some role to play in these teenagers' better command of passives, a point we shall come back to in the Discussion.

2.4 The current study

To investigate the full range of passives in two distinct types of IDs as well as the possible effects of age on the mastery of this complex syntactic structure, the current study focuses on the comprehension of passives in adults with DS vs. in adults with WS, relying on the methodology widely used in the literature with both typically and atypically developing populations to minimize task effects.

For DS, we predict poor performance on psychological passives (these passives being the means of testing the knowledge of passives in the TD population), based on two points: (a) the well-known syntactic deficits in the population with DS, and (b) the cognitive decline attributed to early Alzheimer's dementia in adults with DS over the age of 35, which may also cause a decline in language abilities. Both (a) and (b) predict poor performance on both actional and psychological passives. However, only (b) predicts poor performance on active sentences too, regardless of the verb.

For WS, we predict good performance on passives of actional verbs, and a poorer performance on psychological passives, in line with the results reported in the literature, and the reasonable hypothesis that children with WS (but not those with DS) are able to substitute the adjectival interpretation for the verbal passives for actional verbs. However, based on the individual variation reported for teenagers with WS in Perovic & Wexler (2010), it is also possible that some of our adults with WS may perform relatively well on passives of psychological verbs.

3. Experiment

3.1 Participants

Six adults (two males) with DS, aged 24–47 (mean: 38), six adults with WS (two males), aged 19–43 (mean: 30), and six TD children (two males) aged 4–5;9 (mean: 4;6) were included in the study. The participants with DS were recruited and tested in London, United Kingdom, with the help of the charity Choice Support. The participants with WS and the TD controls were recruited as part of a larger study in the United States, with the help of the Williams Syndrome

Foundation.[2] Adults with WS all lived at home with their families, while adults with DS lived in supported housing, without their families.

Table 1 gives the participants' results on standardized assessments of verbal and non-verbal skills. The adults with DS and the TD controls were matched on the raw score of KBIT Matrices, a measure of non-verbal reasoning (p=.348). The groups with WS and DS were matched on chronological age only; despite the group with DS being 8 years older on average, this difference was not statistically significant (p=.125). These two groups could not be matched on any of the language or intellectual functioning measures, due to the floor effects in the scores of participants with DS on all the standardized measures (see Table 1). All groups were matched on gender.

Table 1. Participants' characteristics

Group	DS	TD	WS
Mean Age in years	38 (9.68)	4;06 (.7)	30 (8.6)
Age range in years	24–47	4–5;09	19–43
KBIT Matrices RS	10 (3.4)	11.5 (5.7)	20.2 (1.5)
KBIT Matrices SS	40 (0)	61.5 (8.5)	61.5 (8.5)
BPVS 2 RS	36.4 (12.8)	59 (10.42)	-
BPVS 2 SS	40 (0)	98.5 (9.85)	-
PPVT-III RS	-	-	142.4 (24)
PPVT-III SS	-	-	76 (18.6)
TROG-2 RS	0.2 (.45)	-	14 (1.8)
TROG-2 SS	55 (0)	-	80.5 (8.58)

RS=raw score; SS=standard score. KBIT: Kaufman Brief Intelligence Test. BPVS: British Picture Vocabulary Scales. PPVT: Peabody Picture Vocabulary Test, the American standardization of BPVS. TROG: Test for Reception of Grammar. For the group with DS, scores on standardized measures are available for 5 out of 6 participants. For the group with WS, scores are available for 5 out of 6 participants for PPVT, and for 4 out of 6 participants on the other measures.

3.2 Method

A two-choice picture selection task was used, created by Hirsch & Wexler (2006), that involved three agentive/actional verbs (*kiss*, *hold*, *push*) and three psychological/experiencer verbs (*remember*, *see*, *love)*, in the following experimental conditions: actional active (AA), e.g. *Lisa kisses Bart*; actional long passive (ALP), e.g. *Bart was kissed by Lisa*; actional short passive (ASP), e.g. *Bart was kissed*; psychological active (PA), e.g. *Marge remembers Homer*; psychological

2 Two nineteen-year-olds with WS participated in the study by Perovic & Wexler (2006), while some of the TD controls' data were used in Hirsch & Wexler (2006) and Perovic & Wexler (2010).

long passive (PLP), e.g. *Homer was remembered by Marge*; and psychological short passive (PSP), e.g. *Homer was remembered*. All sentences were semantically reversible, involving pictures of cartoon characters familiar across ages and cultures. Each verb was used twice in each condition, with different agents and patients. With 6 items in each condition, and 6 experimental conditions, the total number of items was 36.

The procedure involved asking the participants to point to one of the two pictures presented on a computer screen that matched the sentence uttered by the examiner. A detailed introduction to the characters and actions used in the pictures and four training items for which feedback was provided were given to each participant before the task was administered. Additional training was given for experimental items that involved thought bubbles depicting experiencer verbs, *remember* and *love* (e.g. the stimuli for *Marge remembers Homer*, involved a picture of Marge, with a thought bubble containing a picture of Homer, above her head). The sentences were randomized automatically for each participant. Ten neurotypical adults, aged 19–35 (not included in the study), were tested on the task, showing a 100% performance.

4. Results

Our participants' responses (correct or incorrect) were analyzed using GLMM, a logistic regression model known to be better suited to binomially distributed data than standard ANOVAs (Jaeger, 2008). The fixed effects built into the model were Group (DS, WS, TD), Sentence Type (AA, ASP, ALP, PA, PSP, PLP), and Group x Sentence Type interaction. Participants were treated as random effects by this model.

We obtained a highly significant effect of Group: $F\ (2, 90) = 26.261$, $p < .001$, a significant effect of Sentence Type: $F\ (5, 90) = 3.589$, $p = .005$, and a significant Group*Sentence Type interaction: $F\ (10, 90) = 2.430$, $p = .013$.

The overall performance of the WS group, with an estimated probability correct of .88, was not statistically significantly different to that of the TD group's estimated probability correct of .81 ($t(90)=1.369$, $p=.174$). Planned posthoc Sidak-corrected comparisons revealed no statistically significant differences between the TD and WS groups on any of the sentence types (see Table 2). Both groups showed confident performance on actives of actional (AA) and psychological (PA) verbs, as well as passives of actional verbs, short (ASP) and long (ALP). Their performance on long and short passives of psychological verbs (PLP and PSP) was considerably lower, though: in the TD groups it seems no better than chance, with estimated mean probabilities correct at .50 and .53, respectively. While the WS groups showed a higher performance on PLP (.67) and PSP (.75) than the TD group, these differences were not statistically significant.

Participants with DS performed exceptionally poorly: their estimated mean probability correct for all sentences collapsed was only .46, significantly lower than that of the TD controls (($t(90)=5.974$, $p<.001$), and significantly lower than that of the WS participants ($t(90)=7.822$, $p<.001$). Crucially, these participants performed poorly even on the active sentences of actional verbs (AA), with estimated mean probability correct at .39, as well as on active sentences of psychological verbs (PA), with estimated mean probability correct at .42. Planned posthoc Sidak-corrected comparisons revealed that their performance on all sentence types, except for PLP and PSP, was statistically significantly lower than that observed in the TD and WS groups: at $p<.001$ for AA and PA compared to both WS and TD, at $p=.001$ for ASP compared to both WS and TD, at $p<.001$ at ALP compared to WS, and $p=.002$ compared to TD.

Table 2. Estimated mean probabilities correct (standard error) for each sentence type.

Group	DS	TD	WS
AA	.39 (.09)	.94 (.04)	.94 (.04)
ALP	.42 (.09)	.83 (.07)	.89 (.06)
ASP	.44 (.11)	.92 (.06)	.92 (.06)
PA	.42 (.09)	.86 (.07)	.94 (.04)
PLP	.56 (.09)	.50 (.09)	.67 (.09)
PSP	.53 (.15)	.53 (.15)	.75 (.13)

AA: Actional Active; ALP: Actional Long Passive; ASP: Actional Short Passive; PA: Psychological Passive; PLP: Psychological Long Passive.

4.1 Individual differences

Individual variation between participants was present in the TD and WS groups, but not in the DS group. Four participants with WS showed good performance on all passives, including psychological passives: three participants reached 5 or 6 out of the possible 6 correct on all passives, and one participant reached 4 out of 6 on PLP and 6/6 on PSP. The two remaining participants with WS, the youngest (aged 19) and the oldest (aged 43), reached scores that were especially low on PLP and PSP, just like the younger TD children. In the TD group, only one 5-year-old showed near perfect performance; the remaining children showed a more varied range of scores, with the poorest scores on PLP and PSP. In the group with DS, no variation could be observed – there were no participants who showed a confident performance on any of the sentence types, with all participants performing at chance.

5. Discussion

The results of our small-scale study reveal distinct patterns of performance in adults with IDs and TD controls on the different types of passive constructions tested here: the strongest performance was observed in adults with WS, and the poorest performance was observed in the adults with DS. This pattern is in line with previously reviewed literature; however, this is the first study to show an extremely low performance of adults with DS even on the simple Subject-Verb-Object (SVO) sentences, such as actives of actional verbs. We discuss our data in more detail below and discuss possible accounts of the observed patterns, linking the extremely poor performance of adults with DS with the possibility of cognitive decline associated with premature aging.

Adults with WS showed the highest performance, although it was not statistically significantly different from that of the TD control children. Looking at passives individually, we observe that on passives of actional verbs, short and long, both TD controls and WS adults reached a near-ceiling performance. The weakest performance of the TD and WS groups was on passives of psychological verbs, long and short. This is in line with numerous studies in the literature on typical development, as well as with results of children and teenagers with WS in Perovic & Wexler (2010). The TD participants in the current study are aged 4–5;09 – the age before passives are fully mastered. It is expected that within the next year or two, these children will reach adult-like competence, just like the 7-year-olds in Hirsch & Wexler (2006). However, the patterns observed in the data of our WS group have not previously been reported: passive comprehension demonstrated by our adult group with WS is in fact much better than what is reported in the literature. Children and teenagers with WS in Perovic & Wexler (2010) showed an extremely poor performance on both long and short passives of psychological verbs: only .18 proportion correct for PLP, and .33 proportion correct for PSP. These are considerably lower than the estimated mean probabilities correct of our sample of adults in the current study, .67 and .75 estimated probability correct for PLP and PSP, respectively. This result is driven by an excellent performance of four out of six adults in our sample who reached 5/6 or 6/6 correct (and 4/6 on one occasion for one participant) on passives of psychological verbs, the test case of mastery of the passive. This could not be due to the overall better intellectual abilities of our participants, as their standard scores on the test of non-verbal reasoning (KBIT Matrices), ranged between 61 and 70 (cf. the mean of 74 on this measure for participants in Perovic & Wexler, 2010). It is possible that their background language skills were somewhat better developed, however. Note that our participants'[3] receptive grammar standard scores

3 Note that we have no data for one of the participants with WS on any of the standardized measures; this participant, aged 31, scored 6/6 on every sentence type.

(on TROG 2) were 76, 85 and 90, and receptive vocabulary standard scores (on PPVT III) were 81, 83, 88. A similar spread of scores on these same measures is observed in the 5 teenagers in Perovic & Wexler (2010), mentioned earlier, who also showed a strong performance on both types of passives. Still, it is difficult to make comparisons based on data from our very small sample of participants, especially keeping in mind the wide variation in language and intellectual skills in WS. Notice that even within our own "poor" performers on psychological passives, one participant's vocabulary standard score was 85 (in the low average range) and the other's was 43 (in the severely impaired range).

However, a factor that could be relevant is the chronological age of our participants with WS. Unlike in previous studies, our participants were all adults. Significant differences in the profiles of younger compared to older individuals with WS have been noted in the literature, with older individuals performing better (Bellugi et al, 1990; Brock, Jarrold, Farran, Laws & Riby, 2007), which could be a result of the verbal abilities developing faster than non-verbal abilities in this population (Jarrold, Baddeley & Hewes, 1998). Could we interpret the better performance on passives in adulthood as evidence of a more continuous language development in WS? It is impossible to reach such a conclusion on the basis of the data from our small sample of participants, and without recourse to longitudinal data, but it is an interesting idea to explore in the future, in larger samples, and longitudinally. It is also possible that the individual variation observed here is linked to a slightly different genetic makeup for different individuals with WS. After all, with a syndrome caused by the deletion of so many genes, we might expect differential effects of the size of the deletion on the cognitive but also the linguistic phenotype of WS.

The results of our group with DS are even more surprising: these participants showed a performance that was no different from chance, on every one of the 6 experimental conditions, including actives of both actional and psychological verbs. Recall that the same materials and the same active sentences used in our study, of the simple SVO type such as *Marge kisses Homer,* were successfully comprehended by more than 100 TD children aged from 3 years onwards in Hirsch & Wexler (2006), 48 children and adolescents with ASD, both low and high functioning, in Perovic, Modyanova & Wexler (2013), as well as 26 children and teenagers with WS in Perovic & Wexler (2010). Even more relevant is the relatively successful performance of participants with DS on actives in the studies reviewed earlier.[4] Our own studies (Perovic, 2001; 2006; 2008) confirm that young adults with DS are able to comprehend simple SVO sentences that

4 The exception is Joffe & Varlokosta (2007), whose 6- to14-year-olds with DS only showed chance performance on actional actives, at 55%. This could be a task effect, though, considering that both the WS group and the TD control group also showed a relatively poor performance on actives.

contain both proper names and pronouns in the position of subject or object in a sentence. What then could be the reason for the exceptionally poor performance of the participants with DS in the current study?

One obvious explanation would be that our participants have poor overall language and intellectual skills, as observed in their extremely low scores on the standardized measures of grammar, vocabulary, and non-verbal reasoning, significantly worse than the scores of the participants with WS. Their results on the standardized test of reception of grammar (TROG-2) are especially low, with only one participant obtaining a raw score of 1 (understanding 4 out of 4 sentences in one "block"), and the other 5 participants scoring 0, i.e. not passing a single block. Note that, on the German version of TROG, poor performances were reported in most of the adults with DS in Witecy & Penke (2017), with some participants scoring only 2 blocks correct. Witecy & Penke (2017) also report difficulties even with simple sentences in some of their participants.

It could be that by pure chance we recruited participants who were all at extremely low levels of functioning. Although this is possible, it would be unusual to have absolutely no variation in a sample of a population that is known for wide individual differences. However, an interesting avenue to explore is the link between Alzheimer's dementia and DS. We know that individuals with DS are at an increased risk of Alzheimer's disease after the age of about 40 – the average age of our participants. We also know that there may be some overlap between the linguistic impairments found in typical individuals with Alzheimer's and those reported for individuals with DS. However, it has not been established whether the dementia presentation in DS is similar to that seen in typical individuals, in terms of either behavioral or cognitive outcomes (Zis & Strydom, 2018). Little systematic research on the effects of Alzheimer's-type dementia on the language of individuals with DS exists, with results of most studies being inconclusive, as shown in our review earlier. Yet, based on the exceptionally poor performance of our participants on both the standardized tests and our experimental task, we would like to tentatively suggest that the poor comprehension of both active and passive sentences observed in this study is the result of age-related decline. Note, however, that it is impossible for us to determine whether it is specifically the decline in language or cognitive skills that are the result of Alzheimer's-type dementia that caused our participants to perform the way they did. It is important not to confound the lack of language skills with the inability to be tested: our participants may not have been able to understand the task demands and perform on any of the standardized or experimental tasks. Nevertheless, if it were the task demands that were responsible, we would still have to attribute the difficulties here to the effects of aging/Alzheimer's (see Burt et al, 1998). We leave the question to further research.

6. Summary and conclusions

Our small-scale study is yet another attempt to chip away at the question of how linguistic deficits in individuals with IDs might be teased apart from the effects of overall intellectual impairment and general language delays as well as the effect of age on language in IDs. Cross-syndrome comparisons allow for more detailed descriptions of linguistic phenotypes in clinical populations, which are crucial both in helping us understand how language impairment manifests in different conditions and in shedding light on the age-old question of what comes first: language impairment or cognitive impairment.

The surprising patterns uncovered in the linguistic competence of adults with DS and with WS in this study suggest that the decline associated with accelerated aging could be an important factor that hinders linguistic abilities in individuals with DS, while aging may have beneficial effects for at least some individuals with WS. More comprehensive studies are of course needed before we are able to reach any definitive conclusions. Future research should include large numbers of participants who would be tested on a range of standardized linguistic and cognitive assessments, in addition to experimental tasks aiming to gauge different aspects of their linguistic abilities. Cross-sectional studies should focus on participants of different ages (under 40 and over 40), while longitudinal studies should begin around the age of 30. In turn, when ascertaining the effects of Alzheimer's dementia in adults with DS, it is crucial that researchers include assessments of linguistic functioning, because the decline in both cognitive and linguistic skills will affect these people's adaptive functioning in their everyday lives.

Acknowledgments

This research was supported by grants from the Anne and Paul Marcus Family Foundation to the Brain Development and Disorders Project, Massachusetts Institute of Technology, and from Choice Support, London, UK, to Alexandra Perovic. We would like to thank all the participants and their families, the Williams Syndrome Association (WSA) in the US, the UK charity Choice Support, Thomas Doukas, Christopher Hirsch, Nadya Modyanova, and all the students at the Wexler Lab for help with collecting data. The data on DS were presented by Thomas Doukas and Alexandra Perovic at the 15th World Congress of the International Association for the Scientific Study of Intellectual and Developmental Disabilities in Melbourne, Australia, in August 2016.

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Neuropsychological correlates underlying verbal fluency deficits in schizophrenia: The role of attention and executive function

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https://doi.org/10.17234/9789531758314.04

Abstract

Verbal fluency deficits are commonly observed in patients with schizophrenia. The role of executive functions is still a topic of critical debate, although other neuropsychological domains, e.g. attention, working memory and verbal intelligence, may also influence verbal fluency task performance. Furthermore, some studies report semantic fluency dysfunctions suggesting particular semantic access deficits, while others report regular patterns of verbal fluency task performance, with better performance in semantic fluency as compared to lexical fluency, suggesting general retrieval difficulties. In addition, formal thought disorder symptomatology is often associated with reduced verbal fluency performance. To further address these issues of verbal fluency deficits in schizophrenia, patients with schizophrenia (n=50) as well as a healthy control group (n=36) were recruited and tested according to the aforementioned neuropsychological parameters and both semantic and lexical fluency. Results indicate that executive dysfunctions are associated with verbal fluency performance particularly in the lexical fluency domain. Furthermore, a strong relationship was found between sustained-attention deficits and both semantic and lexical fluency, indicating that verbal fluency deficits in general are mainly driven by attention dysfunctions rather than aberrations in the executive domain. Results showed that patients with schizophrenia did not perform differently for letter vs. semantic fluency. Furthermore, controlling for attention, the results suggest that formal thought disorder symptomatology is unrelated to performance on verbal fluency. Taken together, impaired attention drives the decreased performance in verbal fluency tasks in patients with schizophrenia.

Key words: semantic fluency, lexical fluency, schizophrenia, neuropsychology, executive function, attention, language, alogia, formal thought disorder

1. Theoretical background

Deficits in verbal fluency performance are commonly observed in patients with schizophrenia (Bokat & Goldberg, 2003; Henry & Crawford, 2005). The two most common verbal fluency tasks are the semantic (or category) fluency task, in which participants are asked to generate as many words as possible belonging to a specific semantic category, and the lexical (or letter) fluency task, in which participants are asked to generate as many words as possible belonging to a specific initial letter or initial phoneme. Literal repetitions are not allowed in either task, and word-stem repetitions and proper names are off limits in the lexical fluency task. The given time window, which is between one and five minutes, varies among the different studies (Mitrushina, Boone, Razani & D'Elia, 2005; Raboutet, Sauzéon, Corsini, Rodrigues, Langevin & N'Kaoua, 2010). From a neuropsychological perspective, verbal fluency "has been commonly viewed as a component of executive function" (Mitrushina et al., 2005:202). However, the particular role of executive functions – in this context it is often referred to as "dysexecutive syndrome" (Thai, Andreassen & Bliksted, 2019) – on verbal fluency task performance is still a topic of critical debate. Other cognitive domains, such as attention, but also working memory and verbal intelligence, may also influence task performance. On a linguistic level, verbal fluency involves both efficient word retrieval processes and intact access to semantic or orthographic representations (Shao, Janse, Visser & Meyer, 2014; Stielow, 2017). With regard to patients with schizophrenia, semantic fluency dysfunctions were reported (Bokat & Goldberg, 2003; Henry & Crawford, 2005), suggesting particular semantic access deficits. In this context, category switching and clustering performance was found to be aberrant (Allen, Liddle & Frith, 1993; Elvevåg, Fisher, Gurd & Goldberg, 2002), supporting the view that semantic organization within the lexicon is impaired. On the other hand, some patient studies also report regular patterns of verbal fluency task performance, with better performance in semantic fluency than in lexical fluency (Barrera, McKenna & Berrios, 2005; Docherty, Berenbaum & Kerns, 2011; Doughty & Done, 2009), suggesting general retrieval difficulties. These differences may be driven by the presented stimuli *per se* (large [e.g. 'animals'] vs. small [e.g. 'professions'] semantic or lexical fields) as well as by the given time window. Other influencing factors are associated with certain search strategies such as mental imagery (e.g. walking through a zoo) and the presence of formal thought disorder symptomatology. Formal thought disorder is used as a collective term to describe dysfunctions in the formal production or perception of the patients' language, e.g. perseveration or derailment (Kircher et al., 2014; Nagels et al., 2016). Traditionally, a distinction has been made between positive and negative formal thought disorder dimensions. Positive formal thought disorder is associated with disorganized language output, whereas negative formal thought disorder – often referred to as alogia or poverty of speech – is associated with reduced speech and language output. Verbal fluency deficits have been found in both negative (Joyce, Collinson & Crichton, 1996) and positive formal thought disorder (Goldberg, Aloia, Gourovitch, Missar, Pickar & Weinberger, 1998). Docherty et al. (2011) showed that negative formal thought disorder was related with poor controlled retrieval on semantic fluency whereas positive formal thought disorder was related with poor context processing on letter fluency. In contradiction, Egeland, Holmen, Bang-Kittilsen, Bigseth and Engh (2018) reported that positive symptoms were positively related to semantic fluency, suggesting "that this may be due to more efficient spread of associations" (p. 38).

Taken together, many domains seem to affect verbal fluency performance in patients with schizophrenia. The purpose of the current investigation is to identify neuropsychological correlates underlying verbal fluency deficits in schizophrenia and to examine semantic and lexical fluency performance in patients with schizophrenia compared to healthy controls. In addition, it investigates whether positive and negative formal thought disorders influence verbal fluency performance.

2. Methods

2.1. Participants

This study included 50 in- and outpatients diagnosed with schizophrenia (F20.x; 12 females and 38 males; mean age 35.5 years, SD = 11.2) (ICD-10) aged between 19 and 60 years. In- and out-patients were recruited and interviewed at the Department of Psychiatry and Psychotherapy, Philipps University Marburg.

A group of 36 age-matched healthy participants (22 females and 14 males; mean age 36.6 years, SD = 11.3) aged between 18 and 59 years was recruited by means of newspaper advertisements.

2.2. Procedure

Clinical Assessment Procedure

Positive formal thought disorder was measured using the Scale for the Assessment of Positive Symptoms (SAPS) (Andreasen, 1984a). The dependent measure was the subscale score for positive formal thought disorder (subscale IV).

Negative formal thought disorder was measured using the Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1984b). The dependent measure was the subscale score for alogia (subscale II).

Verbal Fluency Assessment Procedure

Verbal fluency performance was assessed using semantic and lexical fluency tasks (Aschenbrenner, Lange & Tucha, 2000). For the semantic fluency task, the participants were instructed to generate as many words as possible beginning with the semantic category *animals* within one minute. In the lexical fluency task, the participants were instructed to generate as many words as possible beginning with the letter *p* within one minute. The dependent measure for both verbal fluency tasks was the number of correctly generated words, excluding repetitions, and rule-breakings.

Neuropsychological Assessment Procedure

The participants' executive functioning abilities were assessed using the Trail Making Test (TMT), parts A and B (Reitan, 1958). In task A, the participants were instructed to connect numbers in ascending order (e.g. 1-2-3). In task B, the participants were instructed to connect numbers and letters alternately (e.g. 1-A-2-B). The participants were asked to finish task A and task B as quickly as possible. The dependent measure was the difference in seconds between the duration of parts A and B.

The D2 test of attention (Brickenkamp, 2002), a paper-and-pencil test, was used to assess the participants' sustained and selective attention processes. The participants were asked to mark any letter *d* with two apostrophes (d") and neglect distractors similar to the target stimulus (e.g. d'). The dependent measure was the raw score of the concentration performance parameter.

The participants' working memory was assessed using the digit span backwards task taken from the Wechsler Memory Scale (WMS) (Wechsler, 1987). In the backwards task, the participants were instructed to memorize and reproduce a sequence of digits in the reverse order. The dependent measure was the raw score of the digit span backwards task.

The MWT-B (Lehrl, 1989), a multiple-choice vocabulary test, was used to assess the participants' verbal intelligence. The participants were asked to identify the correct written word from a list including distractors similar to the target word. The dependent measure was the raw score of all 37 correctly identified words.

All participants completed all tests with the following exceptions. One patient with schizophrenia failed to complete the TMT, and one patient with schizophrenia failed to complete the digit span backwards task.

2.3. Data Analysis

The Statistical Package for Social Sciences (SPSS 25) software package was used to perform all analyses. Dependent measures from the TMT, the D2 test, the digit span backwards task, and the MWT-B were subjected to unpaired t-tests. A Spearman's correlation was computed between (a) the number of correctly generated words in both semantic and lexical fluency tasks, and (b) the dependent measures from the TMT, the D2 test, the digit span backwards task, and the MWT-B as well as for the SAPS (subscale IV) and SANS (subscale II) subscale scores. Whenever neuropsychological test performance was correlated with the SAPS and SANS subscale scores, the effect of neuropsychological test performance on other correlations was examined by performing partial correlation coefficients. Semantic and lexical fluency data were analyzed with two-factor analyses of variance (the factors *group* and *condition*) with repeated measures on the second factor.

3. Results

3.1. Neuropsychological correlates underlying verbal fluency deficits

As shown in Table 1, the dependent measures of all neuropsychological assessments (the difference score in seconds for the TMT, the raw score of the concentration performance parameter for the D2 test, the raw score of the digit span backwards task, and the raw score of all correctly identified words on the MWT-B) revealed statistically significant differences, indicating that the group of patients performed significantly worse in all neuropsychological assessments in comparison to the control group.

Table 1. *Results of the neuropsychological assessments for patients with schizophrenia (PwS) and healthy controls (HC).*

	PwS	HC	
TMT	60.9 (34.3)	29.0 (15.3)	t(70.51) = -5.78; p < .001
D2 test	111.1 (36.8)	166.3 (38.0)	t(84) = 6.77; p < .001
Digit span backwards	5.5 (1.6)	7.8 (2.0)	t(83) = 5.76; p < .001
MWT-B	27.5 (5.6)	31.7 (2.8)	t(75.96) = 4.65; p < .001

Note. Standard deviation is given in brackets. Additionally, the results of unpaired t-tests are given in the right column. For the TMT, higher difference scores indicate poorer performance.

No evidence for a relationship between executive functions ($r_s = -.253$, $p = .079$), working memory task performance ($r_s = .106$, $p = .468$) and verbal intelligence ($r_s = .250$, $p = .080$) and semantic fluency task performance was observed. Performance on executive functions (r_s = -.322, p = .024), working memory task performance (r_s = .343, p = .016) and verbal intelligence (r_s = .287, p = .043) were significantly correlated with the number of correctly generated words only in the lexical fluency task. A strong relationship was found between sustained-attention deficits and both dimensions, semantic (r_s = .443, p = .001) and lexical fluency (r_s = .403, p = .004).

3.2. Verbal fluency performance in patients with schizophrenia

Regarding the number of correctly generated words (see Figure 1), an ANOVA revealed a main effect of task ($F[1, 84] = 335.56$, $p < .001$) and group ($F[1, 84] = 16.28$, $p < .001$), showing that the group of controls generated significantly more correct words than the group of patients and that both groups generated significantly more correct words in semantic fluency than in lexical fluency. There was no interaction effect between task and group ($F[1, 84] = 1.96$, $p = .166$).

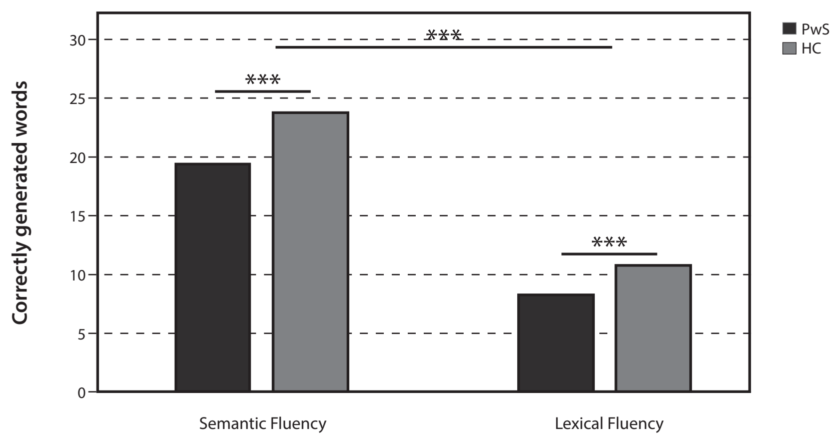

Figure 1. Graphs showing performance on both semantic and lexical fluency (mean number of correctly generated words) of the group of patients with schizophrenia (PwS) and the group of healthy controls (HC).

3.3. Influence of formal thought disorder on verbal fluency

The SAPS subscale score for positive formal thought disorder was not significantly correlated with the number of correctly generated words neither in the semantic (r_s = .079, p = .584) nor in the lexical fluency task (r_s = .102, p = .482). The SANS subscale score for negative formal thought disorder was significantly correlated with the number of correctly generated words in the semantic fluency task (r_s = -.420, p = .002) but not in the lexical fluency task (r_s = -.251, p = .079).

Positive formal thought disorder was not significantly correlated with selective and sustained attention (r_s = -.198, p = .168) whereas negative formal thought disorder was significantly correlated with selective and sustained attention (r_s = -.352, p = .012). No significant correlations between positive and negative formal thought disorder and executive functions, working memory and verbal intelligence were found. A partial correlation was then computed between subscale scores for negative formal thought disorder and performance on semantic (r = -.152, p = .296) and lexical fluency (r = -.145, p = .321), controlling for attention.

4. Discussion

The aim of the present study was to identify neuropsychological correlates underlying verbal fluency deficits in schizophrenia. The results indicate that executive dysfunctions are associated with verbal fluency performance particularly in the lexical fluency domain. Furthermore, a strong relationship was found between sustained-attention deficits and both semantic and lexical fluency, indicating that verbal fluency deficits in general are mainly driven by sustained-attention dysfunctions rather than aberrations in the executive domains. Furthermore, the current study showed that patients with schizophrenia did not perform differently comparing the relation of letter and semantic fluency. Previous research had reported distinctly different findings, with studies reporting disproportionate impairment on semantic fluency tasks and arguing for semantic rather than executive difficulties (Bokat & Goldberg, 2003; Henry & Crawford, 2005) and others reporting a normal pattern of verbal fluency task performance, with better performance on semantic fluency than on lexical fluency, arguing for general retrieval difficulties (Barrera et al., 2005; Docherty et al., 2011; Doughty & Done, 2009). These reported differences may be driven by the variety of the presented stimuli as well as the presence of formal thought disorder symptomatology. Previous studies found verbal fluency deficits in both negative (Joyce et al., 1996) and positive formal thought disorder (Goldberg et al., 1998), as well as contradicting results, showing that positive symptoms were positively related to semantic fluency (Egeland et al., 2018). Correlation analysis in the current study showed that only negative formal thought disorder – often referred to as alogia or poverty of speech – was adversely related with performance on semantic fluency. However, controlling for attention, the results suggest that negative formal thought disorder are unrelated to performance on verbal fluency. In line with aforementioned results, impaired attention drives the decreased performance in verbal fluency tasks in patients with schizophrenia. However, it should be noted that it is challenging to determine tasks that properly test complex cognitive processes. This issue requires future research using additional assessments before definitive conclusions can be made. Additionally, traditional diagnostic procedures of verbal fluency output analyze responses with respect to the number of correctly generated words only. To identify the underlying problem of limited output in verbal fluency in schizophrenia, it might be beneficial to use additional procedures to analyze word generation performance such as clustering and switching component scores (Bozikas, Kosmidis & Karavatos, 2005; Egeland et al., 2018; Robert et al., 1998) as well as temporal parameters (Docherty et al., 2011).

Limitations

Although this study provided detailed descriptions of a variety of factors, the neuropsychological deficits found in schizophrenia vary depending on additional factors, such as on the effect of age, the effect of the duration and phase of the illness, and the effects of medication. Additionally, there are a variety of factors affecting cognition even in healthy control participants, such as the effect of physical activity as well as the effect of possible use of alcohol or drugs, that were not analyzed in the participants.

Acknowledgements

The authors would like to thank Paul Fährmann, Maria Gassmann, Sayed Ghazi, Christian Schales, and Lena Turner.

Anna Rosenkranz is supported by the German Ministry for Education and Research (BMBF, reference number: 01UL1812X).

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Semantic and pragmatic relations in categorization in early-course psychosis

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https://doi.org/10.17234/9789531758314.05

Abstract

In schizophrenia, language processing indicates an over-inclusiveness (Chen, 1994; Brebion, 2010) in category (hypernymy and hyponymy) relations. The aim of this study was to examine the preservation of category relations of semantic memory in first-episode and early-course schizophrenia-spectrum psychosis as it offers an insight to foundations of schizophrenia language deficits. The study was conducted in cooperation with the University Psychiatric Hospital Vrapče on 17 patients. The patients' results were correlated with those of a matched control group. The test that was used to conduct the experiment was constructed for the intent of this study, and it consisted of 10 categories, each of which was tested over 5 trials. For each trial, participants had to choose a member of a presented category. Possible answers included the target word (a category member such as *hobotnica* 'octopus'), a pragmatic-semantically related distractor (e.g. *more* 'sea'), a lexical-semantically related distractor (e.g. *krak* 'tentacle'), and an unrelated distractor (e.g. *truba* 'trumpet'). None of the unrelated distractors in either group were selected as category members. Although both pragmatic-semantically related and lexical-semantically related distractors were classified as category members more often in the patient group, pragmatic-semantically related distractors were chosen more often than lexical-semantically related distractors. While the results support the theory that concept representations in the semantic memory are not completely lost, the question remains whether the representations are degraded or whether there is a difference in search and retrieval processes in patients with first episode psychosis (FEP) when compared to a healthy control group.

Key words: category relations, semantic memory, executive functions, first-episode psychosis

1. Introduction

1.1. Semantic memory and cognitive deficits in schizophrenia

Semantic memory is considered to be organized into concepts represented by nodes of interconnected links which indicate semantic relationships between them (Minzenberg, 2002). Language processing includes the activation of specific connections and nodes in the processes of search and retrieval in language production and reception. Such a framework assumes that the nodes represent boundaries that border concepts themselves and that concepts are enclosed in semantic categories based on their shared properties through their connections.

Theories investigating semantic memory deficits in schizophrenia can be divided into three categories: (i) theories of semantic memory disorganization (Chen et al., 1994; Rossell et al., 1999; Bozikas et al., 2005), according to which the concepts in the semantic memory are disorganized; (ii) theories of impaired semantic memory knowledge (Tamlyn et al., 1992; McKay et al., 1996); and (iii) theories of search and retrieval deficits (Allen et al., 1993; Joyce et al., 1996; Giovannetti et al., 2003), according to which the semantic memory is preserved but the connections between the concepts are not, or access to the memory is impaired. These theories can be further defined as dyssemantic (the first and second theories) and dysexecutive (the third theory) hypotheses (McKenna & Oh, 2005).

The theory of semantic memory degradation, which presumes that concepts and their representations within semantic memory are completely or partially degraded in schizophrenia, was abandoned after studies found that schizophrenia patients had word pools similar to those of control subjects, but that they had difficulties in retrieval under different task conditions. Allen et al. (1993) found that, given enough time, patients could produce an equal number of verbal fluency exemplars on repeated tasks. Considering the findings of studies claiming that semantic knowledge in schizophrenia is not impaired, their language deficits are explained in terms of search and retrieval deficits presumably related to components of executive functions or working memory (Kuperberg, 2010). Hence, language processing deficits are described as attention, working-memory and executive-function deficits, or as semantic memory deficits.

In their meta-analysis of studies on declarative memory, Cirillo and Seidman (2003) show that patients with schizophrenia have a clear deficit in declarative memory, while Goldberg et al. (1990), examining procedural memory, show subtle differences in relation to control groups. Studies investigating the working memory also show deficits in the working memory in schizophrenia (Lee & Park, 2005), while others show an executive function deficit (Orellana & Slachevsky, 2013), deficits in motor functions and speed (Dickinson et al., 2007), and social cognition and attention (Green et al., 2015).

Many studies have tried to establish whether there are executive dysfunctions in schizophrenia subjects and have come to differing conclusions about which domains are affected, such as attentional selection (Pessoa, 2009), cognitive integration (Duff & Brown-Schmidt, 2012), inhibition and cognitive control (Leeson et al., 2005), self-monitoring of speech (Nienow & Docherty, 2004), and working memory (Elvevåg & Goldberg, 1997). Furthermore, executive function deficits have been found in first-episode schizophrenia subjects (Flashman, 2002, as cited in Orellana & Slachevsky, 2013; Joyce et al., 2002). Executive functions, working memory, and attention are different but interconnected domains that enable contextual information processing, reaction to context, planning, directed actions, etc. These domains can be affected separately or mutually in schizophrenia (Poole et al., 1999). Furthermore, some studies indicate that there is evidence of combinatory semantic and executive dysfunctions in thought disorder (Leeson et al., 2005).

1.2. Changes in associations as a symptom of schizophrenia

As loose associations were among the first defined symptoms of schizophrenia (Moskowitz & Hein, 2019) and remain the most prominent symptom in language processing in schizophrenia, many studies have analyzed the production and reception of associations.

Although psycholinguistics uses different methods of studying associations, priming is a prominent one because it enables the specification of the produced association in advance. Priming presupposes the activation of a concept and its features in the semantic memory for a time, which then serves as a source of activation for related concepts. In direct priming, word pairs are directly connected, while indirect priming presupposes word pairs where the target is an association to an association of a prime. In other words, in indirect or mediated priming, word pairs have a connection that is evident through a mediated association. Both priming methods are useful for association studies in schizophrenia because they demonstrate the spreading of activation in the semantic memory in which activated concepts are or are not inhibited.

Priming task studies show that there is a higher activation of the semantic memory (a positive priming effect) in language production in schizophrenia subjects than in healthy subjects. For example, studies conducted by McNamara and Altarriba (1988), Spitzer et al. (1993a), Spitzer et al. (1993b), Moritz et al. (2001), Moritz et al. (2003), and Wentura et al. (2008) show an indirect priming effect. Indirect priming presupposes the construction of a language stimulus with the condition of associative connection. That is, in indirect priming the prime and target words are indirectly connected by an association which both share (for example, the prime *white* and the target *cow* share the association *milk*). Direct priming effect is shown in studies conducted by Rossell and David (2005), Manschreck et al. (1988), and Maher et al. (2005). Direct priming presupposes that the prime and target words are directly connected, as are the words *white* and *black*. The hyperpriming effect in direct and indirect priming tasks is demonstrated in studies conducted by Weisbrod et al. (1998), Moritz et al. (2001), Assaf et al. (2007), Maher et al. (2005), and Kreher et al. (2008). Other studies did not show any effects of hyperpriming Vinogradov et al. (1992), Ober et al. (1995), but other authors conclude that these studies have methodological problems, such as stimulus onset asynchrony or the choice of language material.

A positive correlation in schizophrenia patients between positive priming effects and associations produced in discourse was established by Maher et al. (2005) using a computer program named CAST (*Computed associations sequential test*), which is in line with the spreading activation theory. Increased automatic spreading of activation is further affirmed by idiosyncratic answers on fluency tasks (Johnson & Shean, 1993).

1.3. Semantic categorization

Categories are an integral part of language processing as they represent a natural taxonomy of the world. In 1938, Cameron described a deviation in the means of grouping objects into categories, an overinclusion of objects in categories, in schizophrenia patients in comparison to healthy controls. Lawrence et al. (2007) define overinclusion as an inability to preserve boundaries of categories, a consequence of which is the development of indistinct and broadened category boundaries. In a meta-analysis of semantic categorization studies in schizophrenia, Doughty and Done (2009) conclude that 16 studies have shown a deficit in category relations compared to healthy subjects, although their analysis did not distinguish verbal from non-verbal semantic tasks. Chen et al. (1994) analyzed the integrity of semantic memory and showed an intact integrity of concepts but a broadening of semantic category boundaries where patients include related (*bat – bird*) and unrelated (*rifle – bird*) non-members and borderline (*penguin – bird*) members in categories. Elvevåg et al. (2002), in a study that repeated the task used by Chen et al. (1994), found that patients and controls do not have qualitative differences in their results, although both patients and controls did have slower reaction times to ambiguous borderline category exemplars (exemplars that could be classified as within or outside the category).

They conclude that, although representations may be intact, "movements" between them may not be optimal (Elvevåg et al., 2002). Spitzer et al. (1997) offer a theory of faster spreading activation in semantic memory in search and retrieval processes in schizophrenia, which could account for a different activation of concepts and features than Elvevåg et al. (2002) conclude. Brébion et al. (2004, 2010) are also inclined toward this explanation after conducting studies of the production of category exemplars and verbal memory and finding a broadening of semantic categories.

Moelter et al. (2005) found that patients have difficulties utilizing higher-order categorization processes (cognitive functions simultaneously using basic executive functions) in conducting an animal similarity judgement and organization test. While the control group produced overlapping clusters when exemplars had semantic attributes belonging to different categories, patients produced isolated clusters without considering the overlapping of attributes. Patients relied on the most salient attributes and did not use alternative categorization strategies. The authors conclude that the deficits are a consequence of higher-order categorization process deficits and concur with the explanation of Vinogradov et al. (2002), who propose that the semantic memory in schizophrenia patients is characterized by an increased complexity and diffusion of activation.

Tallent et al. (2001) and Elvevåg and Storms (2003) conducted similar category organization tests with similar results. The broadening of automatic activation of the semantic memory in schizophrenia was indicated on a neural level by Kreher et al. (2008) in an ERP study using indirect priming tasks. Their results indicate that activation spreads further within a shorter time and language processing deficits may be the result of a faster network spreading or/and a reduced inhibition mechanism. Berberian et al. (2016) also conclude that there may be a broader semantic memory activation but propose, based on the results of a verbal fluency test analysis, that semantic categories, while facilitating responses and acting as cues, may also increase neural noise, i.e. activation, which consequently demands an increase of cognitive control. Such an interpretation supports Kreher et al.'s (2008) findings of a broader activation of the semantic memory and a need for a compensating inhibition mechanism and its deficit.

1.4. The current study

The aim of this study was to examine the processing of hierarchy relations in FEP (first-episode psychosis), as they offer a view of category structures and their boundaries in the semantic memory. It was hypothesized that, if the semantic memory was degraded, patients would have difficulties in solving the categorization tasks, but if the semantic memory was intact, patients would be able to solve the tasks with a minimum of incorrect answers. Therefore, it was hypothesized that patients would have less correct answers compared to the healthy control group. Furthermore, if the incorrect answers were pragmatic-semantically related and related both to the category and the target word, they would be activated in the search and retrieval process, while there would be no activation and no need for inhibition for unrelated answers.

The hypothesis supports the model of an intact semantic memory with reduced inhibition processes, which presupposes heightened activation in the semantic memory and a lack of inhibition of incorrectly activated concepts, or a model of loose semantic representations with the activation of concepts loosely connected with the target concepts.

2. Methods

2.1. Participants

The study included 17 first-episode and early-onset psychosis patients from the University Psychiatric Hospital Vrapče (School of Medicine, University of Zagreb) and 17 control subjects. The control group consisted of 17 participants, all students from the Faculty of Humanities and Social Sciences, University of Zagreb. None of the control subjects had a history of a psychiatric disorder, substance abuse, or traumatic head injury. Before the administration of the test, an informed consent was obtained from each of the participants, and the test had been approved by the Ethics Committee of the University Psychiatric Hospital Vrapče (Registry number: 23–485/2–15).

The control group was matched with the patients in age, handedness, and sex. The average age of the patients was 24.18 (SD=3.97) years, 10 were male and 7 female. 16 patients were right-handed, and 1 was left-handed.

Average time after the appearance of symptoms of psychosis was 1.18 (SD=1.63) months. All patients received antipsychotic therapy. Average daily dose of antipsychotics expressed in chlorpromazine equivalents was 442.16 mg (SD=215.11). Thirteen patients were receiving a concomitant psychopharmacological therapy of benzodiazepines, 4 patients were receiving anticholinergics, 2 patients hypnotics, one patient was receiving a mood stabilizer, and one an antidepressant.

2.2. Materials and procedure

The category reception test was constructed for the intent of this study and consisted of 50 examples from 10 different categories (5 examples for each category). The categories used in the test were *animals, vegetables, fruit, trees, musical instruments, food, drinks, vehicles, clothes, and furniture*. These categories were chosen because they are known and used frequently in everyday life occasions. The test booklet was composed of 50 A5-size pages. In each trial, the subjects were presented with a hypernym, and they were supposed to choose the one item out of four possibilities that was a member of the given category. The category was written on top of the page in upper-case Times New Roman font size 36, and the possible answers were stated underneath in lower-case Times New Roman font size 20, both the category and each answer were presented in a frame. For each of the 50 categories, possible answers were constructed consistently. In each trial, three distractors were used, along with a target word. The distractors included a semantic-pragmatically related distractor, a lexical-semantically related distractor, and an unrelated distractor. For example, for the category *životinje* 'animals', along with the target word *hobotnica* 'octopus' three distractors were shown: the semantic-pragmatic distractor *more* 'sea', the lexical-semantically related distractor *krak* 'tentacle', and the lexical-semantically unrelated distractor *truba* 'trumpet'. The target word is a hyponym of the given category, which is its hypernym. The target words and distractors are all consistently highly concrete, unambiguous, and well-known Croatian words. Before the trial, the material was given to several random native Croatian speakers whose task was to recognize if ambiguous or unfamiliar words were used in the test. The categories, as well as the possible answers, are all stated in a random order: the target words and distractors for each task are located in a different position on each page, and therefore, the answers cannot follow an intentional design. The following instructions were given to the participants (which were the same for both the patients and the control group): "After reading the word in upper-case letters at the top of the page, please read all four words in lower-case letters at the bottom of the page. After reading all of them, please choose, and read aloud, the one of those four which you consider to be most connected with the one written at the top of the page." The tasks are shown in succession in the printed material. The participants read their answers, and the examiner marked them on a control form. The testing of the patients was carried out in a quiet and isolated environment at the University Psychiatric Hospital Vrapče, and the testing of the control subjects at the Faculty of Humanities and Social Sciences. The participants performed the tasks at their own pace.

3. Results

Statistical analyses were conducted using the SPSS. Normality of distribution was tested by the Shapiro-Wilks test. Considering that all four dependent variables showed statistically significant deviation from normal distribution, in both the patient group and the control group ($p<0.001$), group comparisons were conducted using the nonparametric Mann-Whitney U-test. All correlations and relations of the categorization test were tested with all the variables.

Both the control group and the patient group achieved high accuracy. The average correct response for the control group was 49.29 (SD=1.21), while the patient group scored 45 correct answers on average (SD=7.13).

Table 1. *Number of chosen semantic-pragmatically related, lexical-semantically related and lexical-semantically unrelated distractors in both the control and patient group*

	Patients	Control group
semantic-pragmatically related distractors	3. 18 (SD=5.11)	0. 18 (SD=0.53)
lexical-semantically related distractors	1. 77 (SD=2.49)	0. 53 (SD=0.94)
lexical-semantically unrelated distractors	0. 12 (SD=0.33)	0

On average, the patients chose 3.18 (SD=5.11) semantic-pragmatic distractors, 1.77 (SD=2.49) lexical-semantically related distractors (meronyms), and 0.12 (SD=0.33) lexical-semantically unrelated distractors. On average, the control group chose 0.18 (SD=0.53) semantic-pragmatic distractors, 0.53 (SD=0.94) lexical-semantically related distractors (meronyms) and none of the participants chose a lexical-semantically unrelated distractor. The Mann-Whitney U-test showed significantly fewer correct answers in comparison to the control group (U=71.00; p=0.011). Furthermore, the patients chose significantly more pragmatic-semantically related distractors than the control group (U=82.00; p=0.031). There were no significant differences in the number of meronyms (U=92.50; p=0.073) and lexical-semantically unrelated distractors (U=127.50; p=0.563). There were no significant correlations of age or sex with the test results in either group. There were no significant correlations with time that had passed since the appearance of first symptoms of psychosis, or the daily dose of antipsychotics in the patient group. A chi-square test did not show any significant relation between additional psychopharmacological therapy and the test results.

4. Discussion

Although the Mann-Whitney U-test showed that patients' answers were significantly less accurate than those of the controls, the patients nevertheless had an average of 45 correct answers out of 50 tasks. If the semantic memory were considerably damaged, we presume that the average number of correct answers would be significantly lower. Therefore, an answer to the question of the statistically lower accuracy in the patient group needs to be answered in line with the theory of loose connections of representations in the semantic memory or in other domains of cognitive functioning. One possible explanation is an executive function deficit that leads to an incapability to inhibit distractors. This is further supported by the fact that the patient group mostly chose a semantic-pragmatic distractor in place of the target word, and not a lexical-semantically related or unrelated distractor. The presupposition is that, during category activation in the semantic memory, the patients' activation was higher, and because of the weakening of executive functions, they were unable to inhibit semantically related answers. Unlike the semantically related answers, the semantically unrelated distractors were not activated because they are not related to the default category or the target word and thus did not need inhibiting. The present data once more suggests the presumption that the semantic memory in schizophrenia patients is not damaged because, if it were, there would be a considerably higher number of unrelated distractors among their answers. Generally speaking, the hypothesis that the concepts in the semantic memory are not lost is confirmed, which corresponds to the viewpoints of authors who suggest that the semantic memory in schizophrenia is not damaged and that the foundations for lexical-semantic deficits in schizophrenia are to be found in other segments of language processing. Primarily, executive functions are a suggested domain of cognition responsible for the deficits, as they are responsible for the retrieval and manipulation of long-term memory information which are necessary components of language processing. Nevertheless, additional studies of executive functions are needed to confirm results that suggest their dysfunction as a basis for lexical-semantic deficits in schizophrenia.

5. Conclusion

Lexical-semantic deficits in FEP have been explored relatively well, but a few questions remain answered in full. Although the results of this study show that there was a marked lexical-semantic impairment in the FEP group of participants in comparison to the healthy control group, they do not corroborate semantic memory deficits but rather indicate deficits in other domains included in language processing. The aim of this study was not to affirm or deny semantic memory deficits but to investigate the preservation of category relations in the mental lexicon of FEP patients with schizophrenic symptoms or symptoms similar to schizophrenia. The categorization test constructed for this study was designed not only to investigate the preservation of semantic memory, but also to test the structural integrity of its relations and activation. The results support the hypothesis that there is no significant damage to the semantic memory in FEP, and that lexical-semantic deficits can be attributed to two possible explanations: a loosening of representations in the semantic memory or a heightening of activation and a lack of inhibition of falsely activated concepts. We argue that the latter explanation corresponds better with our results, as patients were unable to inhibit semantically related distractors but had no need to inhibit unrelated distractors as they were not activated because the structure of the semantic memory remains intact. This further implies that lexical-semantic deficits in FEP are largely due to deficits in executive functioning and specifically inhibition. The results of this study were analyzed in accordance with current psycholinguistic theories, but further studies in domains of executive functions are needed in order to establish a better understanding of language processing and deficit foundations in schizophrenia. Along with the lack of a cognitive test which could establish a correlation with executive functions, another shortcoming of this study is the small subject sample. We conclude that further categorization studies accompanied by executive function studies could additionally enlighten language processing deficits in first-episode and early-onset psychosis.

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Shared lexical-semantic features and the animacy effect in early-course psychosis

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https://doi.org/10.17234/9789531758314.06

Abstract

Language deficits in psychosis, and in schizophrenia, are presumed to be due to increased activation and connectivity of the semantic memory, which is determined by lexical-semantic features of concepts. The aim of this study was to analyse the influence of shared lexical-semantic features on language processing in patients with first-episode and early-course psychosis. The study included 15 Croatian-speaking patients from the University Psychiatric Hospital Vrapče, Zagreb, diagnosed with first-episode and early-course psychosis and a healthy control group. The subjects performed a lexical-semantic decision task in which the primes and the target words were either related as hypernym and hyponym or were unrelated, and in which the target words represented either animate or inanimate concepts. Two results analyses were conducted: one on the taxonomic (hyponym–hypernym) condition and one on the animacy (living/non-living stimulus) condition. The patient group was less accurate on the taxonomy condition because the taxonomy relations were dependent on their shared features. The patients' activation of shared features was higher, and their inhibition was reduced. Consequently, the patients will have a greater number of concepts activated and not inhibited. For the inanimate concepts, a high correlation of distinctive features is characteristic, while the animate concepts have a high correlation of shared features. The presupposition is that the greater activation of shared features influenced the patients' answers, so the distinctive features had no influence. Thus, the control group had higher accuracy for inanimate concepts.

Key words: lexical-semantic features, early-onset psychosis, taxonomy relations, animacy

1. Introduction

The language dysfunction in schizophrenia is explained with a theory that attributes language abnormalities to abnormalities in the structure and function of semantic memory, which in turn lead to the language abnormalities (Spitzer et al., 1993; Aloia et al., 1998, as cited in Kuperberg, 2010). Perhaps the most influential theory of positive thought disorder in schizophrenia is connected with the hyperactivity of spreading activation in semantic memory (Ballerini, 2016) which stems from faster and more automatic spread of activation through semantic memory (Manschreck et al., 1988; Spitzer et al., 1993, as cited in Kuperbeg, 2010). This model is tied to the network model of semantic memory (Collins & Loftus, 1975), which presupposes its organization as a structure of concepts in a distributed connectionist system memory in which words and concepts are linked within a network according to their degree of association or co-occurrence (Collins & Loftus, 1975; Anderson, 1983, as cited in Kuperberg, 2010). Each concept is represented by a node of interconnected links which are different overlapping features and relations of the concept. The activation of concepts in this model depends on the activation and overlapping of feature activation and the connectivity of the network (Minzerberg, 2002; Tyler & Moss, 2001), which is presumed to be increased in schizophrenia. A higher activation of concepts in the semantic memory requires a heightened inhibition of the concepts which have been activated, and this inhibition is believed to decrease in psychosis and schizophrenia. Furthermore, in psychotic disorders, and specifically in schizophrenia, cognitive and lexical-semantic deficits may occur as a syndrome of dysfunctional connectivity and functional changes in the language network (Agcaoglu et al., 2017; Cavelti et al., 2018).

Furthermore, semantic deficits associated with FTD (formal thought disorder) could include impaired access to semantic concepts (Leeson et al., 2005), as well as degraded or disorganized storage of semantic information (Rossell & David, 2006, as cited in Summer et al., 2018). Assaf et al. (2007) suggest that FTD symptoms in schizophrenia may not extend from a disruption of the semantic network but are secondary to a selective dysfunction in specific components of semantic operations related to semantic object retrieval. They showed that FTD is specifically associated with impaired object recall from features in the semantic memory and not with other semantic processes (such as synonym and category judgment). Furthermore, they demonstrated the neural abnormalities that underlie this semantic deficit. The patients retrieved more objects based on unrelated (distant) features and did so more slowly than the healthy controls. These results are generally in accord with the hypothesis of far-spreading activation.

From a psycholinguistic point of view, word retrieval depends on the connectivity of the language network and can be facilitated by shared lexical-semantic features. A question arises concerning the effect of different types of shared and distinctive features. According to the conceptual structure account (Tyler & Moss, 2001), concepts that share the animacy feature predict more correlated intercategory features (and weak correlation of distinctive properties), while inanimate concepts have higher correlation of distinctive features (and weak correlation of shared properties). The animacy feature refers both to the quality and quantity of features. Greater correlations in shared features facilitate the activation of a greater number of conceptual features of the same category, suggesting that the activation of animate concepts will co-activate a more distributed conceptual network. In a study on a speeded feature verification task carried out on healthy participants, Randall et al. (2004) concluded that the subjects processed distinctive, but highly correlated, features of inanimate concepts faster than distinctive features of inanimate concepts that are not highly correlated, but Cree et al. (2006) found no differences in the processing speed of distinctive features of animate and inanimate concepts and concluded that they are both processed more quickly than shared features. Studies on pathologies with structural lesions stress the importance of distinctive features and predict the preservation of inanimate concepts on account of the preservation of highly correlated distinctive features. Since the distinction between animate and inanimate concepts in selective deficits in patients is common (Mahon & Caramazza, 2003), Bonin et al. (2013) suggest an animacy effect category which refers to the presupposition that the stimuli with the animacy feature are processed differently than the stimuli without it (Van Arsadal et al., 2013, as cited in Bonin et al., 2013). A higher activation of shared features is expected in neurofunctional disorders such as first-episode and early-course psychosis, which results in greater activation of concepts in the semantic memory. We presuppose that more intercategory correlated features will account for an equal activation of a higher number of concepts in the same category. Correlated properties are those which frequently occur together; they are more robust to damage because they support one another with mutual activation (Pilgrima et al., 2013; Tyler & Moss, 2001).

Furthermore, taxonomy relations are also dependent on their shared features. From a neurocognitive view, taxonomic categories are generally similarity-based; that is, they have shared attributes, while thematic categories are not based on similarity (i.e. shared features) but on extrinsic relations between two objects. Taxonomic knowledge tells us the properties of a set of objects, whereas thematic knowledge tells us how other categories relate to that set (Murphy, 2010, as cited in Lewis et al., 2015). While taxonomic categories are represented only by their associations to features (Rogers & McClelland, 2004), they do not include relations formed by thematic knowledge. Nevertheless, while taxonomic knowledge includes the properties of an object and its concept, thematic knowledge also includes taxonomic knowledge, as it needs to show how other categories and their constituents relate to the features of concepts so it can form a thematic relation. As taxonomic categories are similarity based and fall under the same superordinate relations, their features are largely shared. When concepts are activated, their relatedness will differ in terms of the amount of information linking them. The higher the relatedness effect, the faster the subjects will answer, due to saliency and the number of their relations. Since taxonomy categories presuppose a high number of shared features, their relatedness effect is expected to be highly accounted for. In a neurofunctional imaging study, Lewis et al. (2015) raised the question of whether taxonomic and thematic information are represented together, and their results show that taxonomic relations strongly predicted anterior temporal lobe activation, and both kinds of relations influenced the temporoparietal junction.

According to the theoretical framework that describes schizophrenia as a syndrome of an inadequate integration of connections and global functional changes in brain regions that are crucial for language processing, the presupposition is that highly correlated shared features will be activated more quickly and that the activation will spread faster within them in the semantic memory.

Greater correlations in intercategory features facilitate the activation of a higher number of conceptual features of the same semantic category, suggesting that the activation of animate concepts co-activates a more distributed conceptual network. The assumption is that patients with early-course psychosis will have greater activation in the semantic memory for animate words than for inanimate ones in hierarchy relations because of the stronger correlation of shared properties.

Moreover, it is assumed that there will be no differences in accuracy with inanimate concepts between the two subject groups, while the patients will have lower accuracy on animate concepts because of a higher activation of shared features. Higher activation of shared features is also expected with the taxonomy condition. Since subjects with first-episode and early-course psychosis have reduced inhibition, which is necessary on both conditions as there is higher activation, the assumption is that the patients will have a higher amount of incorrect answers because relations and concepts will be activated and not inhibited.

The aim of this study was to examine how the activation of shared features influences lexical-semantic processing in patients with first-episode and early-course psychosis. The patients were expected to be significantly statistically less accurate on taxonomy relations (hyponymy and hyperonymy condition) on account of the activation of shared features. Furthermore, the control group was expected to have statistically higher accuracy on inanimate concepts because of the activation of distinctive features, while the patient group results on accuracy would not differ on animate and inanimate concepts because of a heightened activation of shared features.

2. Methods
2.1. Participants

The study recruited 15 Croatian-speaking patients from the University Psychiatric Hospital Vrapče, Zagreb, diagnosed with first-episode and early-course psychosis. On average, the patients were 26.85 years old and had finished 13.6 years of education. At the time of the study, their average time after the onset of illness was 9.07 months. Their average time after the initiation of therapy was 5.13 months. All patients were receiving antipsychotic treatment, and their average daily dose of antipsychotics expressed in chlorpromazine equivalents was 507.78 mg. Informed consent had been obtained from all of the participants before the administration of the test, and the test had been approved by the Ethics Committee of the University Psychiatric Hospital Vrapče (Registry number: 23-305/8-18). The control group for the first analysis consisted of 15 healthy subjects, and for the second, 19 healthy subjects, matched with the patients by age, sex, and by their dominant hand.

2.2 Materials and procedure

The subjects performed a lexical-semantic decision task. The stimuli were presented visually on a computer screen. In some cases, the prime and the target word were related as hyponym and hypernym, while in others, they were unrelated. In addition, the target words represented either animate or inanimate concepts. The prime word was presented for 1000 ms. A 100-ms window followed, after which the target word was presented for 3000 ms. The stimuli were used and consistently balanced, having been taken from Psiholeks_HR (Erdeljac, Sekulić Sović & Miklić, 2018), an online psycholinguistic database including measures for 2000 Croatian words based on data collected from 100 participants. In the database, each word is described according to specified linguistic criteria (morphosyntactic: part of speech; phonological-phonetic-orthographic: number of syllables, number of phonemes, number of letters), and each word is attributed with the measures and values of five psycholinguistic parameters: subjective word frequency, imageability, abstractness/concreteness, word familiarity, age of acquisition, and word associations. The subjects answered *yes* or *no* to the following question: "Does the second word you read represent an animate concept?". Accuracy and reaction times were measured using E-prime 2.0 software (Psychology Software Tools, Pittsburgh) (Schneider et al., 2012). Two independent analyses were conducted, each depending on the different organization of the stimulus materials. The first analysis included 30 stimulus word-pairs, 15 word-pairs in a hyponymy/hypernymy relation and 15 not related in any taxonomy relation. The second analysis included 26 stimulus word-pairs, 13 with the animacy feature (i.e. representing living concepts) and 13 without the animacy feature (i.e. representing non-living concepts).

3. Results

3.1. Statistical analysis of the taxonomy condition

The data distribution was non-normal, and the variances were not homogeneous. Therefore, non-parametric analyses were applied. Differences in the accuracy and time reaction between the two conditions (lexical-semantically related vs. unrelated words) were analysed using a Wilcoxon signed-rank test and Friedman ANOVA, respectively, while Whitney U test was used for testing differences between two independent groups. *P* value was set to .05; however, Bonferroni correction for multiple comparisons was applied. Statistical analyses were performed using IBM SPSS Statistics 23.0.

Table 1. *Descriptive data (median and interquartile range) for the accuracy and reaction time on lexical-semantically related and unrelated words in the control and patient groups*

	Controls (N = 15)			**Patients (N = 15)**		
	Mdn	*Q1*	*Q3*	*Mdn*	*Q1*	*Q3*
Accuracy						
Related words	93.33	93.33	100.00	93.33	80.00	93.33
Unrelated words	100.00	100.00	100.00	100.00	73.33	100.00
Accuracy (%)						
Related words	14	14	15	14	12	14
Unrelated words	15	15	15	15	11	15
Reaction time (ms)						
Related words	704.20	634.09	765.50	978.30	847.80	1437.64
Unrelated words	693.00	608.73	760.33	1029.54	808.73	1395.71

The Wilcoxon signed-rank test for dependent samples showed that there was no significant difference in accuracy between related and unrelated words in the control group ($T(15) = 7.0$, $z = 1.18$, $p = 0.2367$, $r = .31$), nor in the patients' group ($T(15) = 34.00$, $z = 0.39$, $p = .6949$, $r = .10$), which can be seen in Figure 1. However, there was a significant difference in accuracy between the groups: a lower percentage of accuracy was observed in the patients than in the controls, but only for related words ($U(15, 15) = 62.00$, $z = 2.27$, $p = .0229$, $r = .41$), while there was no difference in accuracy between the two groups for the unrelated words ($U(15, 15) = 77.50$, $z = 1.73$, $p = .0834$, $r = .32$).

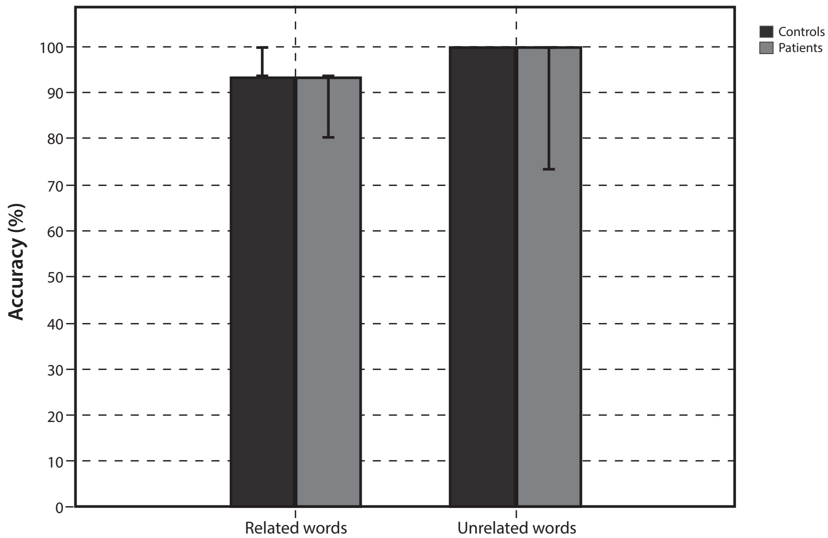

Figure 1. Control- and patient-group accuracy for related and unrelated words (median and interquartile range presented)

There was no significant difference in the reaction time (ms) between related and unrelated words either in the control group ($T(15) = 43.00$, $z = 0.97$, $p = .3343$, $r = .25$) or in the patients' group ($T(15) = 41.00$, $z = 1.08$, $p = .2805$, $r = .28$), which can be seen in Figure 2. However, there was a significant difference in the reaction time between the groups, where longer reaction times were observed in the patients than in the controls both for related words ($U(15, 15) = 8.00$, $z = -4.33$, $p<0.001$, $r = -.79$) and unrelated words ($U(15, 15) = 21.00$, $z = -3.80$, $p<0.001$, $r = -.69$).

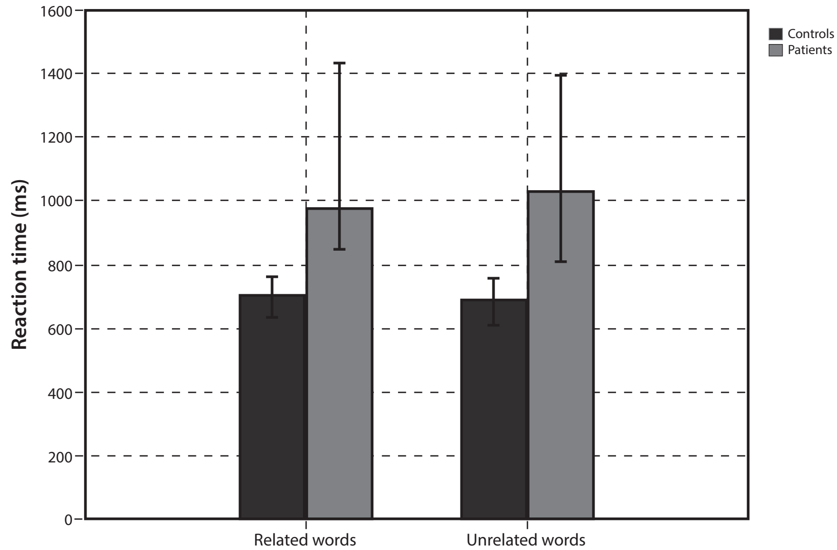

Figure 2. Reaction time (ms) of control and patient groups for related and unrelated words (median and interquartile range presented)

3.2. Statistical analysis of the animacy condition

The data distribution was non-normal, and the variances were not homogeneous. Therefore, non-parametric analyses were applied. The differences in accuracy and reaction time between the two conditions (animate vs. inanimate) were analysed using a Wilcoxon signed-rank test and Friedman's ANOVA, respectively, while a Whitney U test was used to test the differences between the two independent groups. The p-value was set to .05; however, the Bonferroni correction for multiple comparisons was applied. Statistical analyses were performed using IBM SPSS Statistics 23.0.

Table 2. *Descriptive data (median and interquartile range) on the accuracy and reaction time of the control and patient groups for animate and inanimate words*

	Controls (*N* = 19)			**Patients (*N* = 15)**		
	Mdn	*Q1*	*Q3*	*Mdn*	*Q1*	*Q3*
Accuracy						
Animate words	13.00	12.00	13.00	12.00	10.00	13.00
Inanimate words	13.00	13.00	13.00	13.00	9.00	13.00
Accuracy (%)						
Animate words	100.00	92.31	100.00	92.31	76.92	100.00
Inanimate words	100.00	100.00	100.00	100.00	69.23	100.00
Reaction time (ms)						
Animate words	736.23	636.77	797.08	963.58	842.17	1278.77
Inanimate words	653.54	614.64	712.85	1055.69	792.00	1394.25

The Wilcoxon signed-rank test for dependent samples showed that the patients' group displayed no significant difference in accuracy for animate vs. inanimate words in ($T(15) = 30.00$, $z = 0.27$, $p = 0.7897$, $r = .07$), which can be seen in Figure 1. However, the accuracy of the control group was significantly higher for the inanimate words than for animate words($T(15) = 0.00$, $z = 2.02$, $p = .04312$, $r = .52$). Although there was no significant difference between the groups for the animate words ($U(15, 15) = 71.00$, $z = 1.85$, $p = 0.0637$,$r = .34$), there was a significant difference between the groups for the inanimate words ($U(15, 15) = 60.00$, $z = 2.18$, $p = 0.0033$, $r = .40$), where the control group had a higher level of accuracy.

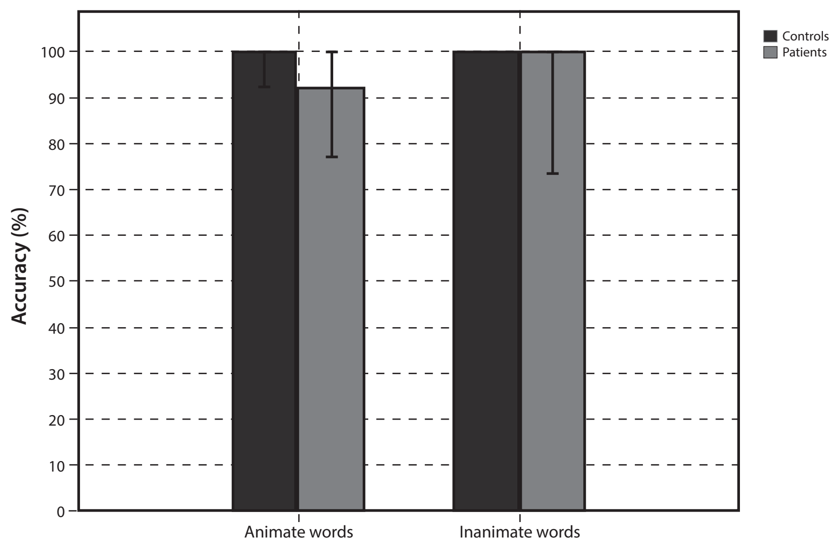

Figure 3. Control- and patient-group accuracy for animate and inanimate words (median and interquartile range presented)

When reaction time was taken into account, the Wilcoxon signed-rank test for dependent samples showed that there was no significant difference in the reaction time (ms) on animate and inanimate words among the control group ($T(15) = 26.00$, $z = 1.93$, $p = 0.0535$, $r = .50$) nor among the patients' group ($T(15) = 53.00$, $z = 0.40$, $p= 0.6910$, $r = .10$), which can be seen in Figure 2. However, there was a significant difference in the reaction time between the two groups: longer reaction times were observed in the patients than in the controls for both animate words ($U(15, 15) = 14.00$, $z = -4.09$, $p<0.001$, $r = -.75$) and inanimate words ($U(15, 15) = 19.00$, $z = -3.88$, $p<0.001$, $r = -.71$).

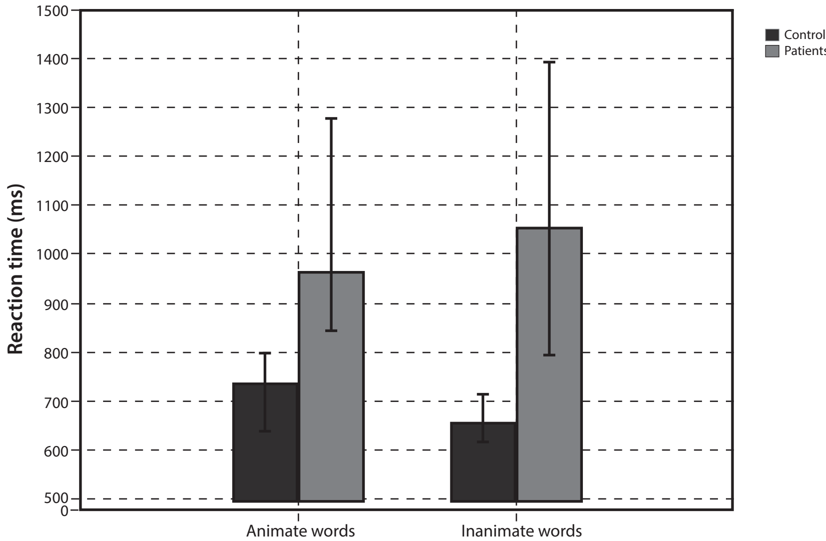

Figure 4. Control- and Patient-group reaction times (ms) on animate and inanimate words (median and interquartile range presented)

4. Discussion

The patient group was significantly less accurate on the taxonomy condition than the control group. The higher activation of shared features, both highly correlated shared features of animate concepts and weakly correlated shared features of inanimate concepts, demanded heightened inhibition, which failed and resulted in the activation of incorrect relations in the semantic memory and lower accuracy in the patient group. Furthermore, when shared features were not activated, there were no differences in accuracy between the two groups.

The control group had statistically higher accuracy on inanimate concepts, and the patient group's accuracy results did not differ on animate and inanimate concepts. Inanimate concepts have more distinctive features, both correlated and non-correlated, which influenced the answers of the control group the most. On the other hand, in the patient group there were no differences in accuracy, as shared features were highly activated in both the animate and the inanimate concepts.

According to Studerus et al. (2016), neurocognitive variables likely play an important role in multi-domain prediction models because cognitive deficits are considered core features of schizophrenic psychoses. The greatest impairments appear to be present in the domains of verbal memory, speed of processing, and working memory (e.g. Schaefer et al., 2013; Fatouros-Bergman et al., 2014; Mesholam-Gately et al., 2009). Furthermore, meta-analyses suggest that, at the onset of psychosis, cognitive performance is on average about one standard derivation (SD) below *been consistently demonstrated* in all cognitive domains with medium to large effect sizes and cannot be attributed to effects of antipsychotics because unmediated and medicated patients are similarly affected (e.g. Fatouros-Bergman et al., 2014). According to Riecher-Rössler and McGorry (2016), impaired performance across a wide range of cognitive domains, especially in the areas of working memory, verbal fluency verbal memory, and speed of information processing, could potentially be used for improving the accuracy of prediction (e.g. Riecher-Rössle et al., 2009; Fusar-Poli et al., 2012).

5. Conclusion

Assessment of the processing of specific lexical-semantic features alongside neuropsychological evaluation might be a valuable tool as an indicator and predictor of particular phases and/or courses of illness. Both analyses confirmed that the activation of shared features influenced language processing in subjects with first-episode and early-course psychosis differently than in healthy subjects. This influence can be observed in accordance with the model of spreading activation of the semantic memory in schizophrenia because the activation of shared features caused slower reaction times and a higher amount of incorrect answers in the patient group, which is presumed to be a result of greater activation and a reduced inhibition of the concepts in the semantic memory.

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The role of imageability and frequency in language production and comprehension in first-episode and early-course psychosis

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https://doi.org/10.17234/9789531758314.07

Abstract

This study is an overview of language production and the comprehension of associations depending on the lexical-semantic imageability and frequency features in subjects with first-episode and early-course psychosis. Concepts with low values of lexical-semantic feature imageability, unlike those with high imageability, demand greater cognitive effort in the creation of their mental image and their activation in the semantic memory. This study included two tests, a forced-choice language comprehension test and an elicited association production test, which were constructed for the purpose of the study on the basis of an existing database of psycholinguistic lexical-semantic features (Erdeljac et al., 2018). Twelve subjects diagnosed with first-episode early-course psychosis were recruited, as well as 12 healthy subjects as a control group. It was confirmed that the target group, the subjects with first-episode and early-course psychosis, processes language differently with regards to the imageability feature in the production test. The patient group had longer reaction times on both imageability conditions in relation to the control group, but while the control group had shorter reaction times on highly imageable words, the patient group's reaction times did not differ on account of the imageability condition. In the comprehension test, the patient group had overall longer reaction times independently of the imageability condition. Furthermore, in the comprehension test, both groups statistically more often chose associations that were of high and medium frequency, when compared to low frequency words, and the target group had longer reaction times on high- and medium-frequency words than on low-frequency words. The results analysis was conducted according to current psycholinguistic theories and further validate the theory that subjects with schizophrenia have increased activation and decreased inhibition in the spreading of activation in the semantic memory during language processing.

Key words: associations, imageability, frequency, early-onset psychosis, forced-choice comprehension test, associations production test

1. Introduction

From a psycholinguistic viewpoint, psychosis, and hence schizophrenia, has most often been studied in terms of deficits in language production and comprehension related to their atypical production of associations. Idiosyncratic and loosely related associations are thought to be prevalent in language production in schizophrenia (Maher et al., 2005, Elvevåg et al., 2007). The basis of such production is thought to be an abnormal activity associated with intralexical automatic spreading of activation in the semantic memory in semantic processing at short SOA intervals (less than 300 ms) which do not include extralexical strategic processes (Mathalon et al., 2010, Neely & Keefe, 1989). Such abnormal activity has been described as a hyperactivity of spreading activation in the semantic memory (Spitzer et al., 1993; Ballerini, 2016) or a slowing of movements between different concepts in the semantic memory (Bokat & Goldberg, 2003). In theories which support the first standpoint, semantic memory is conceptualized as a connectionist model in which each concept is represented as a node of links which are connections to other concepts and present their relations (according to their association strength, features, frequency of use, etc.). In search-and-retrieval processes in language processing, each concept is activated by the activation of its connections. A greater connections network is thought to increase the activation. In schizophrenia, and possibly psychosis in general, this activation, according to the theory of increased spreading of activation, is increased. Increased activation needs a stronger inhibition of incorrectly activated concepts, but it is thought to be decreased in schizophrenia. Based on a priming study, Spitzer et al. (1993) suggest that greater activation in the semantic memory needs a higher amount of inhibition, which is decreased in schizophrenia, and that results in slower reaction times in subjects with schizophrenia than in healthy control subjects. Citing an ERP study on indirect priming, Kreher et al. (2008) have concluded that subjects with schizophrenia display higher automatic activation and decreased inhibition of false answers. The question has arisen as to the influence of different lexical-semantic features, such as imageability and frequency, on language processing in subjects with first-episode and early-course psychosis, as they are considered to be among the lexical-semantic features that strongly influence language processing because the define the quantity and quality of the connections representing a concept.

The semantic memory is a store of knowledge about concepts which are used and manipulated during language processing. It is generally conceptualized as a network structure of nodes that represent concepts and are connected by relational links that are marked according to the features they represent (Minzenberg et al., 2002). The quantity and quality of connections representing a concept and linking it to other concepts depend on its features, such as frequency of use, concreteness, imageability, etc.

Imageability is the ability with which words activate their mental images. Highly imageable words require less cognitive effort in concept activation than do low-imageability words. In a connectionist-type framework, de Groot (1989) concludes that highly imageable and concrete words have a higher number of connections in their concept nodes, but that words with low-imageability and abstract words are connected with a higher amount of different nodes which will cause slower activation and retrieval time.

Since activation of concepts follows a fluid pattern and is dependent on the quality of the connections, highly imageable words will, along with higher activation, require lower cognitive effort. In terms of the spreading activation theory of the connectionist model of semantic memory in the search process of language processing, connections that link the target concept with other concepts are activated. This activation is dependent on the quality and quantity of their connections. Because of that, de Groot (1989) concludes that the activation of highly imageable words will be faster than the activation of low imageability words. The semantic memory is considered as a connectionist model in which each concept is made of concepts and nodes of features connected to other concept nodes. A greater number of activated features results in faster search and activation of the target concepts in healthy subjects. According to the theory of faster automatic spreading of activation in schizophrenia subjects, the more connections to other nodes, i.e. the more features, a concept has, the greater the likeliness that it will activate more competing concepts which need to be inhibited prior to production. Because of this, the stimulus on both tests was made uniform on account of the imageability and frequency conditions, because highly imageable words are expected to have more connections, and highly frequent words are thought to have stronger and more easily activated connections in the semantic memory.

In a language-association production and comprehension study, Sommer et al. (1963) conclude that, although patients with schizophrenia produce more idiosyncratic associations on a production test than a healthy control group, they still choose the most frequent ones on a comprehension test (on the Kent and Rosanoff word-association norms). On account of this, they conclude that patients with schizophrenia can discern frequent from non-frequent associations.

The aim of this study was to determine how two lexical-semantic features, imageability and frequency, affect language-association production and comprehension in subjects with first-episode and early-course schizophrenia-spectrum psychosis. The first task included elicited-association production on stimuli with high or low imageability ratings. The second task was a forced-choice comprehension task which included a frequency condition, as well as an imageability condition. In the production test, both groups were expected to have longer reaction times on associations with low imageability in comparison to associations with high imageability. On the comprehension test, both groups were expected to choose statistically more often high- and medium-frequency associations in comparison to low-frequency associations. Additionally, on the comprehension test, the patient group was expected to have longer reaction times in relation to the control group not dependent on the frequency condition. Better understanding of language processing in first-episode and early-course psychosis could enable the creation of diagnostic markers and instruments for predicting the course of the disorder, especially if possibly accompanied with longitudinal studies.

2. Methods

2.1. Participants

The study included 12 subjects with first-episode and early-course schizophrenia-spectrum psychosis and a control group of 12 matched healthy subjects. The average age of the patient group was 25.29 (SD=3.53) years; 2 patients were right-handed, 4 patients were female, and 8 were male. The average time after the onset of the disorder was 11.88 (SD=14.37) months, and the average time after the beginning of therapy was 6.7 (SD=7.4) months. All patients received antipsychotic therapy. Their average daily dose of antipsychotics expressed in chlorpromazine equivalents was 600 (SD=298.74) mg. The schizophrenia subjects were patients of the University Psychiatric Hospital Vrapče, and the control group were volunteers. The control group was matched with the patient group in terms of age, sex, and dominant hand. All subjects had signed an informed consent for the study, which had been approved by the Ethics Committee of the University Psychiatric Hospital Vrapče on 23 March 2018 (Registry number: 23-305/8-18).

2.2. Materials and procedure

The study was composed of two tests, an elicited-association production test and a forced-choice comprehension test. Both tests were constructed specifically for this study based on the psycholinguistic literature (Sommer et al., 1963; Rossell & David, 2005; Kircher et al., 2008). Materials were constructed using lexical items from the Psiholex_HR database (Erdeljac, Sekulić Sović & Miklić, 2018), which includes, inter alia, data points for associations and imageability collected from native speakers of Croatian or health participants (n:105). On the production test, the subjects were presented with 15 highly imageable words and 15 words with low imageability ratings based on the Psiholex_HR database, on which they were to produce associations. Although the subjects were asked to produce three associations for each experimental item, only the first produced association was included in the analysis. On the comprehension test, subjects were also presented with 15 highly imageable words and 15 words with low imageability ratings based on the Psiholex_HR database. After each word, three associations were shown. The associations were also chosen from the the Psiholex_HR database (Erdeljac, Sekulić Sović & Miklić, 2018). Each item included a highly frequent, moderately frequent and non-frequent association, according to the Psiholex_HR database, from which the subjects were asked to choose the one they thought was most associated with the stimulus. Each experimental item was shown individually, and both the experimental items and the answers were randomized. Both tests were carried out on a computer screen using the E-prime (Schneider et al., 2012) program. Stimulus onset asynchrony was 200 ms, and each stimulus was shown on the screen for one second.

For the production test, reaction times for each experimental item were calculated. Reaction times for words with high and low imageability were compared. For the production test, both the reaction times for the imageability and frequency conditions and the number of chosen associations based on the frequency condition were analyzed.

3. Results

3.1. Production test

Data for the statistical analysis seems to satisfy conditions for a parametric analysis – Kolmogorov-Smirnov and Shapiro-Wilk tests of normality of results distribution were shown to be non-significant for reaction times of both words with high imageability and those with low imageability, and the same applies for the Levene test of homogenous variances. However, residual distribution was shown to be non-normal in both cases, and when the small number of subjects is taken into account, the validity of these tests is questionable. In small subject samples, neither test has the statistical strength to detect significant differences in normality and homogeneity assumptions of variances (Field, 2013). Therefore, non-parametric analyses were used – the Mann-Whitney U test for group differences and the Wilcoxon signed-rank test for in-group differences. The p-value was set at 0.05. Descriptive data is shown in Table 1.

Table 1. *Descriptive data (median and interquartile range) for reaction times for high- and low-imageability associations in both groups*

	Control group (N = 12)			**Patient group (N = 12)**		
	C	*Q1*	*Q3*	*C*	*Q1*	*Q3*
Reaction times (ms)						
High-imageability associations	1955.87	1763.45	2492.73	3030.70	2641.58	3289.33
Low-imageability associations	2278.67	1957.48	2573.77	3155.40	2839.12	3508.73

The Mann-Whitney U test showed that there is a statistically relevant difference ($U(12, 12) = 131$, $z = 3.41$, $p < 0.01$, $r = 0.70$) in average reaction times for high-imageability associations between the control group (C = 1955.87 ms) and the patient group (C = 3030.70 ms). The results were the same for the low-imageability associations, as the average reaction times of the control group (C = 2278.67 ms) and the patient group (C = 3155.40 ms) were statistically relevantly different ($U(12,12)= 135$, $z = 3.64$, p < 0.01, $r = 0.74$).

The Wilcoxon signed-rank test for in-group differences showed that there were statistically relevant differences in reaction time in the control group ($T(12) = 66$, $z = 2.12$, $p = 0.03$, $r = 0.43$), as the control subjects had faster reaction times for high-imageability associations (C = 1955.87 ms) when compared to low-imageability associations (C = 2278.67 ms). However, there were no statistically relevant differences in reaction times with regard to imageability in the control group ($T(12) = 50$, $z = 0.86$, $p = 0.39$, $r = 0.18$). These results can be seen in Figure 1.

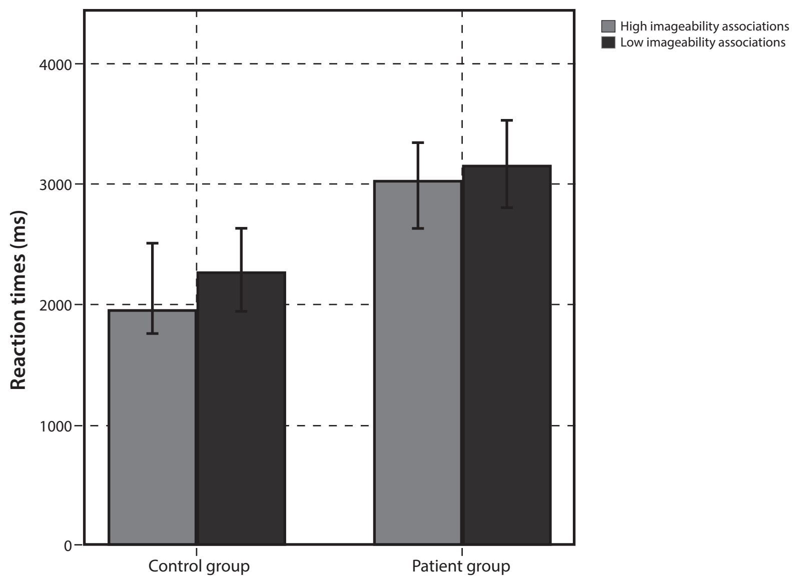

Figure 1. *Median and reliability intervals of reaction times (ms) for imageability in the control and patient groups*

3.2. Comprehension test

The data for the statistical analysis deviate from a normal distribution of results and residuals and do not meet the homogeneity of variances condition, and, as in the production test, the subject sample was small. On account of this, non-parametric tests were used – the Mann-Whitney U test for between group differences and the Wilcoxon signed-rank test for in-group differences; Friedman's ANOVA was also used for in-group differences. The *p*-value for all tests was set at 0.05. With multiple comparisons the Holm-Bonferroni correction was used. Descriptive data can be seen in Table 2.

Table 2. Descriptive data (*median and interquartile range)* for reaction times for high- and low-imageability associations and reaction times and the number of chosen high-, medium-, and low-frequency associations in both the control and the patient group

	Control group (*N* = 12)			**Patient group (*N* = 12)**		
	C	*Q1*	*Q3*	*C*	*Q1*	*Q3*
Reaction times (ms)						
High-imageability associations	1635.20	1038.38	2026.35	2598.23	2283.15	3052.48
Low-imageability associations	1357.10	1090.70	1839.82	2700.23	2206.17	3072.43

	Control group (N = 12)			Patient group (N = 12)		
	C	*Q1*	*Q3*	*C*	*Q1*	*Q3*
High-frequency associations	1278.12	1037.39	1910.45	2275.20	2017.97	2901.69
Medium-frequency associations	1645.82	1184.86	2143.80	2587.99	2147.40	2983.38
Low-frequency associations	2562.89	1840.25	3070	3546.17	2225.03	4279.63
Number of chosen associations(N)						
High-frequency associations	21	18	25	22	12.50	24
Medium-frequency associations	8.50	5	9.75	6.50	5	11.50
Low-frequency associations	0.50	0	2	2	1	5.50

To establish if there were reaction-time differences on high- and low-imageability associations between the two groups, the Mann-Whitney U test was used. It showed that there is a statistically relevant difference ($U(12, 12) = 126$, $z = 3.12$, $p = 0.01$, $r = 0.64$) in average reaction times on high-imageable associations between the control group ($C = 1635.20$ ms) and the patient group ($C = 2598.23$ ms). The same result was obtained for the reaction times on low-imageability associations, and there was a statistically relevant difference ($U(12,12) = 131$, $z = 3.41$, $p < 0.01$, $r = 0.74$) on low-imageability associations between the control group ($C = 1357.10$ ms) and the patient group ($C = 2700.23$ ms).

The Wilcoxon signed-rank test showed no statistically relevant differences in reaction times on low- and high-imageability words in the comprehension test in both the control group ($T(12) = 60$, $z = 1.65$, $p = 0.09$, $r = 0.34$) and the patient group ($T(12) = 24$, $z = -1.18$, $p = 0.24$, $r = -0.24$). These results can be seen in Figure 2.

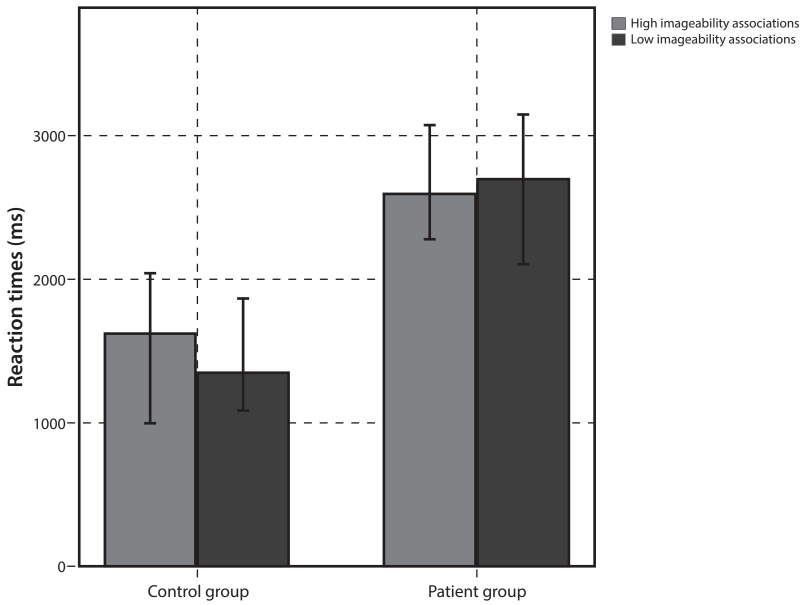

Figure 2. *Median and interquartile intervals of reaction-time reliability (ms) for associations' imageabilities in the control and patient groups*

To review group differences in reaction times for high-, medium-, and low-frequency associations, the Mann-Whitney U test was used. It showed that there is a statistically relevant difference ($U(12, 12) = 129$, $z = 3.29$, $p < 0.01$, $r = 0.67$) in average reaction times on high-frequency associations between the control ($C = 1278.12$ ms) and patient ($C = 2275.20$ ms) groups. A statistically relevant difference ($U(12, 12) = 122$, $z = 2.89$, $p = 0.03$, $r = 0.59$) was also found in the average reaction times on medium-frequency associations between the control ($C = 1645.82$ ms) and patient ($C = 2587.99$ ms) groups. However, the difference was not statistically relevant for low-frequency associations ($U(10, 10) = 44$, $z = 1.52$, $p = 0.15$, $r = 0.34$). These results can be seen in Figure 3.

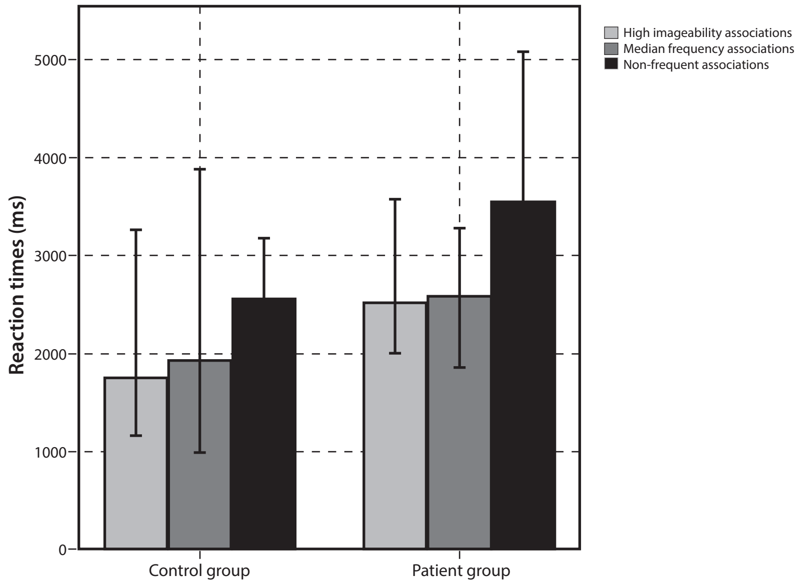

Figure 3. *Median and interquartile intervals of reaction-time reliability (ms) for associations' frequencies in the control and patient group*

Friedman's ANOVA was used to test in-group differences in reaction times and the number of chosen associations on account of the frequency condition in both groups. In the first analysis, the analysis was shown not to be significant for the control ($\chi2(2) = 2.33$, $p = 0.31$) or the patient group ($\chi2(2) = 3.80$, $p = 0.15$), which shows that there were no differences in reaction-time distribution in the frequency condition choices. In the second analysis, the analysis was shown to be significant in both the control ($\chi2(2) = 20.72$, $p < 0.01$) and the patient group ($\chi2(2) = 16.17$, $p < 0.01$).

In the control group, pair comparisons (adjusted Wilcoxon tests) show a significant difference ($T(12) = 1.83$, $z = 4.49$, $p< 0.01$, $r = 0.92$) in the average number of highly-frequency associations chosen (C = 21) when compared to low-frequent associations (C = 0,50), as well as a significant difference ($T(12) = 1.04$, $z = 2.55$, $p = 0.03$, $r = 0.52$) in the average number of median frequency associations chosen (C = 8,50) when compared to non-frequent associations. The difference between high- and medium-frequency associations was not shown to be relevant ($T(12) = 0.79$, $z = 1.94$, $p = 0.16$, $r = 0.40$).

In the patient group, pair comparisons have similar results – there is a significant difference ($T(12) = 1.58$, $z = 3.88$, $p < 0.01$, $r = 0.79$) in the average number of high-frequency associations chosen ($C = 22$) when compared to low-frequency associations ($C = 2$). Furthermore, there is a significant difference ($T(12) = 1.17$, $z = 2.86$, $p = 0.01$, $r = 0.58$) in the average number of medium-frequency associations chosen ($C = 6.50$) when compared to low-frequency associations. As in the control group, there was no significant difference between high- and mediium-frequency associations ($T(12) = 0.42$, $z = 1.02$, $p = 0.92$, $r = 0.21$). These results can be seen in Figure 4.

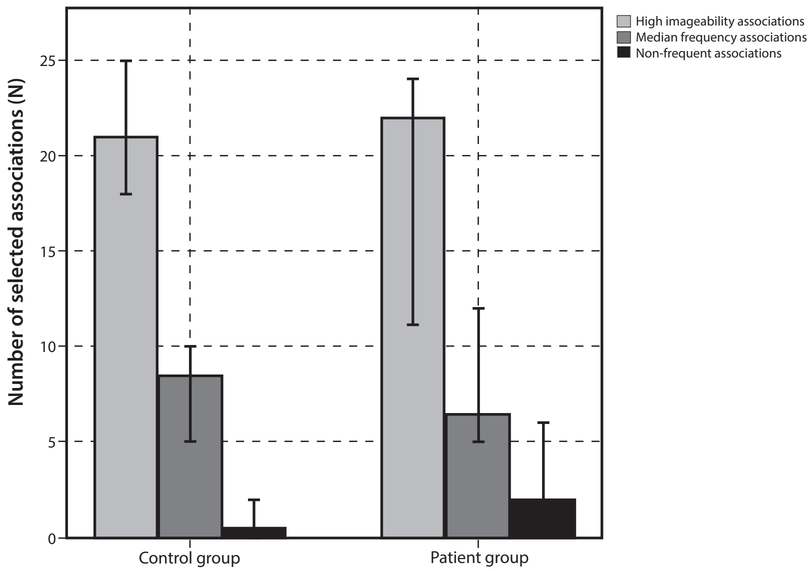

Figure 4. *Median and interquartile reliability intervals on the frequency condition in the control and patient groups*

4. Discussion

The control group had longer reaction times on low-imageability associations, while the patient group reaction times did not statistically differ on the imageability condition. Faster reaction times on highly imageable associations is in line with other studies on imageability processing (Paivio, 1991). The presupposition is that, in schizophrenia patients, highly imageable associations produced a higher amount of activation in the semantic memory and that the decrease in inhibition resulted in longer reaction times, which was the same result as for associations with low-imageability that did not have greater activation in the semantic memory.

Both groups statistically significantly more often chose high- and medium-frequency associations than low-frequency associations. Despite the fact that, on the language production test, the patients with first-episode and early-course psychosis more often produce idiosyncratic, personal, and indirect associations (Maher et al., 2005), on the comprehension test they recognize which ones are most frequently use.

The patients had longer reaction times than the control group only on associations of high and medium frequency, but not on low-frequency associations. This result is in line with the result of the production test, as the control group had no need for heightened inhibition on non-frequent associations, because they had no need for inhibition on low-imageability associations on the production test, so the reaction times for low-frequency associations did not differ from the reaction times of the control group, while the reaction times for highly and moderately frequent associations were longer than those of the control group.

5. Conclusion

Psycholinguistic studies on language production and comprehension contribute to understanding of deficits in psychosis and can contribute to clinical diagnostics. This study analyzed language production and the comprehension of associations in subjects with first-episode and early-course schizophrenia-spectrum psychosis in relation to a healthy control group with regard to the lexical-semantic imageability and frequency features. Our results analysis showed that there is an influence of the imageability feature on language processing in first-episode and early-course psychosis subjects which differs from the influence it has in healthy subjects. In the control subjects, the language stimulus with high imageability facilitated faster processing, but in the patient group, it did not, since more concept features led to higher activation in the semantic memory, which slowed processing as the inhibition mechanisms had to be activated to a higher degree, and it is presupposed that psychosis patients have decreased inhibition together with increased activation in language processing. Similar results were obtained in the reception test for the frequency condition, where the patient group had slower reaction times than the control group on high- and medium-frequency associations, but not on low-frequency associations.

It can be concluded that psycholinguistic studies on imageability can contribute to the understanding of language processing both in subjects with language disorders and in healthy subjects with normal language processing abilities. A shortcoming of this study is its small subject sample, but further studies will certainly provide great support in creating a complete view of language deficits in patients with schizophrenia and other psychotic disorders.

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The influence of the typicality feature in the production of language associations in schizophrenia

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https://doi.org/10.17234/9789531758314.08

Abstract

Language deficits in schizophrenia are hypothesized to be a result of increased spreading of activation in the semantic memory during language processing. The spreading of activation is determined by the features of concepts activated in search and retrieval processes. One of the features thought to have a great influence on processing is the typicality feature (Holmes & Ellis, 2006). The aim of this study was to establish whether there are differences in language processing in schizophrenia subjects compared to a healthy control group in a verbal fluency task based upon the typicality feature. Specifically, the analysis was limited to the first cluster of the verbal fluency task because it requires the least effort in terms of task restrictions (Venneri et al., 2008). The study included 8 patients diagnosed with schizophrenia from the University Psychiatric Hospital Vrapče and 8 healthy control subjects. A category semantic fluency task was conducted on both groups, and the healthy control group was given a typicality rating task consisting of exemplars produced by both groups in the first cluster of the former task. Results analysis showed no differences in the typicality ratings of exemplars between the groups in any of the categories except the *animals* category.

Key words: schizophrenia language deficits, verbal fluency, associations, first cluster, typicality feature

1. Introduction

Studies on the production and reception of language associations in schizophrenia are numerous as the use of idiosyncratic associations as well as a larger amount of direct and indirect associations is considered to be one of its symptoms. Among the first definitions of schizophrenia, Bleueler suggested *loose associations* as one of its main symptoms. In line with that, recent psycholinguistic literature has shown that subjects with schizophrenia use a larger amount of associations in their discourse (Maher et al., 2005; Elvevåg et al., 2007), idiosyncratic associations (Maher, 1983; McKenna & Oh, 2005: 156–158; Johnson & Shean, 1993), and in associative priming tests show a higher priming effect (Kreher et al., 2008). On account of the higher priming effect in associative priming in schizophrenia subjects, compared to healthy controls, Spitzer et al. (1993) concluded that subjects with schizophrenia show a faster spreading of activation and/or a lack of inhibition in the semantic memory during search and retrieval processes in language production. Other studies confirm the faster spreading activation with a lack of inhibition interpretation (Maher et al., 1987; Manschreck et al., 1988). Anderson (1983) proposed the theory of faster spreading activation in which the associations' connections and the speed of concept activation are important in the search processes. This theory presents concepts as hubs of associative elements and features and presupposes that associations are activated because of their connections, which can be semantic features, frequency, co-occurrences, etc. If search and retrieval processes arrive at an activated hub of features, which corresponds to an association, before the search reaches the actual target concept, the association can be produced if it is not correspondingly inhibited. In semantic memory models, spreading activation theories are prevalent in traditional cognitive models such as those presented by Quillian (1968) and elaborated by Collins and Loftus (1975). Quillian's model is hierarchical and supposes that concepts are hubs on different hierarchical aspects and that features are connected to a specific hierarchy level. Collins and Loftus elaborate on the model, claiming it is not hierarchical and that the activation spreads fluidly through concept nodes and hubs, depending upon features, connections, and concepts. The capacity and length of the activation are defined by different criteria, and the search is stopped when a sufficient level of activation is reached or by the passage of time. Collins and Loftus, who agree with this semantic memory model, assume that subjects with schizophrenia have faster spreading activation in which concepts are not appropriately inhibited after being activated before reaching the target word.

Studies on the structure and organization of the semantic memory offer information on associative structures that reflect concept representations. Because of this, they have been conducted since the beginning of interest in the semantic memory. Tulving (1972: 402) concluded that association tests offer a broad view of the semantic memory, and Cramer (1968) introduced them in psychology and linguistic studies Nelson et al. (2000) concluded that they offer a means of constructing the lexical-semantic knowledge of subjects who share the same cultural and language background. Along with free association tests, verbal fluency, lexical decision, priming, and scalar tests (among others) are conducted in association studies. The importance of verbal fluency tests is emphasized by the fact that they are decontextualized, while discourse production and statistical association analysis, for example, can also be contextualized.

Verbal fluency tasks require a subject's language production in assigned conditions and time restrictions. They differ on conditions; for example, there are semantic fluency tasks (listing examples of a specified semantic category), phonological fluency tests (listing examples starting with a same phoneme), and syntactic fluency tasks (listing examples with the same syntactic limitations). Semantic fluency tasks include activation of semantic memory concepts on account of semantic associative relations and include automatized search processes in a specific semantic subcategory (cluster) and controlled processes of transition from one subcategory to another (switching) (Troyer & Moscovitch, 2006: 144).

At the start of the verbal fluency test, production depends on controlled and automatized processes and is restricted only by the restrictions of the task, but as time goes by, the subjects have to take into account further limitations: they need to remember all the produced exemplars and accessed subcategories to avoid repetition and returning to subcategories. Studies which analyzed production of 60 second verbal fluency tasks in 15 second intervals have concluded that the test follows a negative acceleration curve (Crowe, 1998).

It can be surmised that production in the first interval, and first cluster, is dependent mainly on the connectivity of the semantic store and lexical-semantic features of the concepts. Holmes and Ellis (2006) suggested that semantic typicality influences word-processing tasks in healthy adults, and Venneri et al. (2008) suggested that age of acquisition and semantic typicality for production in the first interval of the fluency tasks would be higher in schizophrenia patients when compared to healthy control subjects.

Semantic typicality refers to the degree to which a concept presents a certain semantic category (Rosch, 1975). Elvevåg et al. (2002) have concluded that semantic typicality has a great influence in categorization tests in subjects with schizophrenia. Juhasz et al. (2012) have concluded that schizophrenia subjects, in comparison with healthy control subjects, produce more typical category exemplars in earlier clusters of verbal fluency tasks, while Baskak et al. (2008) have concluded that schizophrenia subjects produce fewer typical category exemplars than healthy control subjects do.

This study analyzes primary clusters, as they require the least effort in verbal fluency tasks (Crowe, 1998). Further cluster analysis was not taken into account because the goal of this study was to analyze the semantic typicality of category exemplars in subjects with schizophrenia in comparison with control subjects. Semantic typicality was established by a typicality rating task results analysis. An additional control group evaluated every produced concept of the primary cluster of both subject groups of the verbal fluency test on a 1–5 scale. Results of the typicality rating task of exemplars produced by subjects with schizophrenia were compared with the results of exemplars produced by the control group.

The goal of this study was to analyze semantic typicality of category exemplars in the first cluster of the verbal fluency task in subjects with schizophrenia in comparison with control subjects. Based on the typicality rating of the exemplars produced, patients produced less typical associations when compared to the healthy control group. The results for the patient group on typicality rating differed from the healthy controls depending on the category.

2. Methods

2.1. Participants

The study included eight patients from the University Psychiatric Hospital Vrapče, School of Medicine, University of Zagreb. Six patients had been diagnosed with acute schizophrenia-like psychotic disorder (F23.2), and two patients had diagnoses of acute polymorphic psychotic disorder with symptoms of schizophrenia (F23.1). The average time since the onset of the disorder was 1.5 (SD=2.73) months. All patients received antipsychotic therapy, and the average daily dose of antipsychotics expressed in chlorpromazine equivalents was 460.625 (SD=231.82). Informed consent was obtained for all patients before the administration of the test, and the test was approved by the Ethics Committee of the University Psychiatric Hospital Vrapče (Registry number: 23–485/2–15). The average age of the patients was 25.375 (SD=5.55); 6 were female, 2 male, and all were right-handed. The healthy subjects for the first task were matched with the patients in age, handedness and sex. For the second test, the typicality rating task, another control group of healthy subjects, 42 Croatian-speaking volunteers with an average age of 26.6 (SD=2.51) years, were recruited.

2.2. Materials and procedure

The study consisted of two experiments, a semantic category verbal fluency test, and a typicality rating task. The semantic category fluency test was used in the first part of the study. The subjects were required to produce category exemplars in a restricted time frame of 60 seconds. The following categories were examined:

animals, vehicles, beverages, clothes, trees, furniture, vegetables, fruits and *musical instruments*. All the categories were introduced by the examiner, through questions such as *What animals can you think of?* The replies were recorded by a voice recorder and later transcribed. The second experiment, the typicality rating task included exemplars produced by subjects in the first cluster of the verbal fluency task. The subjects made a subjective assessment of typicality of every word on a scale of 1 to 5. This test was used to estimate words in relation to association prototype. The typicality rating task consisted of three associations forming the first cluster obtained from schizophrenia patients and healthy control subjects through the category fluency test. The participants were supposed to evaluate to what extent the task word is a prototype of a certain category. In addition to the listed associations, the experiment also contained brief instructions on how to evaluate the words from 1 to 5 in relation to the bolded word, written above the task word, representing the category: *On a scale 1 to 5, where 1 represents not typical and 5 represents very typical, please judge how typical you consider this example to be as a prototype for its category*.

3. Results

Differences between the healthy controls ($N = 8$) and the patients ($N = 8$) were tested for the first, the second, and the third association in the different categories of words (Table 1). The only difference was established for the second association of the category *animals* ($U(8, 8) = 8.00$, $z = 2.52$, $p = .0117$, $r = .63$), where the healthy controls had a higher typicality rating (*Mdn* = 4.67, *Q1-Q3* = 4.51-4.75) than the patients (*Mdn* = 3.31, *Q1-Q3* = 2.92-4.32).

Table 1. Results of Mann-Whitney U test of the differences between the healthy controls and the patients

	Controls Mdn	*Patients Mdn*	*U*	*Z*	*p-level*	*r*
Animals_first	4.60	3.98	26.00	0.63	.5286	0.16
Animals_second	4.67	3.31	8.00	2.52	**.0117***	0.63
Animals_third	4.06	3.75	26.00	0.63	.5286	0.16
Vehicles_first	4.90	4.50	26.00	0.63	.5286	0.16
Vehicles_second	3.83	3.57	27.00	0.53	.5995	0.13
Vehicles_third	3.67	3.45	26.00	0.63	.5286	0.16
Trees_first	3.81	4.12	20.00	-1.26	.2076	-0.32
Trees_second	4.24	4.12	31.00	-0.11	.9164	-0.03
Trees_third	3.99	3.14	17.50	1.52	.1278	0.38
Furniture_first	4.43	4.69	18.00	-1.47	.1415	-0.37
Furniture_second	4.24	4.69	21.50	-1.10	.2701	-0.28

	Controls Mdn	Patients Mdn	U	Z	p-level	r
Furniture_third	4.38	4.38	32.00	0.00	1.0000	0
Drinks_first	4.81	4.36	16.50	1.63	.1036	0.41
Drinks_second	4.30	3.86	27.50	0.47	.6365	0.12
Drinks_third	3.99	3.85	29.00	0.32	.7527	0.08
Vegetables_first	4.43	4.05	13.50	1.94	.0520	0.49
Vegetables_second	4.21	4.39	25.00	-0.74	.4623	-0.19
Vegetables_third	4.43	4.43	27.00	0.53	.5995	0.13
Clothes_first	4.80	4.95	26.00	-0.63	.5286	-0.16
Clothes_second	4.67	4.95	15.50	-1.73	.0831	-0.43
Clothes_third	4.27	4.05	30.00	0.21	.8336	0.05
Fruits_first	4.86	4.48	19.00	1.37	.1722	0.34
Fruits_second	4.24	4.44	29.50	-0.26	.7929	-0.07
Fruits_third	3.55	4.24	28.50	-0.37	.7132	-0.09
Instruments_first	4.95	4.94	22.00	1.05	.2936	0.26
Instruments_second	3.74	3.99	23.50	-0.89	.3720	-0.22
Instruments_third	3.94	3.48	22.50	1.00	.3184	0.25

Legend: * $p < .05$

Table 2. Results of Mann-Whitney U test measuring the differences between healthy controls and patients for different categories of words

	Controls Mdn	Patients Mdn	U	Z	p-level	r
Animals	12.98	11.49	8.00	2.52	**.0117***	0.63
Vehicles	12.54	11.58	25.00	0.74	.4623	0.19
Trees	12.30	11.84	20.00	1.26	.2076	0.32
Furniture	12.77	13.74	20.50	-1.21	.2271	-0.30
Drinks	12.73	11.96	27.00	0.53	.5995	0.13
Vegetables	12.89	12.18	16.00	1.68	.0929	0.42
Clothes	13.43	13.43	31.00	0.11	.9164	0.03
Fruits	12.64	12.85	30.50	0.16	.8748	0.04
Instruments	12.58	12.04	26.00	0.63	.5286	0.16

Legend: * $p < .05$

4. Discussion

The aim of this study was to analyze the production of language associations in subjects with schizophrenia, in relation to a healthy control group. Specifically, the aim was to analyze typicality of associations in the first cluster of the semantic fluency task, since typicality is considered to be one of the features that influence production in healthy and schizophrenic language processing the most, and the first cluster requires the least effort and is not dependent on further constraints of the task.

The leading hypothesis was not confirmed, as the schizophrenia subjects did not produce less typical associations when compared to the healthy control group. However, they did produce associations with a lower typicality rating in one of the analyzed semantic categories, the *animals* category. Animals are the only category containing the animacy feature, which, according to the CSA theory (Tyler & Moss, 2001), is processed differently because of a higher amount of shared features in the semantic memory, unlike concepts without the animacy feature which are thought to be processes mostly on account of their distinctive features. Therefore, it is not unexpected to find the only relevant difference in the *animals* category.

Our results show us that, in all categories except one (*furniture*), the healthy control group achieved higher scores in typicality ratings of associations in the first cluster, although the difference was not statistically relevant ($p>0.5$). The only statistically relevant difference was in the *animals* category, in which the patient group produced statistically less typical category exemplars. No other inter-group differences proved statistically relevant. This could be a result of the small subject sample. Nevertheless, although the rest of the tested categories show no statistically relevant inter-group differences, there is a tendency toward the production of less typical exemplars in the patient group, which could be statistically relevantly reproduced on a larger subject sample.

The results obtained from the two tests (the semantic category fluency task and the typicality scale task) have shown differences between the two subject groups only in the *animals* category, while there were no differences in the rest of the semantic categories. These results are not in line with either Juhasz et al.'s (2012) or Baskak et al.'s (2008) results, who found differing typicality rating results in the first cluster for their schizophrenia subject groups when compared to healthy control groups. The reason for this could be the small sample of the present study, but also the fact that the patients examined were first-episode psychosis patients early in the course of their illness, and the typicality rating could be a "state marker," changing across the phases of the illness.

These results also indicate differences in the language processing of the *animals* category and could suggest differences in the processing of animacy features. Additionally, the results show that there are no differences in language processing of the typicality feature in other semantic categories in first-episode psychosis subjects in relation to the healthy control group. Future studies should additionally analyze the processing of animacy features and typicality in schizophrenia-spectrum disorders across different illness phases.

5. Conclusion

The results of this study were analyzed in accordance with current psycholinguistic theories, but further studies are needed on a larger subject sample, although the statistical analysis provided clear results.

This study chose to analyze only the first cluster of verbal fluency task as it is thought to be the cluster most dependent on the automatic processes of language production, since each subsequent cluster demands further task restrictions which are considered to be under the controlled processes domain. Hence, the first cluster relies the most on automatic processes, i.e. on the connectivity of the semantic memory and the lexical-semantic features of the concepts which form it. As the goal of this study was to analyze the influence of the typicality feature, the analysis of the first cluster of production proved to be the most relevant. Analysis of the whole production on the fluency task by intervals could prove valuable and remains an interesting suggestion for further studies.

In this study, the typicality rates were provided by the healthy control group; one possibility for a follow-up study would be to compare the typicality ratings of both subject groups, so as to further establish differences between the groups' lexical-semantic processing of both associations and the typicality feature.

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Modality-specific sensory norms: a new window into semantic organization[1]

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https://doi.org/10.17234/9789531758314.09

Abstract

In this chapter we will give a brief overview of the research that emphasized the importance of perceptual information in the structure and function of semantic knowledge. We will then describe a recently developed approach in operationalizing conceptual representations that relies on the relevance of perceptual information. The core of this approach builds upon word concreteness (the extent of perceptual experience with an object denoted by a word) and further elaborates it by estimating perceptual experience across separate sensory modalities (visual, auditory, tactile, olfactory, gustatory). We will summarize the data collected in several languages that converge to show the structure of perceptual space within the semantic system. Finally, we will propose to use this approach as a novel way of obtaining insights into the structure of the semantic systems of special populations. Here, we will focus on language of individuals with schizophrenia, but we will suggest that it can be used in general.

Key words: embodied cognition, perceptual experience, schizophrenia, semantic representations, word concreteness

1. Different approaches to semantic knowledge

The beginning of psychological research on the structure of semantic knowledge has been marked by numerous attempts to detect relevant semantic categories and relevant principles of classification. Early attempts viewed semantic knowledge as a hierarchical network of concepts, the topography of which was defined by the number of hierarchical levels (nodes) between the concepts (Collins & Quillian, 1969). The knowledge was structured in an encyclopedic way,

1 This research is funded by the Ministry of Education, Science, and Technological Development of the Republic of Serbia (grant number: 179033 i 179006).

by placing subordinate concepts under the node of the superior concept (e.g. *cat, mouse, lion* etc. under the node for *mammals*), and by propagating the features of the superior concept to all of the subordinates (e.g. *all mammals have fur*). Given that empirical data collided with multiple predictions from such a model, the hierarchical topography was replaced with a topography defined by similarity among concepts (Collins & Loftus, 1975). However, these models were not able to account for the fact that not all concepts could be classified into categories, and that not all categories have clear boundaries (McCloskey & Glucksberg, 1978). Therefore, the prototype theory was introduced (Rosch, 1973; Rosch & Mervis, 1975), which approached the semantic system in a different way. Within this approach, categories were organized around an abstract entity – the so-called prototype – which entailed all the features of the concepts within the given category, weighted by frequency of occurrence. Concepts were organized according to the level of typicality, i.e. similarity to this abstract category average. Although this model was able to account for more empirical data than its predecessors, it was not able to account for the fact that not all concepts have their prototype (Hampton, 1981), or for the human capability to form ad hoc categories (Barsalou, 1985), and it was not able to capture information on the variability within a category (Rips & Collins, 1993). In order to resolve these issues, exemplar theory was introduced (Nosofsky, 1988; 1991; Kruschke, 1992). According to this model, the concept is not defined by the abstract entity, but by all the exemplars that we have encountered which are stored in the memory. The relevance of the idea of the existence of a categorical organization in the semantic system has also been strengthened by neuropsychological and neuroimaging data. Multiple cases of category-based agnosia have been documented (Samson & Pillon, 2003; Shelton, Fouch, & Caramazza, 1998; Warrington & McCarthy, 1983; Warrington & Shallice, 1984), and numerous studies have identified brain areas that correspond to categories of objects (e.g. *houses, animals, fruits, tools* etc. Chao, Haxby, & Martin, 1999; Martin & Chao, 2001).

Simultaneously with describing relevant categories of concepts, attempts were made to specify relevant features that describe those (Cree & McRae, 2003). For example, Smith, Shoben, and Rips (1974) proposed the feature overlap theory, according to which concepts are stored in the form of the list of their defining features that are present in all category members and characteristic features that are specific to the given concept. The process of recognizing concepts and discriminating among them would rely on the process of feature comparison. Others have stressed the importance of perceptual (important for living things) versus functional (important for tools) features (Farah & McClelland, 1991; Warrington & Shallice, 1984). The relevance of features has also been documented in the profiles of neuropsychological patients (Lambon-Ralph, Howard, Nightingale, & Ellis, 1998), as well as in neuroimaging data (Goldberg, Perfetti,

& Schneider, 2006; Hauk, Johnsrude, & Pulvermuller, 2004), as will be discussed in more detail in section 2.

In addition to defining categories and features of concepts, attempts were made to understand whether conceptual representations should be defined in terms of analogue properties or in terms of abstract formal relations. Paivio (1971; 1991; 2013) advocated for the representational difference between concrete and abstract concepts (those that can and cannot be experienced perceptually; e.g. *apple* vs. *truth*). According to his dual-coding theory, all concepts are stored in so-called logogens (mental representations entailing various lexical characteristics), but concrete concepts have additional mental representations, so-called imagens, which entail analogue perceptual characteristics. On the other hand, Pylyshyn (1984, and also Anderson & Bower, 1973) argued that all concepts can be stored in terms of propositions – abstract relations among them, without the need to introduce analogue code in order to store the semantic knowledge. The view that perceptual information is not relevant for the organization of the conceptual system was shared by others (Fodor, 1975; Smith & Medin, 1981; Tulving, 1972). More recently, other theories were proposed to account for the observed differences between concrete and abstract concepts. For example, context availability theory (Schwanenflugel, Akin, & Luh, 1992) attributes concreteness effects to the stronger and richer associations of contextual knowledge (both in terms of discourse and relations to other language items).

The ideas originally proposed by Paivio (1971; 1991; 2013) were revived within the embodied cognition accounts that have gained popularity during the last decades, especially within the perceptual symbol theory (Barsalou, 1999). According to this theory, mental representations are traces of perceptual experiences and reside within the same system with the perception states that produced them. The activation of the mental representation is based on the re-activation of the same neural pathways that were involved in the perception of the given entity. Therefore, visual aspects of the mental representation of an object should be located in brain areas involved in visual perception, auditory aspect in brain areas involved in auditory perception, and so on.

2. The embodied approach to semantic knowledge

2.1. The importance of perceptual information

In the past decades, numerous studies were dedicated to testing for the relevance of the perceptual information in the concept representation (Barsalou, 1999; Barrós-Loscertales et al., 2012; Goldberg, Peretti & Schneider, 2006a; 2006b; González, et al., 2006; Kiefer, Sim, Herrnberger, Grothe & Hoenig, 2008; Pecher, Zeelenberg & Barsalou, 2003; Pulvermüller, 2005; Simons, et al., 2007). Goldberg and colleagues (Goldberg et al., 2006b) conducted an fMRI study in which participants were scanned during a property verification task. The participants had to respond whether a concrete word (i.e. an object denoted by that word) possessed one of the four modality-specific perceptual properties: colour, sound, touch, or taste (for example, *Is an apple green?*). They aimed to find which brain regions were engaged in the encoding of modality-specific perceptual information. The results supported a multi-modal view: the sensory experiences of an object and the decision about its perceptual property seem to share common neural activations. For instance, retrieval of the tactile knowledge of an object was related to increased activation in the somatosensory cortex, motor and premotor brain regions. Furthermore, taste knowledge provoked increased activity in the orbitofrontal cortex, the region that had been previously found to be associated with the semantic categories, such as the category of food, for which the taste information is essential (Goldberg et al., 2006a). In a similar manner, auditory knowledge was linked with increased activity located in the left superior temporal sulcus, inferior and posterior to the primary auditory cortex, whereas visual knowledge evoked ventral parts of the left temporal cortex, an area involved in the generation of color information of objects. The relevance of the color and motor properties of objects and their modality-specific brain representations was demonstrated by Simmons and his colleagues (Simmons et al., 2007). They applied two different tasks during the fMRI scanning: a property verification task and a color perception functional localizer task. In the property verification task, the concept followed by the property (*banana* followed by *yellow*) were presented and the participants had to decide whether the property is true for the concept or not. In the later phase, only the concept was presented, without the property, in order to apply subtraction and to see which neural parts are active during the processing of conceptual properties. With this task, researchers wanted to explore the conceptual representations of color and motion, whereas the color perception functional localizer task was applied to provide insight into the brain region activations during color perception. In the color functional localizer task, participants were instructed to judge whether the five color or grayscale widgets are ordered by hue – from lightest to darkest. This study design provided a simultaneous comparison of brain area activations during conceptual processing and during perceptual processing within the same participant. Results showed that both conceptual and perceptual processing provoked stronger activity in the left fusiform gyrus. Contrary to this, verification of the motor properties of an object resulted in increased activity in the left middle temporal gyrus, the area for which previous studies showed to be evoked during observation of motions (for example, Beauchamp, Lee, Haxby, & Martin, 2002). Associations of auditory object features with brain regions that are active during auditory perception are also well documented in the literature. In one such study, the authors, who were motivated to unambiguously determine that concepts are grounded in perception, combined conceptual and perceptual tasks with both fMRI and ERP imaging techniques (Kiefer et al., 2008). They advocated that conceptual grounding could be demonstrated only if conceptual processing during the implicit task could activate rapidly a complementary perceptual brain region. In other words, in order to make such claim, the activation of brain areas which does not occur as a consequence of mental imagery should be demonstrated. The inclusion of ERP enabled researchers to determine the timeline of brain region activations during the course of conceptual processing. They found that, during the lexical decision task, the words with acoustic conceptual features (e.g., *telephone*) provoked stronger activity in left posterior superior and middle temporal gyrus compared to words without acoustic conceptual features (e.g., *flower*). The processing of sounds elicited activation in the same posterior temporal area. Moreover, ERP recordings showed that these activations occurred early in the conceptual processing (at 150ms after a word's onset), thus without the engagement of auditory imagery (Kiefer et al., 2008). Activations of olfactory brain regions during the reading of words with strong olfactory associations were demonstrated as well (Gonzales et al., 2006). In that study, reading words such as *garlic* or *cinnamon*, compared to olfactory neutral words, elicited bilateral activations in primary olfactory areas and the right amygdala, the brain regions that are active during the processing of real smells. The grounding of gustatory conceptual associations was revealed in one recent study (Barrós-Loscertales et al., 2012). The authors found increased activation of the primary and secondary gustatory brain regions, responsible for gustatory perception, during the reading of words strongly associated with the gustatory modality (for instance, *salt*). Those words were matched for a large number of lexical attributes, namely, arousal, emotional valence, imageability, frequency of use, and number of letters and syllables, in order to exclude possible lexical explanations.

2.2. Modality-specific sensory norms

The first variable that was linked to the relevance of perceptual information was word concreteness, as popularized by Paivio (1971; 1991; 2013; but also mentioned in Woodworth & Schlosberg, 1954). It was operationalized as the extent of sensory experience with an object (phenomenon, feature, and action) denoted by a given word (Brysbaert, Warriner, & Kuperman, 2014; Brysbaert, Stevens, De Deyne, Voorspoels, & Storms, 2014; Ćirić & Filipović Đurđević, 2017; Paivio, Yuille, & Madigan, 1968). It was typically measured on a bipolar scale with one end denoting abstract words (i.e. words that denote objects that cannot be experienced perceptually, e.g. *truth*, *justice*), and the other end denoting concrete words (i.e. words that denote objects that can be perceptually experienced, e.g. *apple*, *chair*).

Lately, word concreteness has been elaborated further and a novel operationalization has been proposed (Connell & Lynott, 2012; Filipović Đurđević, Popović Stijačić, & Karapandžić, 2016; Popović Stijačić & Filipović Đurđević, in preparation; Lynott & Connell, 2009; 2013; Miklashevsky, 2018; Speed & Majid, 2017). Instead of collecting one rating of general perceptual experience with an object, the separate ratings are collected for each sensory modality. Participants are presented with a task to rate the extent to which they were able to experience the object denoted by a given word in visual, auditory, tactile, olfactory, and gustatory modality, i.e. to rate (on separate scales) the extent to which they were able to see, hear, touch, taste, and smell an object denoted by a given word. Additionally, in order to test for the relevance of the real experience with an object, as opposed to the rated possibility of experiencing it (for example, we could touch the moon, but only a few people have actually done so), authors of the Serbian norms proposed two rating instructions: one that was related to possible experience (to what extent is it possible to experience the concept through the particular perceptual modality) and the other that was related to real experience (to what extent the concept was actually experienced with the specific sense). This distinction between rating instructions should contribute to the theoretical distinction between "weak" and "strong" embodiment theories (Meteyard, Cuadrado, Bahrimi & Vigliocco, 2012). For example, strong embodiment theories emphasize the relevance of perceptual experience with an object and the activation of primary cortical areas in semantic processing. Therefore, the predictive advantage of the sensory ratings based on the real experience with an object over the sensory ratings based on the possible experience with the same object would advance this point of view.

The data on modality-specific sensory experience which have been collected in several languages seem to converge in multiple ways. For example, within the space of perceptual variables, the strongest associations were recorded for gustatory-olfactory and visual-haptic modalities, whereas auditory modality showed a distinct relational pattern. In other words, auditory perceptual modality had either negative or zero correlations with other perceptual modalities (Lynott & Connell, 2013; Filipović Đurđević et al., 2016; Popović Stijačić & Filipović Đurđević, in preparation; Miklashevsky, 2018; Speed & Majid, 2017). Furthermore, the principal component analysis in most cases converged into two components, one which was saturated with visual and haptic modality ratings, and another that was loaded with olfactory and gustatory ratings (Speed & Majid, 2017; Miklashevsky, 2018; Popović Stijačić & Filipović Đurđević, in preparation). The analysis of correlations with word concreteness revealed that majority of modality specific ratings had positive correlations with this variable. Positive associations with concreteness were registered for visual, gustatory, olfactory, and tactile modality, whereas auditory modality and concreteness had negative and/or zero correlations.

The contribution of normative studies is reflected in one additional aspect. Connell and Lynott (2012) and Filipović Đurđević et al. (2016) advanced several integrative measures of perceptual richness as a more suitable measure of perceptual experience compared to concreteness. Some of these measures are suggested as ones expressing the intensity of perceptual experience (maximal perceptual strength & modality exclusivity; Connell & Lynott, 2012); others, as a way of capturing variability and multimodality (entropy, number of modalities; Popović Stijačić & Filipović Đurđević, 2015; Filipović Đurđević et al., 2016), and there are measures which are constructed to quantify both the intensity and multimodality of the perceptual experience (summed perceptual strength and vector length; Filipović Đurđević et al., 2016). Maximum perceptual strength represents the maximal mean value recorded on one of the five modality-specific perceptual strength scales (Lynott & Connell, 2012), thus it is the most comparable to traditional concreteness among other perceptual richness measures. Modality exclusivity is computed as the ratio of the range of five modality-specific perceptual strength ratings and their sum; accordingly, the largest value is assigned to a word that has high values on one modality rating and low values on the others, whereas lower values are specified for those words that have high saturation on each of the five perceptual strength scales (Connell & Lynott, 2009). The lowest possible value (0) is assigned to words with no variability in ratings. However, in this case (if the ratings are equal across modalities), this measure does not differentiate between words that can be fully experienced in all modalities (all mean ratings have maximum value) and words that cannot be experienced in any modality (all mean ratings have the minimum value). In order to remedy this situation, Filipović Đurđević et al. (2016) proposed entropy as the measure of variability across modalities. The number of modalities is defined as the number of perceptual modalities through which a concept could be experienced (Popović Stijačić & Filipović Đurđević, 2015; Filipović Đurđević et al., 2016), while the summed perceptual strength is calculated as the sum of the averaged scores on each modality-specific perceptual strength scale. Finally, the vector length is operationalized as the Euclidean distance of the vector from the zero point (Connell & Lynott, 2012). In other words, it represents a five-element vector, and it is more informative than summed perceptual strength, although essentially it captures highly similar information.

The relevance of these measures for language processing was validated in language processing tasks. For example, in a Serbian norming study (Filipović Đurđević et al., 2016), all perceptual modalities significantly predicted response latencies in a lexical decision task, after controlling for concreteness, word length and lemma frequencies. In other words, an increase in modality-specific perceptual strength was accompanied by a decrease in reaction times, with the exception of auditory modality, which was not predictive of the processing latencies. When it comes to integrative measures of perceptual diversity, the results have not yet fully converged. In a British study (Connell & Lynott, 2012), the maximum perceptual strength outperformed word concreteness and imageability in lexical decision tasks. However, in a Serbian study (Filipović Đurđević, et al., 2016), the predictive power of concreteness was outperformed by summed perceptual strength, vector length, and entropy. In other words, these results suggested that both the strength and the variability of the perceptual experience facilitate word recognition. Finally, results have revealed that in predicting processing latencies, integrative measures based on the ratings of real experience outperform the measures based on the ratings of possibility to experience.

3. The application of modality-specific sensory norms to the language of special populations

We have focused on the relevance of perceptual experience to illustrate the embodied approach to cognition (although it includes other bodily experiences as well, such as motor and emotional experience). We would like to argue that the embodied cognition approach which has dominantly been applied to investigating the language of healthy speakers can also be a useful tool for understanding impaired language. We believe that this approach has the potential to be applied to a wide spectrum of disorders. However, given that the topic of the meeting which inspired the current volume was the language of the individuals with schizophrenia, we will focus here on this specific population. We will start by briefly introducing the peculiarities of language in schizophrenia and continue by illustrating the application of the approach in question to this particular population.

3.1 Relevant topics on language and schizophrenia

Schizophrenia is a mental disorder that usually becomes apparent in young adulthood and is clinically described via a set of heterogeneous symptoms (American Psychiatric Association, 2000). It affects states and functionality in the cognitive, affective, and motivational domains and is typically described in terms of positive and negative symptoms. Positive symptoms refer to the presence of states and behaviors that are not present in the typical population, such as hallucinations, delusions, or disorganized language output. Negative symptoms refer to the absence of states and behaviors that are present in typical population, such as lack of motivation, flat emotions, or poverty of speech.

When it comes to language, individuals with schizophrenia manifest both negative and positive symptoms. Negative symptoms are usually characterized by the poor language output, whereas positive symptoms come in several different forms. As Kuperberg (2010a) summarized, positive thought disorder, which is closely linked to positive language symptoms can include "derailment" (spontaneous speech that starts as related to the topic but slips into speech that is partly or completely unrelated to it), or "tangentiality" (responsive speech that is irrelevant to the question which initiated it), whereas both of them could be described as "loosening of associations" (Kuperberg, 2010a, p3). These disorders are related to the level of the sentence and discourse, and in fact, they represent the most common language disorders in patients with schizophrenia. However, there are also symptoms related to the level of the single word (e.g. neologisms, idiosyncrasies in word meanings etc.). According to Kuperberg (2010a), statistical analyses of the speech output of individuals with schizophrenia showed that their words were less predictable as compared to the speech of control participants, characterized by weaker and less restricted lexical associations, and that they produced fewer different words relative to the total number of words produced (as expressed by the Type:Token ratio). Additionally, at the level of lexical and syntactic structure, their words were more related to the previous word than to the topic, and their sentences were less complex and more grammatically deviant. Finally, at the level of the discourse, their cohesion devices were linking the speech with real-word referents and previous referents in a manner that was less specific, less informative, and less relevant.

When it comes to theoretical attempts at understanding language disorders in schizophrenia, two main streams have been identified. According to Kuperberg (2010a), one theoretical stream attributes language disorders in schizophrenia to abnormalities in the structure and function of semantic memory. The other stream focuses on working memory, especially executive function deficits which, according to this view, lead to problems in adequate use of context and consequently bring about language dysfunction. On the one hand, semantic/associative priming in schizophrenia seems to be augmented in tasks that favor automatic processes, whereas it seems to be attenuated in tasks that favor strategic processing (Pomarol-Clotet, Oh, Laws, & McKenna, 2008). Kuperberg, Deckersbach, Holt, Goff, and West (2007) linked this asymmetry to the asymmetry of activation in the fronto-temporal network. They observed reversed neural priming (increased activation to associated targets) in the fronto-temporal cortices of individuals with schizophrenia, with particularly increased activation in the temporal cortex of individuals with positive thought disorder. They interpreted this as a sign of reduced efficiency of the inferior prefrontal cortex in controlling strategic lexico-semantic retrieval (selection of semantic representations stored in the temporal cortex), and increased residual activation in the temporal cortex which occurred consequently (this activation occurs automatically but is typically controlled by a functional prefrontal cortex; see also Kuperberg, Delaney-Busch, Fanucci, & Blackford, 2018). On the other hand, the performance of individuals with schizophrenia on working memory and executive function tasks is severely degraded. Multiple research has established an association between the level of decline in executive functioning, on the one hand (as tested by the Stroop task, tasks of sustained attention, sequencing, distractibility, etc.), and thought disorders, on the other hand (Kerns, 2007). Some studies even determined a link between executive functioning and errors in referential communication (Docherty, 2005). However, although the link between schizophrenia and executive function deficits has clearly been established, not many studies have been aimed at determining a link between executive function deficits in schizophrenia and language disorders in schizophrenia. The results of studies that investigated sentence processing in individuals with schizophrenia suggested that it was more driven by lexical-semantic relations, and that these individuals were less likely than controls to use the context in constructing interpretation (as reviewed by Kuperberg, 2010b).

3.2. A proposal of a novel approach to language in schizophrenia

Numerous studies have unequivocally established that multiple cognitive functions are deficient in schizophrenia (Kuperberg, 2010a). Few would object that individuals with schizophrenia suffer from some kind of disturbances which arise at the interplay of the changed semantic associations and compromised working memory functions. At the same time, not everybody agrees as to what represents the core deficit, and what appears only as its consequence (Zaytseva et al, 2018). However, in this chapter, we want to draw attention to the possibility of taking a completely different point of view, and doing so with completely different tools.

3.2.1. The rationale

We would like to focus on the preserved aspects of cognitive functioning, namely the preserved structure of the semantic system. We believe that, in order to be able to fully understand a deficit, one must clearly establish not only what is damaged, but also what is preserved. In terms of semantics, it has been widely investigated and determined that language in schizophrenia is characterized by loosened associations among concepts (Kuperberg, 2010a). However, to the best of our knowledge, there have been no inquiries into the nature of representations beyond their position in relation to other concepts. Here, we propose to focus on perceptually relevant conceptual representation in individuals with schizophrenia in order to determine whether it is comparable to that of a control population. If it were comparable, the finding would serve as the starting point of knowing what is preserved in the semantic system, and further investigation should be directed towards higher levels in the language hierarchy (phrases, sentences, discourse, etc). If it were altered, the findings would bring novel insights into the language of this specific population. Once the link has been established between the structure of the perceptual-semantic system and schizophrenia, this finding could help differentiate the diagnosis during the first psychotic episodes, or even prior to the onset of symptoms in populations under risk. Some research has already suggested the existence of specific characteristics in the language system of individuals who belong to families with an identified risk of schizophrenia (Thermenos, et al., 2013). Similarly, it has been shown that the structure of the semantic system can be informative of the risk of developing schizophrenia (Tonelli, 2014).

At the same time, we would argue that insights into the level of preservation of the semantic system in schizophrenia would also be informative for theories of the semantic system in the general population. For example, there is an ongoing debate on whether semantic representations are stored in the temporal cortex. On the one hand, there is a view that the left temporal cortex (along with the left inferior parietal cortex) stores not only phonological and syntactic knowledge, but also semantic word knowledge (Hagoort, 2005, 2014). Similarly, there are claims that posterior temporal regions serve to control semantic representations that are stored in the anterior temporal lobe (Jefferies, 2013; Noonan, Jefferies, Visser, & Lambon Ralph, 2013; Ralph, Jefferies, Patterson, & Rogers, 2016). On the other hand, there are views that the temporal cortex does not serve as the store of the semantic word knowledge (Hickok & Poeppel, 2004, 2007, 2015). According to this view, the temporal cortex provides the mappings of sound to meaning, whereas meaning is distributed widely across different cortical areas. We believe that insight from research on the semantic system in schizophrenia could inform this important debate. On the one hand, we advocate for the exploration of the structure of perceptual space of individuals with schizophrenia. According to embodied cognition views (Barsalou, 1999), perceptual space (which is neurally based in cortical sensory areas) homes the knowledge of word meanings. On the other hand, it has been known that the functioning of the temporal lobes is changed in schizophrenia (Lawrie et al., 2002; Turetsky et al., 1995). Therefore, a finding that the structure of perceptual space is intact in schizophrenia would strengthen the views that semantic knowledge is distributed.

Additionally, the approach that we are advocating would contribute to the efforts of disentangling language-specific processes from those related to executive functions. For example, one of the most frequently administered tests to assess cognitive functioning in individuals with schizophrenia is the verbal fluency task. As this task taps both into language and the executive functioning (Aita, et al., 2018; Whiteside, et al., 2015), the researchers typically applied two versions of this task – phonemic fluency and semantic fluency to try to disentangle the impairment that could be attributed purely to the challenged executive functioning from that of the challenged semantic system. As reviewed by Henry and Crawford (2005), the level of impairment seems to be larger for the semantic fluency task, thus suggesting impairment to the semantic system, and not only to the executive functions. We suggest that this issue be approached by taking advantage of the attested empirical effects that have been previously observed in the healthy population and interpreted in light of the embodied cognition approach. Such effects are believed to arise as a consequence of the structure of the semantic system and have not been shown to be influenced by executive functions.

3.2.2. The proposed strategy

We therefore propose to start with two lines of research. The first line of research would address the structure of the semantic system as rooted in the modality specific perceptual information. The first step would be to collect modality specific sensory norms from individuals with schizophrenia, following the methodology that has already been applied in control populations (Connell & Lynott, 2012; Filipović Đurđević, Popović Stijačić, & Karapandžić, 2016; Popović Stijačić & Filipović Đurđević, in preparation; Lynott & Connell, 2009; 2013; Miklashevsky, 2018; Speed & Majid, 2017), while adapting it to the cognitive functioning of the participants from the special population. For example, instead of administering bipolar Likert scales to collect ratings, we suggest using simple yes–no questions (e.g. *Can a strawberry be tasted? Have you ever tasted a strawberry?*). This change in the procedure would make the task easier to administer and less demanding for the participants, who are often under medication or face hardship in complying to the complicated task requests. At the same time, it would not jeopardize the reliability of the collected data, given that there is a body of research in linguistics showing that yes–no questions and Likert scales provide converging data (Bader & Häussler 2010; Fukuda, Goodall, Michel, & Beecher 2012; Weskott & Fanselow 2011). Statistical analyses performed on these ratings would enable insight into the structure of semantics, namely the structure of the perceptual space in schizophrenia, and the comparison of this structure to the structure observed in the control population. The preserved structure of the modality specific perceptual information, i.e. the one that is comparable to that of healthy speakers, would inform us of what is preserved in the semantic system and direct the research towards other aspects of language in schizophrenia, while also strengthening the view that semantic word knowledge is distributed across sensory cortical areas, as discussed earlier (in 3.2.1.). The altered structure of the modality specific perceptual information (i.e. the one that is different from that of healthy speakers) would be particularly informative, as it would show, for the first time, that sensory specific perceptual space is different in schizophrenia. This novel finding would indicate that individuals with schizophrenia code their world knowledge differently, hence further research would be necessary to understand the dimensions of the newly discovered semantic space. Such understanding would enable both more efficient diagnostics and therapy. Although novel, such a discovery would not be overly surprising given the findings that show deficiencies in sensory processing in schizophrenia (e.g. as described in Tschacher, Giersch, & Friston, 2017).

The second line of research would further focus on the disentangling of language-specific (and also semantics-specific) processes from processes that are related to executive functioning. It would build upon the collected normative data to compare the healthy population and the population with schizophrenia, with respect to attested empirical effects that rely on the usage of interconnected perceptual information and demonstrate the relevance of perceptual information for language processing (Filipović Đurđević et al., 2016; Goldberg et al, 2006a; 2006b; Simons et al, 2007; Lynott & Connell, 2013; Živanović & Filipović Đurđević, 2011). For example, the integrative measures of perceptual richness (as discussed in 2.2.) could be introduced as predictors of processing latencies of individuals with schizophrenia (i.e. in the lexical decision task). This would allow for the investigation of efficacy in the use of perceptual information. Research with healthy participants showed that speakers make use of the rich perceptual traces of previous experiences with an object denoted by the word while performing word recognition (Lynott & Connell, 2013; Filipović Đurđević et al., 2016). Similarly, healthy speakers take advantage of the matching (congruence) of the modalities of the channels through which they obtain information (e.g. incoming information and stored knowledge). For example, they are faster at recognizing spoken words which denote an object that can be experienced by hearing (e.g. *chirp*) and printed words which denote object that can be experienced by vision (e.g. *sky*; Živanović & Filipović Đurđević, 2011). Similarly, they are faster if consecutive information arrives within the same channel than when the channel switches modality (Pecher, Zeelenberg, & Barsalou, 2003). Based on some previous insight, there is reason to expect that individuals with schizophrenia would fail to take advantage of perceptual richness during word recognition, as well as of the overlap between the channels of available information. For example, there are findings that schizophrenia is characterized by a lack of connectivity among sensory experiences and even elaborations on how this could lead to other symptoms: "Sensory processing would be fragmented, which might affect the patient's ability to feel as being immersed in the world, and to experience themselves as one single and continuing entity." (Tschacher, Giersch, & Friston, 2017, p. 749). Within such an approach, schizophrenia is seen as the case of disembodiment: "The resulting lack of intermodal integration could result in an impaired development of the embodied or 'ecological self' and its perceptual, cognitive and emotional ties with the environment." (Fuchs & Schlimme, 2009, p. 573). Such disembodied cognition would be manifested in a state of being overwhelmed by details without being able to grasp their meaningfulness or their relation to the context and consequently lead to detachment from the continuity of self and the environment.

4. Conclusion

We have briefly reviewed the main approaches to the understanding of semantic knowledge and particularly focused on the approach that views mental representations as enactments of the processes that were involved during perception. We have summarized the group of empirical findings that demonstrate the importance of perceptual information in language processing and in memory, suggesting that an important part of semantic knowledge is widely distributed in different cortical areas, namely in the areas that are involved in the processing of the relevant sensory information. We have also described a novel approach to describing word meaning in the form of profiles of sensory experience across different sensory modalities. Finally, we have suggested that this approach be used as a tool to investigate the language of impaired populations and illustrated our proposal by focusing on the case of schizophrenia. We looked into the typical issues in language processing in schizophrenia and proposed to apply both modality specific sensory ratings and various phenomena related to the importance of perceptual information in order to gain a better understanding not only of the language of individuals with schizophrenia, but also of the language of other special populations.

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Glossary

https://doi.org/10.17234/9789531758314.10

Alogia – poverty of speech, short and concise answers, with no additional information, usually monosyllabic.

Alzheimer's dementia – dementia occurring as part of Alzheimer's disease, a progressive irreversible, neurodegenerative brain disorder. Alzheimer's dementia is a mental disorder, with onset usually in old age, characterized by generalized cognitive impairment including memory, attention, and orientation disturbances, changes in judgment, mood alterations, and language impairments.

Animacy – feature of words representing animate (living) concepts, as opposed to inanimate (non-living) concepts.

Association – the relationship between two contents of a concept based on experience or on the quality and quantity of relations connecting two concepts.

Associations production test – a task in which subjects are asked to name either as many words that come to mind (free association test) or a predetermined number of them (discrete association test).

Attention – the cognitive ability to focus on one set or aspect of information.

Category relations – relations of concepts which share conceptual features of the same category.

Derailment – lack of cohesion in language production of which the subject is not aware, jumping from theme to theme, a characteristic of which is the use of unclear pronouns.

Down syndrome – a chromosomal disorder caused by the trisomy of chromosome 21. It is one of the most common causes of intellectual disability. It is accompanied by both cognitive and language deficits, a range of medical issues, and specific facial characteristics.

Early-course psychosis – a psychotic disorder in its early stages characterized by less significant social and work impairment, with relatively preserved cognitive functions. Although there is no clear consensus, a tentative cut-off of five years after illness onset has been suggested.

Embodied cognition – the set of theoretical approaches according to which cognition is shaped by (or based on) not just the brain, but also various elements of the entire body, such as the motor system, perceptual system, interactions of the body and the environment, etc.

Executive function – the set of cognitive abilities which enable cognitive control and purposeful behaviour.

First cluster – the first, and the least effortful, bout of production in verbal fluency tasks.

Forced choice comprehension test – a test which offers more than one answer, in which the subject compares the offered answers and chooses the most preferred one.

Formal thought disorder – a thought disturbance, usually associated with schizophrenia-spectrum disorders, affecting the form but not the content of thoughts. Formal thought disorder is characterized by the loosening of associations, incoherence and derailment, illogicality, tangentiality, perseveration, and neologisms.

Frequency – a lexical-semantic feature which denotes the frequency of occurrence, or use, of words. Highly frequent words are thought to have stronger and more easily activated connections in the semantic memory.

Hyperpriming – enhanced indirect semantic priming as a result of increased spreading of activation.

Hypopriming – diminished indirect semantic priming.

Imageability – a lexical-semantic feature which depends on the ease with which subjects create a visual or auditory reference to the concept.

Lexical semantic features – the basic conceptual components in the semantic memory with which a concept is constructed.

Neuropsychology – the discipline that investigates the relation between brain and behaviour by focusing on the behavioural consequences of neurological traumas or conditions.

Overinclusion – the inclusion of non-members of a category in the category; the inability to maintain the borders of a category.

Perceptual experience – experience based on perceiving; experiencing something based on data acquired through the senses, i.e. by seeing, hearing, touching, smelling, tasting, etc.

Psychosis – a mental condition characterized primarily by impairments in reality testing, delusions, and hallucinations. Psychosis is a leading feature of psychotic disorders, such as schizophrenia, but it can also occur in other mental disorders.

Schizophrenia – a severe mental disorder from the spectrum of psychotic disorders, characterized by changes in thoughts, feelings, and behavior that lead to progressive impairment on multiple levels. Symptoms seen in schizophrenia can be divided into positive (e.g. delusions, hallucinations), negative (e.g. flat affect), and cognitive symptoms (e.g. impaired executive functions).

Semantic fluency – verbal fluency with semantic conditions. Subjects with semantic fluency are able to list examples of a specific semantic category.

Semantic memory – The semantic memory is a long-term memory system containing organized knowledge about words and their meanings, referents, and relations.

Semantic representations – mental representations stored in the semantic memory containing all information about the words they are encoding.

Spreading of activation – activation of concepts and their relations in the semantic memory in the process of the search and retrieval of concepts.

Tangentiality – the quality of answers that are only indirectly connected, or not connected at all, with the questions they purportedly answer.

Taxonomic relations – relations in taxonomic categories which are similarity-based. Concepts in taxonomic relation fall under the same superordinate categories, and their features are largely shared. Their shared properties are a consequence of their intrinsic similarities.

Typicality feature – the degree to which a concept represents a certain semantic category.

Verbal fluency – language production ability under assigned conditions and time restrictions. Verbal fluency can be tested by means of semantic fluency tasks (e.g. listing examples of a specified semantic category), phonological fluency tasks (e.g. listing examples of words starting with a same phoneme), or syntactic fluency tasks (e.g. listing examples with the same syntactic limitations).

Williams syndrome – a rare genetic disorder caused by the deletion of about 26 genes on the long arm of chromosome 7. It is accompanied by cognitive deficits, primarily in the visuo-spatial domain, and a range of medical issues, in addition to specific facial characteristics. Language is relatively preserved.

Word concreteness – a lexical-semantic feature dependent on the attainability of a concept to sensory experience.

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https://doi.org/10.17234/9789531758314.11

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https://doi.org/10.17234/9789531758314.12

Interdisciplinary Linguistic and Psychiatric Research on Language Disorders is a collection of scientific papers presented at the International Scientific Workshop on Clinical Linguistics, held on 20 November 2018 at the Education Centre of the University Psychiatric Hospital Vrapče.

The Erdeljac & Sekulić Sović research group in clinical linguistics, based at the Department of Linguistics, Faculty of Humanities and Social Sciences, University of Zagreb, in collaboration with psychiatrists from the Department of Biological Psychiatry and Psychogeriatrics and the Department of Diagnostics and Intensive Care, both at the University Psychiatric Hospital Vrapče, present a unique example of an academic publication designed to spotlight ongoing research on semantic processing in individuals diagnosed with psychosis spectrum disorders who are native speakers of Croatian.

A further value of this book lies in the co-authors' contributions, written by specialists in clinical linguistics and psychiatry to expand the focus of research in clinical linguistics to other domains of language disorders while showcasing the research being undertaken at prominent institutions such as University College London, the University of Cologne, Johannes Gutenberg University Mainz, Philipps University Marburg, the University of Belgrade, the University of Novi Sad, and Massachusetts Institute of Technology.

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ISBN 978-953-175-831-4

University Psychiatric Hospital Vrapče

FF press