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LANGUAGE IMPAIRMENTS IN THE DIFFERENT PHASES OF SCHIZOPHRENIA: A SYSTEMATIC REVIEW

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Abstract

Introduction: Language is one of the domains mainly affected in schizophrenia. It is characterised by its heterogeneity and it is linked to thought processing and therefore, thought disorder. Schizophrenia is categorized in different phases that overlap with each other. **Objectives:** The main aim of this systematic review is to assess the different language impairments in each stage of the syndrome. **Methods:** In this work, inclusion and exclusion criteria were applied to select a total number of 36 articles. **Results:** The most affected language domain seems to be pragmatics, which analyses the relationship between language and context and involves parameters like cohesion and coherence. Additionally, figurative language comprehension appears compromised. During the initial phases of schizophrenia, subtle language disorganization is prevalent, while the acute phase following first-episode psychosis is characterized by heightened abnormal language use, often exacerbated by auditory hallucinations. In the chronic phase, despite increased stability, individuals commonly exhibit fragmented speech patterns. **Conclusions:** There is a consistent impoverishment along the language domain in schizophrenia. The sensibilisation of healthcare workers should be further implemented in the clinical practice. Although notable advancements in recent years, further standardized studies would need to be done. Artificial Intelligence techniques already play an important role in diagnosis and intervention of language impairments in schizophrenia.

Key words: schizophrenia, language, thought, healthy control, clinical high-risk psychosis, prodromal, first-episode, acute, chronic.

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1. Introduction:

1.1. Overview of Schizophrenia.

Schizophrenia is a severe mental illness characterised by a combination of symptoms. It is a heterogeneous psychiatric disorder that significantly impacts an individual's biological, psychological and social functioning (1). The prevalence of schizophrenia is around 1% and it is more prevalent in men; to a proportion of 1,4/1. An excess of complications in fetal life, a higher paternal age during the growing up of children, a lower social and economic background, migration, drug abuse of e.g. amphetamine and cannabis, such as childhood adversities like abuse, seem to increase the probability to develop schizophrenia (2). The typical age of onset for men is in the late adolescence or early 20s, while for women it is typically in the latter half of the 20s or early 30s. However, schizophrenia can also appear in childhood or later in life, although it is less common. Schizophrenia is associated with many other comorbidities such as cardiometabolic disease, osteoporosis and fractures, poor oral and dental health, respiratory conditions, sleep disorders, anxiety and addiction to e.g. alcohol, cannabis or other substances (1).

Among its symptoms they can be divided into positive, negative and cognitive symptoms. Positive symptoms encompass hallucinations, delusions and disorganized thinking; negative symptoms include deficits or reductions in normal functioning, lack of motivation, reduced emotional expression, social withdrawal and anhedonia; and cognitive symptoms refer to difficulties related to thinking processes and mental abilities. Focused on the symptomatology, the *Positive and Negative Syndrome Scale* (PANNS), published in 1987, is one of the most used instruments in schizophrenia research (3). It consists of 30 items divided into three scales: scale of positive symptoms (7 items), scale of negative symptoms (7 items) and general psychopathology (16 items). Each item is evaluated on a seven-point scale ranging from *absent* to *extremely severe* (4). The Fifth Edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) was published in June 2013. In order to diagnose schizophrenia according to DSM-5, it is necessary for individuals to exhibit at least two out of the five distinctive symptoms for a period of at least 1 month, which include delusions, hallucinations, disorganized speech, grossly disorganized/catatonic behaviour, or negative symptoms (2).

Schizophrenia needs to be understood as a variable and heterogeneous process containing overlapping phases: clinical-high risk psychosis, prodromal phase, acute phase, chronic

phase, residual or remission phase and relapse phase. The first phases of schizophrenia are mainly characterised as a functional decline marked by reduced motivation and non-specific symptoms such as anxiety, dysthymia, or poor concentration (5). These vague symptoms can be manifested as mood changes and academic difficulties, characterizing these phases as asymptomatic. During this period, individuals often become introverted and avoid sharing their inner world with others (3). The prodromal phase of schizophrenia has been subject to conflicting studies regarding its onset and duration. Most of the articles found report that 80-90% of patients undergo a prodromal phase lasting for approximately 1 year (3, 6). In the remaining 10%, the onset is marked by a first episode without a recorded prodromal phase. Alternatively, some perspectives define the beginning of this phase as the first day of admission to the hospital (3, 6). In any case, determining the transition from a first-episode psychosis to frank schizophrenia is better evaluated with the combination of *PANNS Scale,* language analysis and demographic characteristics (7).

In one study the course of schizophrenia is divided into 4 phases (6): 1. *Something is wrong 2. Boiling up 3. Breaking Point 4.Losing Control.* In the first phase, subjects live a first subjective episode where they notice the onset of the illness (weird acts, concentration problems, difficulties in writing, inability to be understood, depressive mood). They progressively have unusual feelings and thoughts, so as to doubts about experiences being real or not. During the *Boling up* phase these episodes increase in severity and frequency: participants show a special concern towards the distorted perception of time and words, which make them question reality. Difficulty in processing stimuli and information make them feel overwhelmed and as if they had a ‘tightness’ in their minds. A clear discordance is found between what participants want to communicate and what the receiver perceives. Also, patients are not able to comprehend information correctly. During the next phase (*Breaking Point*) patients are inmersed in long repetitive activities, feel out of control and have distorted behaviours that they are not aware of. Suicidal thoughts might appear during this phase. They start experiencing strong imagination that is related to past experiences. The last phase (*Losing Control)* is characterised by the indivual experiencing a feeling of being possessed, a loss of control over their actions and a deep fear, and would coincide with the acute phase of schizophrenia.

1.2. Assessment of Basic Symptoms in schizophrenia.

Both the *Bonn Scale for the Assessment of Basic Symptoms (1987- Huber)* and the *Ultra-High Risk Scale* (UHR) are used to evaluate the transition into psychosis. The *Bonn Scale for the Assessment of Basic Symptoms* has been a well-known instrument assessing basic symptoms in schizophrenia. Basic Symptoms constitute the earliest experiences subjectively reported by the patient. However, they can occur in every stage of the illness, whether as pre- psychotic syndromes in the prodromal phase of the first psychotic episode, in the prodromal stages of relapses, in residual states, or even during the psychotic episode itself. Assessing and self-evaluating these symptoms in the latter scenario are hindered by the prominence of psychotic symptoms. Although potentially reversible, basic symptoms are an essential component of the prodromal and residual stages and can be considered the most immediate symptomatic expression of the neurobiological substrate of the disease. These are sort out in three different levels that form a continuity. According to its original concept, early symptoms of psychosis would evolve into three forms (8). Level 1 or "non-specific: Discomfort in will, affect, concentration, and memory; Level 2 or "specific." Discomfort, particularly related to thinking, language, body perception, and motor action; Level 3. Frank psychotic symptoms, such as delusions and hallucinations.

These symptoms might be manageable as long as they stay within the individual's personal capabilities and strategies, being unnoticed by others. They remain in the subjective subconsciousness of the patient. However, if they go beyond the individual's resources, the person may begin to display avoidance behaviours, engage in isolation, or experience other functional impairments (9). The *Cognitive- Perceptual Basic Symptoms* and *Cognitive Disturbances Basic Symptom (COPER/COGDIS)* represent two subsets that assess basic symptoms in clinically high-risk (CHR) patients. When combined with *Schizophrenia Prediction Instrument Adult Version (*SPI-A) (8) and symptom duration, these scales can contribute to determining the onset of schizophrenia.

1.3. Language disturbances in Schizophrenia.

Patients with schizophrenia tend to have persistent abnormalities in thought, language and communication. Disturbances in thought processing are associated with deficiencies at the linguistic level. There are different levels of linguistic impairments: lexical, morphologic, semantic, pragmatic impairments. The latter seems to be most impaired in schizophrenia. (10). Language in schizophrenia has gained increased importance in the last years. It is an

important tool for diagnosis, especially in the first stages of the illness. In normal conditions, the left hemisphere is mainly responsible for the production of language, motor actions and arithmetic, while the right hemisphere is mainly responsible for visuospatial ability, geometry and figurative language such as metaphors and irony (11). In comparison to controls, patients affected by schizophrenia, even in the early phases, are thought to have a „reversed hemispheric activation" focused on the right hemisphere which is also called "reduced lateralisation" (12, 13). Magnetic Resonance Imaging (MRI) studies have proven a correlation between changes in neurological pathways and speech alterations in schizophrenia. The grade of neurological impairment varies according to each phase and goes along with different alterations related to the processing of language, such as perception, declarative memory and working memory, mainly controlled through the dorsolateral prefrontal cortex. Working memory plays a role in language comprehension. Both hypoactivity and hyperactivity in this area have been discovered in chronic schizophrenia (CSZ) patients (14). The dorsolateral prefrontal cortex is closely related to *Broca Area,* an important brain area in charge of language production. *Ramyead et al.* (2016)*,* showed prefrontal cortical abnormalities and disrupted cortico-cortical communications in first-episode psychosis (FEP) patients (15). Grey matter volume in some language processing areas (LPAs) is related to verbal ability and positive symptoms in FEP patients. Many of these LPAs belong to the left superior temporal gyrus, one of the most known altered structures in schizophrenia, whose volume tends to decrease over the course of the illness (16, 17). Patients with a reduced volume in this structure display more severe positive symptoms and diminished verbal intelligence. Left grey matter structures also seem to be smaller in FEP patients than in Healthy Controls (HCs), while right parts show no great group difference. Alterations in the left insula are found to be associated with bizarre and unusual thoughts. (18). White matter abnormalities in the fornix and disruptions in myelin are also identified in both early and chronic stages of schizophrenia (19). More specifically, the *Brain-Derived Neurotrophic Factor* serves as a marker in memory neuroplasticity processes. Individuals experiencing FEP, when compared to HC, are expected to exhibit a reduced quantity of this protein, also observed in other phases of the illness. (20).

From a psychopathological approach, *Andreasen* defined language impairments in her *Scale for the assessment of Thought, Language and Communication (TLC) (21, 22).* After the vague concept of *associative loosening* (derailment or disconnection of associative elements) described by *Bleuler* in 1950, the creation of this scale aimed to establish a uniform set of

definitions for language impairments in schizophrenia for clinical use, ensuring high reliability in its application. The TLC's set of definitions place a strong emphasis on objectively assessing thought disorder through the observation of language behaviour. It contains definitions for 20 item subtypes of 'thought disorder.' It includes both the definitions and guidelines for assessing severity on a scale of 0-3 or 0-4, depending on the specific item. Formal thought disorder is even though not pathognomonic for schizophrenia present in most psychiatric disorders and some healthy individuals. It can be clinically divided in positive and negative, and objective and subjective according to the most recent *Thought and Language Disorder Scale (TALD),* composed of 30 items (17). Positive symptoms include among others derailment, loosening of associations, increased amount of speech, pressure of speech, logorrhoea, neologisms or newly words often with idiosyncratic meanings, manneristic speech; negative symptoms represent a quantitative deficit in speech and thought production; poverty of speech and content, slowed thinking (10).

Differences in culture may also have an influence on the expression of language among patients with schizophrenia. In the case of *Mete et al*. (1993), the content of language and the most spoken themes by Turkish patients with schizophrenia were quantified through computer content analytic. The patients showed a higher cognitive activity related to *thinking* compared with other psychiatric and non-psychiatric patients. They were making allusions to thought processes using words like *"think, thought, believe and suspect"* and referring more to political or abstract topics, rather than to self-references or their own feelings. Day-to-day topics or banal issues played a secondary role (23). This study was limited by the fact that non-western cultures tend to have more family support and tend to depress negative emotions and manifestations more. This could change the reliability of the results. Constructive communication among family members and the social circle of the patient play a very important role. An indirect correlation between enviromental support and the apparition of episodic positive has been proved (24).

Taking all this into account, quantifying and qualitatively assessing the severity and changes of thought disorder and language in schizophrenia may enhance the effectiveness of its treatment (25). Additionally, language impairments can be used as a predictor for high-risk psychosis patients to predict a later onset of psychosis (26). The *Structured Interview for Prodromal Symptoms* (SIPS) incorporates sub psychotic positive symptoms characterized by lower intensity and shorter duration. These symptoms include unusual thoughts, suspiciousness, grandiosity, perceptual disturbances, and disorganized communication.

Notably, the presence of unusual thought content and suspiciousness has been identified as significant predictive factors for the transition from the prodromal phase to frank psychosis (27, 28). Therefore, there is a need to know language impairments and their potential modifications across the different stages of schizophrenia. Schizophrenia presents challenges beyond the medical needs, that require professionals such as speech therapists, who work on improving communication and cognitive skills. It also goes along with significant healthcare costs, legal issues due to the engagement in actions contrary to society rules, and socio-laboral dysfunction, hindering employment and relationships. Addressing these interconnected aspects is crucial for effective schizophrenia management and support. ***Annex 1.*** *Scales for the Assessment of Language, Thought and Cognitive Impairments in SZ.*

2. Objectives:

The main aim of this work was to perform a systematic review of the language impairments across the different phases of schizophrenia. This contributes to the advancement of knowledge about language in schizophrenia and raises awareness among health care professionals and the general population.

Specific objectives were 1. the recognition of language patterns in the development from the stages of high-risk psychosis to frank psychotic symptoms, 2. the encouragement of early diagnosis and treatment of schizophrenia focusing on language and thought patterns in these patients.

2. Methods

According to the inclusion criteria this systematic review included scientific articles addressing language, speech, or communication across various phases of schizophrenia. These articles were sourced from PubMed and were required to be available in English, German, or Spanish. The only exclusion criterium was the time frame. Only articles published between January 1st 2013 and April 4th 2023 were included. Both qualitative and quantitative studies were accepted. A total number of 202 articles were selected.

The search procedure implied a fixed term search strategy (*Schizophrenia* OR Psychosis) AND (Language OR Speech OR Thought OR Communication OR Lingu*) AND (high-risk OR prodromal OR first-episode OR acute OR chronic OR residual OR relapse) AND (phase OR*

stage), followed by the exclusion of abstracts not pertinent to the study objectives. Studies containing any proband under the age of 12 or clinical trials with less than 50 patients were excluded. Furthermore, abstracts not related to the main objective of the work were excluded. Additionally, supplementary articles meeting the inclusion criteria were manually added to the review. ***Annex 2.*** *Articles included in the systematic review.*

4. Results

Following inclusion and exclusion criteria, a total of 29 papers were selected for the use in this review. A total of 8 articles not found through the standard search but included in the time frame, were added by hand (29+8). ***Annex 3.*** *Language impairments in every language level in SZ.*

4.1 Clinical High-Risk Psychosis

According to *Corcoran et al* (2016) perceptual disturbances and subtle impairments in speech and language, also referred to as subtle thought disorder, may be present in this phase. The key difference between subtle psychotic disorder and psychotic disorder lies in the preservation of reality in the former; individuals experiencing this phase do not perceive themselves as mentally ill *(5).*

The Latent Semantic Analysis (LSA) (19-21) is a frequently employed tool for evaluating language during the early stages of schizophrenia. This technique involves analysing the connections between a set of documents and the terms within them. LSA reveals latent relationships between words and the concepts they convey, relying on the observation that words used in similar contexts tend to have similar meanings. Essentially, it measures coherence at a semantic level. For instance, the words "white," "liquid," and "breakfast" would collectively signify "milk," illustrating a higher level of coherence. Conversely, a lower level of coherence would involve associating a word with a distant meaning, such as "water."*(29-31)*. While *de Boer et al. (2020)* considered it as an useful tool to detect formal thought disorder (29), *Bedi et al. (2015)* also utilized it as an automated speech tool to aid in determining the onset of psychosis in high-risk patients. They assessed specific parameters, including the minimum semantic coherence between consecutive phrases, the frequency of determiners, and the maximum number of words per phrase. Despite only approximately 5% of participants progressing to schizophrenia in the follow-up study, those who did exhibit common characteristics. These included a lower frequency of determiners, such as "which"

or "who" normalized by phrase length, a decrease of the minimum semantic coherence and a shorter maximum phrase length compared to those individuals at clinical high risk (CHR) who did not develop psychosis *(30).*

The probability of converting to schizophrenia and the most alerting signs to determining it were analysed by *Cannon et al. (2016).* Utilizing a Risk Calculator for Psychosis. The key contributing factors to conversion included features like unusual content and suspiciousness, lower verbal learning and memory performance, slower processing speed, and a younger age at baseline. (27) Likewise, *Carrion et al. (2016)* aimed to determine the accurracy of the *North American Prodrome Longitudinal Study* (*NAPLS-2)* estimating the conversion to psychosis. Items included in this scale were: unusual thoughts and suspiciousness (two variables belonging to *Structured Interview for Prodromal Symptoms, SIPS Scale*), symbol coding test performance, verbal learning test performance, decline in social functioning, baseline age and family history. It was demonstrated that all these variables together gave a higher degree of accurracy than the items *P1 - suspiciousness and P2 - unusual* belonging to the *SIPS* alone, to predict conversion to psychosis. The area under the curve had increased by 0.12, from 0.64 to 0.79 stating that a combination of variables discriminated better than individual predictors (32).

Pawelczyk et al. (2019) conducted an analysis of higher-order language functions, such as irony, metaphors, implied information, and context comprehension. The study encompassed the assessment of indirect speech understanding, semantic processes, and prosody (intonation and rhythm) in individuals at CHR and in FEP, comparing them to a HC group. Results indicated that, in comparison to HCs, CHR individuals scored lower in interpersonal communication and the comprehension of implied information. However, their performance in these aspects was better than that of individuals with FEP (33). Emotional response in individuals at CHR showed a decreased negative response to unpleasant stimuli and a decreased positive response to pleasant stimuli. (34).

Bianciardi et al. (2023) categorized CHR patients into CHR-positive (CHR-P) and CHR-negative (CHR-N) groups based on the *CAARMS,* used for the attenuated psychotic symptoms group, COPER/CODGIS, and SPI-A Scales, mentioned before. The study investigated prosody and temporal variables in language, encompassing rhythm, intonation, stress, tone variation, intensity, vowel space, frequency or number of pauses, speech duration, and articulation rate. When compared to CHR-N and HCs, CHR-P individuals

exhibited a higher speech rate and a shorter mean length of sentences. They also had fewer pauses. In contrast, CHR-N showed more frequent silent periods than CHR-P or HCs. Furthermore, pitch/tone variation was directly correlated with higher scores in CAARMS-p and SPI-A. (35).

Digital communication is likewise altered in schizophrenia. An innovative study done by *Grossman et al (2020)* collects a questionnaire about satisfaction, difficulties and frequency of face-to-face and digital communication, in both FEP and CHR patients compared to HC. These clinical groups showed a less frequent communication at work or in their personal lives. They also presented more barriers and seemed more unsatisfied. This unsatisfaction was directly related to a smaller number of communication episodes. In contrast, there were no relevant differences between face to face and digital communication among both groups of schizophrenia (36).

4.2 Prodromal phase

The *Early Recognition Inventory* (*ERIraos*) based on *The* R*etrospective Assessment of the Onset of Schizophrenia (IRAOS)* is a clinical instrument used to assess patients in the prodromal phase of schizophrenia. It is composed of three phases: *Step 1,* where the self-perception and testimony of the patient is taken into account; *Step 2,* composed of 50 items, among which loss of drive/ slowness, social withdrawal, suspiciousness, delusional misinterpretations and delusions of reference are the most common ones; and *Step 3,* where patients go through a personal questionnaire. This tool is used to establish the likelihood of psychosis onset and includes, as proved, a lot of language parameters (37).

Hartopo et al. (2022) describes a cohesion disorder in this phase. Cohesion is part of the pragmatic language level. Pragmatics describes the relationship between language and context, in which patients with schizophrenia seem more impaired. Cohesion is represented through the correct use of words that bond sentences together and give a more solid structure. An increase in lexical cohesion (pronouns, conjunctions, repetition, word 'like'…) is typical for the prodromal phase of schizophrenia (38). *Chang et al. (2021)* asked patients about social media, electronic social interactions, day-to-day situations and youth concerns and gathered their responses. Negative symptoms were determined concluding that the *5-factor model* is the one that best fits for both, CHR meeting prodromal criteria, and CSZ. This model includes: *blunted effect,* known as the inability to express emotions, *alogia,* known as

poverty of speech, *anhedonia*, *avolition* and *asociality*, and it resulted in the best conceptualization of negative symptoms among every phase of schizophrenia. (28)

According to *Grossman et al,* during the early phases of psychosis, patients present a rusher decision making compared to controls. After presenting different social situations, probands were asked multiple different questions where psychotic patients jumped to social conclusions and showed a higher rate of overconfidence in false responses on tasks of social cognition. As they were provided with further information about the different situations, both controls and prodromal patients showed similar responses (39).

4.3 First-episode psychosis

In general terms, *Man et al. (2018),* uses the '*Repeatable Battery for the Assessment of Neuropsychological Status' (RBANS*) to assess cognitive domains, including language in FEP. *RBANS* measures cognitive functioning in 5 sections: language, immediate and delayed memory, attention and visuospatial domains. Language assessment included picture naming and semantic fluency tasks. 80 FEP drug naive patients and 80 HC patients took part in the study. They had been diagnosed with an acute episode according to the *DSM-4* by two independent psychiatrists and FEP patients showed a significant lower cognitive performance on the RBANS total and four of its five subscale scores, including language, in comparison with HC. The visuospatial domain remained unaltered (20).

Related to language, FEP patients showed verbal fluency impairments, while deficits in naming and semantic memory, meaning long memory responsible for storing general knowledge about facts, concepts, meanings of words and symbols, seemed not yet apparent (14).

Delvecchio et al. (2018) analyses syntactic comprehension in FEP and HC patients. They stated that language impairments in schizophrenia are divided into 1. Comprehension and 2. Syntactic Processing. Probands needed to match a sentence they heard to one out of 4 pictures. Only one of the vignettes represented the stimuli. The study analyses the following grammatical structures: Locative ('*The child is below the table'),* Active negative ('*The child does not eat').* Passive negative *('The child is not entertained')* and Relative *('The child who is in the kitchen is entertained').* FEP patients committed more errors in these constructions than HCs, except in the *Passive-negative* sentences. It was hypothesized that there was a lower lateralisation of the language in patients with schizophrenia. Moreover, a direct correlation was observed between *PANNS-negative* score and grammatical errors. *S*everity

of the illness was directly correlated to a worsening of syntactic comprehension. (40) This abnormal lateralisation was already suggested by other authors such as *Chou et al. (2017).* In his study, probands were asked to carry out a verbal fluency test and were tested through Infrared Spectroscopy*.* FEP patients showed a lower *Lateralisation Index* in the inferior frontal gyrus during the verbal fluency test, confirming this hypothesis also for the early phases of schizophrenia. A generally lower brain activity was observed in more severe negative psychotic patients (13).

The clinical trial carried out *by Barajas et al. (2019),* analysed participants with a recent onset of FEP, less than one year since the onset of the illness and 2 or more psychotic symptoms. Prodromal symptoms were included in IRAOS. One of the dimensions tested was language (*IRAOS-L*). From the study population, around 33% showed poverty of speech, 9% used neologisms, 33% presented incoherence, 41% derailment and 31% alterations in non-verbal communication. It was concluded that patients with language problems may develop a more severe psychosis. Poverty of content of speech resulted as the most specific symptom. Others like thought blocking and weakness of focused thinking played a less significant role (37, 41).

Spencer et al. *(2021)* analysed CHR, FEP and HC patients. Speech connectedness was assessed through directly transcribed quotes from patients. They were given a total of 8 photos and asked to comment each of them for one minute. Two different parameters were used to measure: *Largest Connected Component (LCC)* and *Largest Strongly Connected Component (LSC),* meaning firstly the total number of words in the largest connected paragraph and secondly, the total number of words in the largest connected paragraph where every word needed to be related to the last. Values for both parameters close to 1 meant random junctions with a loss of goal, no referential explications or incorrect use of pronouns. Group differences in speech connectedness were observed. Speech connectedness was lower among FEP patients in comparison to CHR and HC patients. The *Thought and Language Index (TLI),* a measure of the severity of formal thought disorder, is also used in order to define the correlation between connectedness and Formal Thought Disorder. Both LCC and LSC were linked to a negative TLI Score; loss of goal and poverty of speech (42).

Figueroa-Barra et al (2022). analysed HC, CSZ and FEP patients using Mimicking Technique. With this technique, machine learning algorithms can be trained to recognize language patterns associated with schizophrenia. By mimicking the learning process of the

human brain, these algorithms can identify linguistic features that distinguish individuals affected by schizophrenia from those that aren't. Parameters such as verbal productivity, verbal fluency and semantic coherence were altered in FEP patients with the apparition of non-functional pauses, dysfunctional use of pronouns and semantic coherence alterations associated mainly with patients that were suffering from negative symptoms (7).

Most recently *Zanelli et al. (2022)* sorted out FEP patients and carried out a 10-year follow up study. Two bases of data were collected: one at baseline or first episode and another after 10 years. The results found differences in the following parameters: verbal learning, immediate and delayed verbal memory, vocabulary, comprehension, verbal fluency and semantic fluency. With the parameter *d= 0.2/0.5/0.8* (small, medium and large effects respectively), a comparison with HCs was highlighted. The most remarkable differences were observed in the following items: Verbal learning 0.74, Vocabulary 0.61, Verbal Fluency: 0.26, Semantic fluency: 0.63. Additionally, FEP patients appeared to have a lower IQ, that decreased through the course of the illness, and was also present among children who later developed schizophrenia (43).

Figurative language though more linked to acute schizophrenia, has also been studied in FEP. However, *Perlini et al. (2018),* carried out a clinical trial, in which the understanding of metaphors and idioms were tested in the FEP group. These patients showed an altered understanding of metaphors and idioms both in the open and in the closed task. The open task consisted of giving a spontaneuous answer, and the closed task consisted of answering a multiple choice test. An example for the *Open-Metaphor* would be the following: '*Your room is a jungle'* (Punctuation 0: '*In your room many animals live';* 1: '*You need help to fix your room'* 2: *'Your room looks very untidy*'). It was demonstrated that the most effective discriminating parameter between FEP and HC patients seemed to be the Closed Task for Idioms. (44). These higher order language functions were also described by *Pawelczyk et al. (2018,2019)*. FEP patients showed a lower comprehension of implicit information, understanding of metaphors, following of discourse and interpersonal communication, in comparison to both CHR and HC patients. The results were based on the fact that higher-order functions were mainly associated with the right hemisphere, using the *Right Hemisphere Language Battery* to assess these impairments. (33, 45). *Villalta-Gil et al (2013)* had already found differences in brain activation among FEP patients when comparing processing of explicit and implicit information, different types of emotions, happy or fear, and emotional intensity (50-100%). It was explained to be due to a poor emotional processing(46).

In the study conducted by *Caletti et al. (2018),* the analysis focused on prosody in individuals experiencing FEP. During the prosody comprehension assessment, participants were required to identify the intonation (positive, negative, or interrogative) of a given sentence. Additionally, in the emotional prosody comprehension subtest, participants were tasked with distinguishing between expressions of anger, happiness, and sadness, categorizing them into positive or negative feelings . The findings revealed that in the prosody comprehension task, individuals with FEP scored lower specifically in the interrogative domain compared to the HC group.Moreover, in emotional prosody comprehension, FEP patients exhibited lower mean scores across all three domains—anger, sadness, and happiness—when compared to HCs. Furthermore, when comparing first-episode non-affective and first-episode affective, the former demonstrated a higher emotional deficit (46, 47).

4.4 Acute phase schizophrenia

According to the findings by *Curcic-Blake et al. (2017),* individuals experiencing verbal hallucinations in this phase demonstrate tangentiality, characterized by drifting away from the main topic of conversation and shifting towards unrelated or loosely related topics. Additionally, they exhibit loosening of associations, a form of formal thought disorder, impairing their ability to maintain a logical flow of thought.

Verbal hallucinations happen due to alterations in brain connectivity. They are linked to language, memory and auditory domains. These verbal hallucinations, linked to alterations in brain connectivity, are associated with language, memory, and auditory domains. These hallucinations may stem from the activation of latent memories, especially those related to childhood trauma, thereby confirming the connection between verbal hallucinations and memory domains. The relationship involves the interplay between frontal brain areas, including Broca's area, and the auditory cortex in the temporal region. Interestingly, talking suppresses the processing of auditory connections, providing relief for individuals experiencing auditory hallucinations. These patients encounter auditory hallucinations during the acute phase of schizophrenia, and such experiences manifest themselves in alterations observed in their language patterns (48). According to *Wyszomirska et al. (2020),* during the acute phase of schizophrenia, individuals exhibit disruptions in comprehending and producing non-literal language. Particularly, they face challenges in grasping metaphors, and these difficulties may be indicative of reversed hemispheric activation in relation to figurative language. Research suggests a more direct association between the understanding of

metaphors and negative symptoms, while dysfunctions in catching irony, more prevalent in the chronic phase of schizophrenia, are correlated with positive symptoms (11).
Finally, *Kahn et al (2015)* and *Ayer et al (2016)* state that language impairments may improve or remit after an acute phase and then often remain stable until the next episode (3, 49).

4.5 Chronic schizophrenia

Grimes et al. (2021) aimed to prove whether verbal fluency, both semantic and phonemic, remained stable in chronic patients throughout a follow-up of 6 months and 1 year. Therefore 4 categories were used: the *semantic verbal fluency*, number of words produced from a central category, *phonemic verbal fluency*, number of words produced from a letter, *cluster size category*, number of words produced within a subcategory and *cluster switching category*, number of times the patient changes to a different topic). The results showed a medium decline in verbal fluency. Throughout the three timepoints of the study, both semantic verbal fluency and phonemic verbal fluency remained stable (50).
Watson et al.(2017) gathered studies analysing processing speed in patients with schizophrenia. Processing speed was defined as ‘the speed with which an individual can perform any cognitive operation’. It was measured with the correct number responses on a task within a specific time. Tasks from the different studies were distributed according to difficulty levels. It was concluded that patients with schizophrenia, in comparison to non-clinical patients, have a quicker initial thinking but a slower thinking processing during the resolution of the task or problem with a higher number of errors, especially during the highest difficulty levels. Patients failed in planning and preferred to carry out a step-by-step processing. This was hypothesized to be due to a degree of impulsivity and an impairment in working memory. Among verbal productivity, statements with aberrant pauses were also a common pattern along patients, resulting in a fragmented speech. (7, 51)
Figurative language is also altered in the chronic stage of the illness. Patients have problems understanding irony involving reading of non-literal messages in comparison with controls. (11).
Langdon et al. (2017) categorizes this group as *'concrete thinkers'* due to their misinterpretation of metaphorical speech. Theory of Mind (TOM), an important component of social cognition, is evaluated in both chronic patients and HCs, assessing the capacity to comprehend the feelings and thoughts of others for predicting human behavior. TOM is approached in two ways: the implicit, unconscious, or automatic way, and the explicit or conscious way, which only develops once the child acquires language and demonstrates

higher-order mental skills. Patients with schizophrenia fail in explicit processes and generate, not rarely, false implicit hypothesises or delusions. Participants were tested in the explicit domain: they were asked to watch a video (*H&S animation*) and imagine the dynamic geometric shapes as if they were people carrying out some action. This was called the people instruction. The total word count was gathered such as different types of mental-state language (words referring to perception, emotions, desire, driven actions or intentions…). Even though results revealed that CSZ patients did not differ from HC patients in the number of words generated, they showed fewer mental- state terms, including basic and more complex language related to emotions, showing impairments in the explicit domain. (52)
CSZ is as well characterised by emotional stress. Alexithymia, the difficulty of identifying and expressing feelings, is associated with poorer neurocognition, and therefore with a lower language output. The description of feelings itself in CSZ patients is thought to be due to a higher emotional stress or mental pressure (53).

4.6 Remission

No relevant information about language impairments according to the inclusion criteria were found in this phase.

4.7 Relapse phase

According to the *Boer et al (2020),* an indicator of potential relapse is an elevated usage or pronouns, swear words, and terms associated with anger and death, together with a reduced use of words related to everyday life, work, friends and health (29).

No further information has been found about this phase.

5. Discussion

The present systematic review aimed to synthesize and critically evaluate the existing literature on language impairments in each phase of schizophrenia. One of the key findings of this review is the consistent evidence supporting the existence of language impairments across various linguistic domains in individuals with schizophrenia, mainly pragmatics (10). However, schizophrenia being such an heterogenous syndrome explains why the variables analysed in the different articles included in this review, are very wide and different from each other. Getting to know language impairments across the course of schizophrenia contributes to a better understanding of the relationship between language and the progression of the

disorder. Assessing language from various perspectives, such as linguistic levels and social cognition, offers valuable insights into understanding language impairments. Examining language at a linguistic level involves analysing phonology, syntax, semantics, and pragmatics to highlight specific deficits in language processing and production. This approach helps identifying structural and grammatical abnormalities that may contribute to communication difficulties in individuals with language disorders. On the other hand, considering language within the context of social cognition explores how individuals comprehend and use language in social interactions, including understanding non-verbal communication, interpreting intentions or understanding social norms.

Early Detection

Identifying early markers in the early phases of schizophrenia has gained increased attention due to its potential significance in early identification and intervention. While the linguistic deficits in the prodromal stage may not be as pronounced as in the later phases, these findings underline the importance of considering language assessment as part of early detection strategies, particularly. This emergent psychosis is considered particularly as a subtle language disorganization (5). The prodrome phase, understood both as the phase before the frank psychosis or the pre-psychotic period before a relapse phase, (54) is an area of potential early intervention. Pre-psychotic states need to be organised in order to minimise all the psychological, social and legal disruptions from schizophrenia.

Transition to a first-episode or frank psychotic symptoms

In recent years, researches have increasingly focused on a significant concern related to language parameters responsible for the development from a CHR or FEP to a frank psychosis. Some predictors found among the studies were a less use determiners, a lower semantic coherence and a shorter maximum phrase length (30).

Consequently, this review contains a substantial amount of information regarding this transition. Each study uses different scales or parameters to establish this transition: the *UHR (Ultra-high risk Mental State)* to assess the risk of transition to psychosis which includes attenuated psychotic symptoms, brief limited intermittent psychotic symptoms and genetic risk and deterioration syndrome (9); the *ERIraos* (*Early Recognition Inventory- Retrospective Assessment of the Onset of Schizophrenia*) used in the transition from a prodromal phase to a FEP (37) and the transition from FEP to frank schizophrenia using the combination of *PANSS,* language alterations and demography (7), among others.

Acute phase of the illness

During the acute phase of the illness, our review confirmed a substantial exacerbation of language impairments. Language production becomes more disorganized and is closely related to the apparition of auditory hallucinations and positive symptoms that promote an abnormal use of the language (11, 48). Increasing awareness about the acute phase underscores the importance of early intervention services (54), especially reducing the duration of untreated psychosis and promoting better long-term outcomes for individuals with schizophrenia.

Figurative language in schizophrenia

The assessment in this review focuses as well on figurative language, a crucial element as it appears to be compromised throughout the course of the illness. This impairment is closely linked to enhanced social integration, comprehension of humour, and the effective functioning of both cognitive and affective abilities. (11, 46). The review findings confirm the presence of deficits in the comprehension and production of figurative language among individuals with schizophrenia, especially in the first-episode psychosis, acute and chronic phases. They have difficulties in discerning the intended meaning and may lead to a barrier in social interactions. From a clinical aspect, speech and language therapists, together with mental health professionals could develop therapeutic approaches to improve both the cognitive and communicative aspects of figurative language and therefore, improve social functioning.

Natural Language Processing and artificial intelligence

Techniques like *Mimicking* intelligence were included in this review (7). It makes part of Artificial Intelligence (AI) which could be of future use in the analysis of natural speech in order to identify different language parameters that would be useful in the characterisation of schizophrenia. Natural Language Processing (NLP) is also a field of AI that focuses on the interaction between computers and human language. Natural Language Processing (NLP) techniques are gaining great importance when applying them to the linguistic analysis but are not yet introduced in a day-to-day clinical practice. They involve the development of algorithms and computational models that enable machines to understand, interpret, and generate human-like language. NLP encompasses a range of tasks related to language, including text analysis, speech recognition, and language generation (55).

Limitations

Despite the progress made in understanding language impairments in schizophrenia during the last years, several gaps and methodological limitations were identified. Heterogeneity in study designs contain a big number of different *Scales* and *Indexes* that are used indistinctively among the studies and use different parameters. This leads to a limitation in the interpretation of the results. Many studies were excluded due to small sample sizes (minimum method criteria established was n=50). Language is in addition influenced by culture and linguistic factors that might have been built up through each generation. Studies conducted in different cultural contexts may reveal variations in the manifestation of language impairments. In general, non-Western cultures exhibit a more positive outcome for being more sociocentric than egocentric*;* they usually depress negative expression, have more family and society support and stigmatize schizoprenia less. Language has a subjective and literal part that can be interpreted differently by every patient. Studies that specifically made use of sentence interpretation may have a *response bias* for this review (36, 37, 39). Lastly, this review does not differentiate between probands who have or have not received antypsychotic treatment previously, which leads to to differences in the results, specially in the acute phase of the illness.

Future Directions

Future research should prioritize standardized methodologies and larger, more representative samples to enhance the normalisation of findings and enable cross-study comparisons. Cultural differences and their impact on the findings such as the differentiation between patients with or without psychotic medication may also need to be considered. From a clinical point of view, the use of *Artificial Intelligence* may offer a promising future in the clinical practice. Family and social support may also help fighting against the stigmatisation of schizophrenia and building a constructive communication in order to improve language impairments in schizophrenia. No research was found regarding language impairments in the residual phase or remission of schizophrenia; and very few was found related to the relapse phase, denoting a need to invest more in this field.

Programes like the one that *Bosco et al.* proposes may be taken into account by proffessionals in order to give effective communivative treatment programmes to patients with schizophrenia. The patients from his study took part in a *Cognitive Pragmatic Treatment* programme, made up of 20 group sessions focused on linguistic (language expression),

extralinguistic (gestures), paralinguistic (tone), theory of mind and other cognitive funcitons. Most of them used video-taped scenes based on different language tasks. The goal of his study was to help patients to interpret the intended meaning and to consider the non-literal one, corresponding to the pragmatic level. It consists of a rehabilitation programme where probands experiment improvement in the linguistic ability, including direct and indirect speech, irony and deceit (4).

Schizophrenia affects every dimension of the person and is related to many other comorbidities. Support with a long-term monitoring of physical health provided by primary care practitioners, specialists and other health care professionals like speech therapists would enrich the quality life in these patients (1). Speech therapists mainly engage in therapeutic interventions aimed at improving communication skills and cognitive functions in individuals with schizophrenia. Furthermore, schizophrenia imposes substantial healthcare expenses on society, such as costs associated with hospitalizations, medications, and specialized treatments. Legal issues often emerge from the behaviours demonstrated by individuals with schizophrenia, as they may face impaired judgment and engage in actions contrary to societal norms, requiring legal interventions and support mechanisms. Additionally, schizophrenia contributes to socio and working dysfunction, as individuals may encounter difficulties in maintaining employment, forming stable relationships, and integrating into mainstream society due to the debilitating symptoms and social stigma associated with the disorder. These interconnected aspects underscore the imperative for comprehensive approaches that address the clinical, financial, legal, and socio-occupational dimensions of schizophrenia management and support.

6. Conclusions

Based on the objectives outlined in this review, the subsequent conclusions could be drawn.

1. Various approaches have been utilized to analyse the primary language impairments associated with schizophrenia, revealing a consistent impoverishment across language domain. This depletion aligns with the progressive deterioration of the illness from a psychopathological perspective.
2. The encouragement of early diagnosis may prevent the apparition of an acute episode, especially in the early phases, and guide the patient to a phase of relapse or remission, without experiencing frank psychosis.

3. The existing literature remains limited on the topic. There has anyway been significant progress in the last years, particularly concerning specific phases of the disorder like CHR and FEP. Studies examining language deficits in schizophrenia often employ diverse parameters and methodologies, making it challenging to draw consistent conclusions across different phases of the illness. Variations in sample characteristics, assessment tools, and diagnostic criteria contribute to the complexity of interpreting findings.

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ANNEX 1. SCALES FOR THE ASSESSMENT OF LANGUAGE, THOUGHT AND COGNITIVE IMPAIRMENTS IN SCHIZOPHRENIA		
SCALE	**PHASE**	**ITEMS**
Scale for Assessment of Thought, Language and Communication ***(TLC)*** ***Andreasen, 1979*** *(21, 22, 56)*	Every phase	20 items. thought disorder: poverty of speech, poverty of content, pressure of speech, derailment, incoherence, illogicality, clanging, neologisms, word approximations, circumstantiality, loss of goal, perseveration, echolalia, blocking, salted speech, self-reference…
Bonn Scale for the Assessment of Basic Symptoms ***(BSABS)*** ***Huber 1986, Gross et al 1987.***	Every phase	Inability to divide attention, thought interference, thought pressure, thought blockages, disturbance of receptive speech, disturbance of expressive speech, disturbance of abstract thinking. Cognitive Alterations- C
Positive and Negative Syndrome Scale ***(PANNS)*** ***Kay et al., 1987***	Every phase	PANNS-Total. PANNS-Positive. PANNS- Negative. PANNS- Psychopathology. Clinical Status.
*Structured interview for psychosis-risk syndromes (****SIPS****)* ***Cornblatt A, et al, 2002.***	Prodromal phase	-Positive -Negative -Disorganised -General.
Schizophrenia Proneness Instrument, Adult version. ***(SPI-A)*** ***Schultze-Lutter et al., 2007*** *(8)*	Prodromal phase	Interference of emotions, disturbances of receptive and expressive speech, increase indecisiveness in decision-making, disturbance of immediate recall.
Thought and Language Disorder Scale ***(TALD)*** ***Kircher et al, 2014.*** *(17)*	Every phase	30 items. Objective Subjective

ANNEX 2. ARTICLES INCLUDED IN THE SYSTEMATIC REVIEW		
ARTICLE	**SAMPLE PROBANDS**	**TYPE OF PUBLICATION**
Kahn et al, 2015 *(3)*		Narrative review
Corcoran et al, 2016 *(5)*		Narrative review
Figueroa-Barra et al, 2022 *(7)*	49 HC (51% women), 38,6 mean age. 40 FEP (37% women), 18,1 mean age 44 CSZ (43% women) 35,5 mean age	Case-control study
Wyszomirska et al, 2019 *(11)*		
Salinger et al, 2018 *(24)*	58 CHR psychosis (40% women) 45 CHR bipolar (69% women) 13-17 years old	Cohort study
Cannon et al, 2016 *(27)*	Baseline: 743 CHR (42,3% women) Follow up: 596 CHR 12-35 years old	Cohort study with follow-up (2 years)
Chung et al, 2021 *(28)*	164 CHR (59% women), 20,26 mean age 377 Ep (early psychosis- (57% women), 21 mean age	Case-control study
de Boer et al, 2020 *(29)*		Review
Magnani et al, 2023 *(31)*	90 CHARMS criteria + 90 HC 14-25 years old	Case-control study with follow-up
Carrion et al 2016 *(32)*	Baseline: 210 CHR subjects Follow up; 176 12-25 years old	Transversal study
Pawelczyk et al, 2019 *(33)*	20 HC (45% women), 18,25 mean age 33 UHR (57,6% women), 19,6 mean age 20 FEP (45% women) 19,45 mean age	Case-control study
Gruber et al, 2018 *(34)*	29 UHR (38% women), 19 mean age 32 HC (60% women), 18,5 mean age 23 affective disorder/substance abuse	Case-control study
Bianciardi et al. 2023 *(35)*	50 CHR-Positive 23 CHR-Negative 17 HC	Case-control study
Grossman et al, 2020 *(36)*	19 CHR 57 FEP 51 HC 12-22 years old	Case-control study
Hartopo et al, 2022 *(38)*		Review
Grossman et al, 2020 *(39)*	35 prodromal psychosis (18% women), 23,57 mean age 35 HC (29% women), 23,34 mean age	Case-control study

Delvecchio et al, 2018 *(40)*	218 FEP (166 non-affective; 52 affective) 46% women, 30,5 mean age 106 HC (55% women), 31,8 mean age	Case-control study
Barajas et al, 2019 *(41)*	79 FEP (55,7% women) 20,22 mean age Mean age first prodromal feature: 19,41 Mean age onset psychotic episode: 19,9	Observational study
Spencer et al, 2021 *(42)*		Review
Zanelli et al, 2022 *(43)*	Baseline: HC 230, SZ 98, Bipolar 39 (54% women) Follow up: HC 103, SZ 64, Bipolar 19 (52% women) 16-65 years old	Case-control study
Perlini, et al, 2018 *(44)*	228 FEP (60 FEP-Affective, 168 FEP-Non-affective) 44% women, 30,4 mean age 70 HC (58% women), 34 mean age	Case-control study
Pawelczyk et al, 2018 *(45)*	34 FEP (47% women), 20,85 mean age 32 HC (53% women) 20,21 mean age 34 healthy relatives (47% women), 49,44 mean age	Case-control study
Villalta-Gil et al, 2013 *(46)*	22 FEP (41% females) 23,34 mean age 31 HC, mean age: 25,57, 51% females	Case-control study
Caletti et al, 2018 *(47)*	208 FEP (156 non-affective, 52 affective), 41% women, 30,3 mean age 77 HC (55% women), 30,81 mean age	Case-control study
Curcic-Blake et al, 2017 *(48)*		Narrative review
Grimes et al, 2017 *(50)*	Baseline: 70 CSZ or schizoaffective disorder Follow up: 53 CSZ (30% women) Mean age: 39,2 years old.	Observational descriptive study (6 months)
Watson et al, 2017 *(51)*		Narrative review
Langdon et al, 2017 *(52)*	45 CSZ (42% women), 42,2 mean age 27 HC (48% women), 41,5 mean age	Case-control study
Fogley, et al, 2014 *(53)*	65 CSZ	Observational descriptive study

ANNEX 3: LANGUAGE IMPAIRMENTS IN EVERY LANGUAGE LEVEL IN SCHIZOPHRENIA					
LANGUAGE LEVELS	**Clinical High-risk phase**	**Prodromal phase**	**First-episode psychosis phase**	**Acute phase**	**Chronic phase**
Morphologlic Syntactic Level.	-Less frequency of determiners -Maximum phrase length shorter. **-CHR-P:** higher speed rate and lower mean length of sentenced. Smaller number of pauses. **-CHR-N:** more frequent silent periods. -Lower verbal learning and memory performance, slower speed or processing → conversion.	**-Cohesion disorder**: increase in lexical cohesion (pronouns, conjunctions, words '*like*'…) → more lexical connectors.	**-Poverty of speech content.** -Less **verbal fluency** and vocabulary learning. -Alterations in **syntactic comprehension-** locative, active negative and relative sentences. -Less verbal and vocabulary learning.		**-Aberrant pauses. Fragmented speech.**
Semantic Pragmatic Level.	-Reduced semantic **coherence** (LSA).		-Lower cognitive performance: picture naming and semantic fluency tasks. -Non-functional pauses, dysfunctional use of pronouns and semantic coherence alterations (+ negative symptoms). -Less semantic fluency. **Less speech connectedness** → loss of goal, random junctions, no references, incorrect use of pronouns. >Negative TLI Score->loss of goal and poverty of speech.		-Medium decline in **semantic verbal fluency**. -Aberrant pauses Fragmented speech. .

Higher order functions	-Lower interpersonal communication. -Less understanding of **implied information.** -Less digital communication.		-Lower comprehension of implicit information, metaphors, following discourse and interpersonal communication. -Altered non-verbal communication. -Altered **figurative language-** Altered *Closed Task for Idioms* -Prosody: interrogation domain deficit and emotional prosody deficit.	-Difficulties in understanding **metaphors** → reversed hemispheric activation related + to negative symptom	-Difficulties in understanding **irony –** *concrete thinkers.*
Thought disorder	**-Subtle thought disorder →** subtle speech disturbances. -Unusual content and suspiciousness →conversion. -Constructive social communication → less episodic positive symptoms -Reality is retained. -Functional decline, anxiety, dysthymia, poor concentration, changes in mood, loss of motivation, enclosed in themselves. -Asymptomatic. -Bad response to stress.	**-Mild thought disorder:** sub psychotic positive symptoms: unusual thoughts, suspiciousness, grandiosity, perceptual disturbances, disorganised communication. -5-factor model. Rusher decision making, overconfidence, social conclusions. -Loss of drive, slowness, misinterpretations, delusions of reference. -Unusual thought of content and suspiciousness → conversion.	-Thought blocking and weakness of focused thinking. -Neologisms, derailment, alterations in non-verbal communication. -Lower IQ	**-Positive formal thought disorder. Tangentiality and loosening of associations.** -Verbal hallucinations related to alterations in speech (relief when talking).	-Quicker initial thinking, slower subsequent thinking in problem resolution. More errors. -Fewer mental-state terms related to emotions. -Difficulty understanding and describing feelings; emotional stress.