


Contributions of Experimental Psycholinguistics to the
understanding of language disorders /
*Contribuições da Psicolinguística Experimental para a
compreensão dos distúrbios de linguagem*


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Received in: 02 may. 2026. **Approved in:** 10 may. 2026.

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How to cit this article:

FERREIRA, Jullyane Glaicy da Costa. Contributions of Experimental Psycholinguistics to the understanding of language disorders. *Revista Letras Raras*. Campina Grande, v. 15, n. 1, p. e7582, mai. 2026. DOI: 10.5281/zenodo.20262621.

ABSTRACT

This study is characterized as a theoretical-analytical literature review aimed at discussing the biological bases of human verbal communication and analyzing the factors associated with language disorders. In this sense, it emphasizes the use of experimental methodology from Psycholinguistics to investigate internal aspects of language comprehension and production. The study is grounded in the theoretical assumptions that underpin psycholinguistic research, with emphasis on language processing mechanisms. For the analysis, studies published between 2010 and 2023 were selected from academic databases such as SciELO, PePSIC, and institutional journal platforms, based on their relevance to the field, including Mendes *et al.* (2010), Alves *et al.* (2021), and Correia *et al.* (2023), which address dyslexia, Alzheimer's disease, and stuttering, respectively. The results indicate that the analyzed disorders present specific alterations in language processing, including increased processing time in online tasks, impairments associated with working memory, and disruptions in lexical access and representation, as well as the identification of potential neural markers. It is thus evident that Experimental Psycholinguistics makes a significant contribution to the understanding of language disorders by articulating empirical evidence and theoretical models in the interpretation of cognitive processes, supporting the description of linguistic phenomena and enabling more effective interventions for the development of functional communication.

KEYWORDS: Experimental Psycholinguistics; Language Disorders; Language Processing.

RESUMO

Este estudo caracteriza-se como uma revisão de literatura de natureza teórico-analítica, voltada à discussão das bases biológicas da comunicação verbal humana e à análise dos fatores associados aos distúrbios da linguagem. Nesse sentido, enfatiza o uso da metodologia experimental da Psicolinguística na investigação de aspectos internos da compreensão e da produção linguística. Parte-se dos pressupostos teóricos que fundamentam os estudos psicolinguísticos, com ênfase nos processos de processamento linguístico. Para a análise, foram selecionados trabalhos publicados entre 2010 e 2023, disponíveis em bases de dados acadêmicas como SciELO, PePSIC e portais institucionais de periódicos, considerando sua relevância para a área, dentre os quais se destacam Mendes et al. (2010), Alves et al. (2021) e Correia et al. (2023), que abordam, respectivamente, a dislexia, a doença de Alzheimer e a gagueira. Os resultados indicam que os diferentes distúrbios analisados apresentam alterações específicas no processamento linguístico, evidenciadas por maior tempo de processamento em tarefas on-line, comprometimentos associados à memória de trabalho e alterações nos processos de acesso e representação lexical, além da identificação de possíveis marcadores neurais. Evidencia-se, assim, que a Psicolinguística Experimental contribui de maneira significativa para a compreensão dos distúrbios da linguagem, ao articular evidências empíricas e modelos teóricos na interpretação dos processos cognitivos, favorecendo a descrição dos fenômenos linguísticos e subsidiando intervenções mais adequadas para o desenvolvimento da comunicação funcional.

PALAVRAS-CHAVE: Psicolinguística Experimental; Distúrbios da linguagem; Processamento linguístico.

1 Introduction

Communication through verbal language is one of the defining characteristics that distinguishes humans from animals, since, in addition to enabling the advancement of knowledge

passed down through generations orally and in writing, it also facilitates life in society. This activity, which is common for most individuals, may not occur effectively for some, whether due to genetic alterations, diseases, or even as a result of an accident—this is what we call language disorders.

According to Hübner (2015), language disorders can be described as impairments that affect an individual's language, which may manifest in speech production, writing, oral comprehension, and even reading. For this reason, conducting research with patients who have these disorders is crucial, as it allows for a comprehensive understanding of the specificities of each alteration in the internal mechanisms responsible for linguistic communication.

A relevant approach to investigating language disorders involves collaboration with Experimental Psycholinguistics, a field dedicated to describing and analyzing the processes involved in language comprehension and production, with a focus on phenomena related to its processing (Leitão, 2008). From this perspective, psycholinguistic studies focus on the internal aspects of human language, based on the generative assumption that language is an innate ability, underpinned by biological mechanisms responsible for its acquisition, comprehension, and production.

In light of this, Experimental Psycholinguistics provides methodological tools and a solid theoretical foundation that enables researchers to investigate human language processing through online and offline experiments, such as: self-paced/self-monitored reading, acceptability judgment, eye tracking, and the electroencephalogram (EEG). These methods allow for the controlled observation of aspects of linguistic processing that would not be accessible through descriptive approaches alone.

Based on these considerations, this study aims to analyze the contributions of Experimental Psycholinguistics to the understanding of language disorders, through a discussion of studies investigating different linguistic conditions. This is a theoretical-analytical study, characterized as a literature review. Studies published between 2010 and 2023 were selected from recognized academic databases, such as SciELO, PePSIC, and institutional journal portals, based on their relevance to the field of psycholinguistics and language disorders. The analysis focuses on the contributions of Mendes *et al.* (2010), Alves *et al.* (2021), and Correia *et al.* (2023), which address, respectively, dyslexia, Alzheimer's disease, and stuttering.

The established time frame aims to cover both classic studies and more recent works, allowing us to track changes in theoretical and methodological approaches within the field of Experimental

Psycholinguistics. The selection of authors analyzed is based on the relevance of their contributions to the study of language disorders, particularly regarding the relationship between experimental data and the interpretation of linguistic processes.

The article is structured in three parts: first, language disorders are discussed, with an emphasis on their development and biological bases; next, the perspective of Experimental Psycholinguistics is addressed, including its theoretical foundations and its relationship with language disorders, as well as a review of relevant studies; finally, the concluding remarks are presented, summarizing the main contributions of the study.

2 Language Disorders

The development of human language is shaped by both biological and cultural factors and forms the foundation for the dissemination of human knowledge, since it is through language that individuals communicate their understanding of the world around them, create and recreate history, build upon past discoveries, and lay the groundwork for the future. Within generative theory, language is one of the distinguishing features between humans and animals, given the degree of complexity of the symbols and combinatorial rules used to express what we want.

Language skills develop from childhood, maturing and incorporating new information so that individuals can communicate and perform everyday tasks throughout their lives. Language acquisition follows a pattern, regardless of the individual's location; thus, "although the degree of efficiency with which language is acquired is not fully understood, it is known that children from different cultures appear to follow the same general path of language development" (Schirmer *et al.*, 2004, p. 96). This information aligns with the concept of innateness in generative theory, which proposes a biological basis for language.

Schirmer *et al.* (2004) identify a series of key milestones in language acquisition for each age group, up to the first two years of life. Even at this early stage, children are able to intuitively recognize various parts of speech, such as articles, verbs, and even prepositions, as well as form sentences and ask questions. This process, then, occurs concurrently with the development of four interdependent

systems: the pragmatic, phonological, semantic, and grammatical systems, which integrate knowledge related to social context, sound perception and production, understanding of word meaning, and comprehension of grammatical rules.

What we observe is the recruitment of various brain mechanisms and abilities — perceptual, articulatory, and others — so that language can become established. All of these play a crucial role in individuals' linguistic development. However, it is particularly important to address the biological foundations of language. For a long time, researchers have been seeking to locate language within the human brain, and much of this research falls within the scope of neuroscience.

The fact is that there is an inherent complexity in the processes occurring within the human body until codes are transformed into comprehensible information, as we can observe in the following excerpt:

The language process is quite complex and involves a network of neurons distributed across different regions of the brain. In response to environmental sounds, speech encompasses multiple sounds that occur simultaneously, at various frequencies, and with rapid transitions between them. The ear must tune into this complex auditory signal, decode it, and transform it into electrical impulses, which are conducted by nerve cells to the auditory area of the cerebral cortex in the temporal lobe. The lobe then reprocesses the impulses, transmits them to the language areas, and likely stores the acoustic signal for a certain period of time. (Schirmer *et al.*, 2004, p. 97)

Based on these observations, the researchers describe the path of information in the brain, with the assistance of other human sensory organs, such as hearing, for example. Not all acoustic information carries meaning; it is necessary to filter out what is important for establishing communication. Furthermore, this information must be stored in a memory capable of retaining and retrieving what is essential at the appropriate moment. Most impressively, all these operations occur in milliseconds and are not controlled by individuals, that is, they are automatic.

These operations are successfully carried out thanks to the coordination of actions by the brain, which has a dynamic and flexible nature that adapts to changes and new knowledge acquired throughout life. Thus, according to Schirmer *et al.* (2004), when studying the brain of an adult in comparison to that of a child, several differences become evident, reflecting the organ's maturation with each new experience.

The localization of language in the brain gained prominence through clinical cases of aphasia, that is, the occurrence of patients who, due to a genetic condition or a traumatic brain injury, began to exhibit different behaviors regarding both language production through speech and language comprehension.

To illustrate this point, we can cite the findings of scientists Karl Wernicke and Paul Broca, who, according to Martelotta *et al.* (2008), conducted studies that identified and named language-related brain lesions, which were termed Wernicke's aphasia and Broca's aphasia. These lesions are related to specific areas of the brain dedicated to language comprehension and production; in this sense, language comprehension is processed in Wernicke's area, "located in the temporal lobe, which recognizes patterns of auditory signals and interprets them to form concepts or thoughts, activating a distinct group of neurons for different signals" (Schirmer *et al.*, 2004, p. 97). Regarding language production, we have Broca's area, where "an internal representation of the subject is activated, channeled to Broca's area in the inferior portion of the frontal lobe, and converted into the neural activation patterns necessary for speech production" (Schirmer *et al.*, 2004, p. 97).

In addition, there is a connection between Wernicke's and Broca's areas, which is established via a bundle of fibers. According to Martelotta *et al.* (2013), this bundle is called the arcuate fasciculus, and brain lesions in this area are referred to as conduction aphasias. These findings demonstrate that there is a complex organization of brain functions that enables language in humans, connecting and transforming information to make it comprehensible and useful for communication. However, disruptions in these mechanisms can lead to language disorders.

Understanding the biological basis of language is fundamental to identifying the neural mechanisms that underpin verbal communication, especially regarding linguistic production and comprehension. This knowledge provides essential theoretical support for the study of language disorders from the perspective of Experimental Psycholinguistics, since such conditions arise from alterations in these systems. Thus, the analysis of the brain's organization of language offers important insights for investigating the atypical manifestations discussed in the following section.

2.1 Oral and written language disorders

Discussing language disorders directly implies an alteration in the brain's normal processes related to language production and comprehension, modifying or interrupting the flow of information, which can lead to communication difficulties in various ways. The most common causes may be accidental, such as a head injury; an illness; or even a genetic condition.

Hübner (2015) offers a definition of language disorders:

Language disorders are abnormalities manifested in an individual's language, which can occur in either spoken or written production, as well as in oral comprehension or reading. These disorders, which are caused by genetic or acquired factors, can manifest at any age at which a person already uses language; that is, they can begin in childhood, adolescence, or adulthood. (Hübner, 2015, p. 99)

The author identifies the forms in which these disorders manifest, namely comprehension and production, both of which have two dimensions: speech/writing and oral expression/reading. This distinction is fundamental, since there are many ways in which brain changes can manifest in terms of language.

The distinction between the causes of aphasia is also an important aspect, since, according to Hübner (2015), neurodegenerative diseases can cause profound damage to individuals' cognition, leading to losses over time and significantly affecting language, as is the case with the well-known Alzheimer's disease. In cases of aphasia, however, there is a focal brain lesion that alters the functioning of language mechanisms; nevertheless, there is a possibility of restoring cognitive functions, taking into account various factors, such as the nature and extent of the lesion.

Considering the stages of human development, we can identify language disorders from childhood through adulthood to old age. In childhood, for example, the "most common disorders have genetic causes (as in the case of Down syndrome and autism—the latter, however, may have causes other than genetic ones), brain tumors, or traumatic brain injury (TBI)" (Hübner, 2015, p. 99). According to the author, there are also aphasias that are subdivided into: dysarthrias or apraxias, depending on the location and severity of the affected region.

By defining human cognition as a set of brain or mental abilities whose function is to aid in understanding and acquiring knowledge about the world and oneself, the researcher then brings together the abilities resulting from cognition, such as: “thought, reasoning, abstraction, language, memory, attention, creativity, planning, problem-solving ability, monitoring of actions, among other functions” (TCE) (Hübner, 2015, p. 100). These abilities enable the construction of knowledge and the learning of different types of knowledge.

Among the components of human cognition, memory and executive functions stand out, as we can see in the following excerpt:

Among the components of cognition are memories (classified by duration as short-term or long-term; by content as procedural or declarative; and by function as working memory, which integrates elements from previously stored memories with new elements to enable the generation of new knowledge); executive functions (which are responsible for planning, controlling, and monitoring actions; for the mental flexibility required, for example, to alter a procedure in response to a change in the rules of a game; and for the inhibitory control needed to select one response and inhibit another, competing one). (Hübner, 2015, p. 100)

In light of these considerations, it is evident that not only do specific areas of language play a role in linguistic comprehension and production, but a range of different cognitive skills are also fundamental to successful language use. This characteristic introduces a complexity that extends to research studies examining the relationship between language and cognition.

Among the different types of language disorders that can be studied, Schirmer et al. (2004) present a classification of language impairments regarding speech, namely: delay, which is characterized by a slow pace resembling that of an earlier age group; dissociation, in which there is a discrepancy between language development and that of other areas; and deviation, marked by qualitative anomalies in language development that are common in individuals with autism.

Other disorders may arise from epileptic seizures, through convulsive episodes and electroencephalographic discharges which, according to neuroscience studies, can interfere with language. Thus, “it can be said that there are three disorders most commonly reported in epileptic patients: developmental dysphasias associated with epilepsy; critical (acute) aphasias, in which a transient alteration of cognitive function occurs; and acquired epileptic aphasia” (Schirmer et al., 2004,

p. 97). In addition, the authors list the etiology of language disorders, namely: environmental causes, isolated expressive language delay, cognitive deficits, hearing deficits, autism, and specific language disorders.

It is also worth mentioning language changes resulting from autism, given the increase in diagnoses of the disorder, particularly in childhood. On this issue, Schirmer et al. (2004) discuss speech impairments, which cease to be functional in many cases, as well as the regression of previously established linguistic aspects, and more severe cases that present a serious impairment culminating in the absence of language. In this context, it is essential to conduct studies that enable the identification of different language disorders and increasingly facilitate appropriate interventions, providing individuals with conditions conducive to verbal communication.

The discussion of language studies, including their origins and the various manifestations of aphasia, highlights the importance of this field for understanding linguistic processes. This body of knowledge forms the foundation for the analysis presented in the following section, which examines language studies from the perspective of experimental psycholinguistics.

3 Language Disorders from the Perspective of Experimental Psycholinguistics

Experimental psycholinguistics has established itself as a significant approach to the study of language comprehension and production processes by incorporating experimental methods that allow for the controlled observation of how linguistic processing works. Throughout this section, fundamental concepts will be addressed, such as the emergence of psycholinguistics, the objective of experimental psycholinguistics, its main lines of research, and the primary experimental study techniques that are widely used. In addition, we will discuss the methodological advantages that can aid in the investigation of various language disorders, focusing on recent data and their implications, which will be done through a review of the literature.

Modern psycholinguistics emerged in the 1950s, bringing together linguists and psychologists from the United States with the aim of expanding studies on human language using techniques already established in psychology at the time. According to Leitão (2008), two seminars were instrumental in the consolidation of the field: the 1951 summer research seminar on psychology and linguistics at

Cornell University, and the 1953 summer seminar on psycholinguistics at Indiana University. These opened the door to discussions on human cognition and effective research methods.

Following these developments, psycholinguistics underwent a period of nearly 50 years before aligning itself with the generative perspective proposed by Noam Chomsky, which advocates a view of language as biological and innate to human beings, distinguishing humans from other animals—for example, in terms of creativity—since humans are capable of creating new sentences in an unlimited manner. In this sense, it is important to note that “the generative proposal internalizes the concept of language, defining a linguistic faculty that is innate and located in the human mind” (Leitão, 2008, p. 218). Thus, the location of linguistic constructs becomes a mutual interest of both fields: Linguistics and Psychology.

Although there was a shift away from generativism in the mid-1970s, which allowed psycholinguistics to converge with cognitive linguistics in studies of semantic approaches, the line of research returned to generative theory in 1995. This scenario resulted from reformulations in Chomskyan theory, such as the creation of the Minimalist Program, in which “generative procedures come to be understood as a computational system no longer detached from the production/comprehension of utterances, but rather as a derivation that acts on lexical items active in memory” (Leitão, 2008, p. 220).

Given the historical trajectory and the interests that underpin psycholinguistics, a definition of the field is necessary: “Psycholinguistics is a science that seeks, through experimentation, to understand how we acquire, process, and produce language” (Sá and Oliveira, 2022, p. 6). The authors emphasize the main aspect of this line of inquiry: understanding the mental processes that occur automatically in the human mind to enable the production and comprehension of language.

To investigate language phenomena, a robust methodology is required, as these mental processes occur in milliseconds. Regarding this fact, Sá and Oliveira (2022) make the following observations:

In psycholinguistics, introspection can serve as a starting point, but never as an endpoint. To test hypotheses, we design experiments aimed at collecting quantitative data. In psycholinguistics, since it is not possible to observe the phenomenon in its processing, acquisition, or production itself, the causal relationship is inferential; that is, based on such data, we perform statistical

analyses that allow us to make inferences and thus verify whether our hypothesis is true and, consequently, whether our theory regarding the processing, acquisition, or production of the linguistic phenomenon is also true. (Sá and Oliveira, 2022, p. 6)

The careful design, implementation, and statistical analysis of experiments are part of a psycholinguist's routine; based on the formulation of hypotheses, they seek to test individuals of different ages and linguistic backgrounds, while carefully controlling the variables of the proposed experimental model.

According to Leitão (2008), psycholinguistics aims to investigate three main areas: the acquisition, production, and comprehension of language by humans. Consequently, the field is subdivided into: Developmental Psycholinguistics, which focuses on language acquisition, and Experimental Psycholinguistics, responsible for the study of linguistic production and comprehension. The term "Experimental" is essential in this field, since researchers frequently use experimental tasks to study a wide variety of linguistic phenomena.

[...] The fundamental aim of experimental psycholinguistics is to describe and analyze how humans understand and produce language, by observing linguistic phenomena related to language processing. In other words, these phenomena are addressed and examined from the perspective of how they are carried out by speakers/listeners through their perceptual/articulatory apparatus and memory systems. (Leitão, 2008, p. 221)

Leitão (2008) observations underscore the importance of this line of research from a procedural perspective, which, in order to shed light on internal aspects of language, collects data on the perceptions of language speakers and listeners, as well as on memory, a crucial mechanism in reading and understanding language. What the author means by this is that the everyday act of reading a sentence, which on the surface may seem simple and very quick, actually involves various mental operations that ensure the transformation of symbolic codes governed by agreed-upon rules—the letters—into meaningful information that directs thoughts and even actions; in other words, visual information is transformed into linguistic information.

Given the complexity of linguistic phenomena, it is necessary to separate investigations into comprehension from those that focus on language production. This distinction, according to Leitão (2008), is necessary because the nature of the phenomena is different. From the outset, research into

the biological nature of language and its location in the brain has drawn on studies of patients with language disorders. These can range from “production disorders without significant impairment in comprehension, as in the case of aphasias with lesions in Broca’s area, to comprehension disorders without significant impairment in production, as in the case of aphasias with lesions in Wernicke’s area” (Leitão, 2008, p. 222). Another point worth mentioning is the imbalance in research design between these two areas, resulting in a vast number of studies on comprehension at the expense of language production, which is due to the methodological advantages and ease of conducting studies on the former.

That said, we will discuss the methodological framework employed in Experimental Psycholinguistics, which can be divided into two types, as shown in the following excerpt:

Methods that provide data on participants’ reaction times during the course of linguistic processing, such as self-paced reading, are online methods. In contrast, methods that provide data on participants’ behavior in response to previously processed linguistic stimuli, such as acceptability judgments, are referred to as offline methods. Thus, this classification distinguishes between methods that investigate participants’ behavior at the exact moment a linguistic unit is processed (online methods) and those that investigate behavior after such processing (offline methods). (Sá and Oliveira, 2022, p. 8)

Thus, it is understood that, based on two experimental approaches, online and offline, different techniques can be employed, depending on the researcher’s objective. Online methods provide information at the exact moment of sentence or word processing, for example; offline methods, on the other hand, allow for the extraction of data relating to a moment after processing, when the individual has had time to reflect on the experimental set presented.

The main techniques used among online and offline methods are: self-paced/self-monitored reading, acceptability judgment, eye tracking, and the electroencephalogram (EEG). For each of these, control of the experimental set is necessary in various aspects, such as quantity and type, in addition to standardized screening of participants, so that the primary variables influencing the tested phenomenon are those that have been previously controlled.

Given this, psycholinguistic studies provide methodological tools and a solid theoretical foundation that allow researchers to investigate human language processing, both in individuals with

adequate functioning of mental linguistic functions and in those with language disorders, helping to map the characteristics and aspects that can alter individuals' relationship with language.

3.1 The Relationship Between Psycholinguistics and Language Disorders

Following the convergence between generative theory, led by Chomsky, and modern psychology, it became possible to study the internal aspects of human language processing. While maintaining an emphasis on the study of linguistic competence, psycholinguistic research began to investigate language performance. Over the years, the field has grown in terms of the volume of research conducted and in its interfaces with different lines of research aimed at mapping language phenomena.

According to Maia (2015), there has been an increase in the contribution of psycholinguistic studies to expanding knowledge about language from different angles. Among the best-known interfaces, the author cites sentence processing, computational grammar, anaphoric processing, word processing, language acquisition, language production, language disorders, literacy, reading, grammatical description, second language processing, neuroscience, and cognitive neuroscience. Given the variety of fields that share scientific interests with psycholinguistics, we highlight experimental research on language disorders.

First, it is important to note that much of what is known about the biological aspects of language has come from medical research, particularly with aphasic patients. For this reason, studies involving language disorders provide insight into the structure of the human brain and help identify areas and functions related to language. Because language is a complex phenomenon involving various mechanisms, such as memory and attention, for example, research is conducted with caution, analyzing each aspect and relating it to overall performance, as we see in the following excerpt.

An aphasic individual exhibits a dissociation among the symptoms of language disorders; for example, they may or may not show varying degrees of impairment in certain areas such as auditory and visual comprehension, verbal fluency, reading, writing, and naming; they may or may not exhibit paraphasia (substitutions of words or their morphemes or phonemes), anomia (difficulty or inability to name

objects), or speech apraxia (a neurological disorder that causes difficulty in executing the precise movements and gestures necessary for speech). Due to this dissociation, one can infer how processing occurs at each of the linguistic levels (syntax, semantics, discourse, etc.) and relate each type of processing to the brain areas responsible for them, since when an area is affected—as in the case of lesions causing aphasia—the fact that they are affected may lead to a specific type of language disorder. (Hübner, 2015, pp. 102–103)

According to Hübner (2015), each linguistic level may be associated with a different area of the brain, allowing for a detailed understanding of each type of aphasia. In this regard, psycholinguistic studies focus on identifying possible patterns of brain/mental organization in language production and comprehension, even though there are many individual differences among subjects.

As a framework for conducting an experimental study, the researcher cites the subdivisions of aphasia types, identifying three categories: “expressive (greater difficulties in speech and writing production, as in Broca’s aphasia), receptive (greater difficulties in oral and written comprehension, as in Wernicke’s aphasia), and mixed (difficulties in both expression and comprehension, at similar levels)” (Hübner, 2015, p. 103). This distinction is fundamental, since there are many manifestations of aphasia, each with distinct characteristics.

In addition, certain manifestations among aphasic patients can be highlighted, such as: “paraphrases, anomia, stereotypies, perseverations, neologisms, circumlocutions, agrammatisms, and reductions or omissions” (Hübner, 2015, p. 103). Based on the identification of these manifestations, which can occur at the word, sentence, or even discourse level, the aim is to map them and propose recovery strategies so that affected individuals can improve their communication skills and quality of life.

From the perspective of experimental psycholinguistics, linguistic phenomena are studied using experimental techniques designed to gather data on the processing of words and sentences, employing both online and offline methods, as mentioned earlier. According to the researcher, the experimental techniques most commonly used with aphasic patients are electromagnetic functional neuroimaging (EEG), hemodynamic functional neuroimaging techniques (functional magnetic resonance imaging), and transcranial magnetic stimulation. These experimental techniques can also be combined, depending on the objectives of each study, which ensures a greater amount of information about the phenomenon under investigation.

Hübner (2015) emphasizes the importance of multidisciplinary work, enabling cooperation among different professionals to better understand language processing in aphasic patients. Preliminary questionnaires can be helpful in filtering information that may serve as a variable in the investigation, such as reading habits and even whether the individual is bilingual. In this regard, the author advocates for a holistic view of the human being, recognizing that various factors can influence test results, including health habits, hygiene, occupation, and educational background. In other words, it is not enough to focus solely on the linguistic aspect; rather, a range of factors must be considered to obtain reliable results.

Based on these assumptions, it is possible to understand how Experimental Psycholinguistics has been applied to the investigation of language disorders, as will be discussed in the following subsection.

3.2 Studies on Language Disorders within the Field of Experimental Psycholinguistics

This study is a theoretical-analytical literature review. To construct the corpus, we selected studies published between 2010 and 2023, based on their relevance to the field of Experimental Psycholinguistics and studies on language disorders. The studies analyzed were identified in recognized academic databases, such as SciELO, PePSIC, and institutional journal portals.

It should be noted, however, that the objective of this study was not to conduct an exhaustive survey of the literature in the field, but rather to select studies that highlight the contributions of Experimental Psycholinguistics to the understanding of various language disorders, such as stuttering, Alzheimer's disease, and dyslexia. In this regard, the works of Mendes *et al.* (2010), Alves *et al.* (2021), and Correia *et al.* (2023) stand out, as their analyses highlight the diversity of approaches and methodologies employed in the investigation of linguistic processes.

We will begin with a study titled *Dyslexia and Syntactic Processing*, conducted by Mendes *et al.* (2010). The main objective was to examine, at the syntactic level, how dyslexic subjects process language, particularly in relation to syntactic apposition and subject-verb agreement in sentences containing a restrictive adjective clause. In this regard, the study's target population consisted of dyslexic children (target group) and non-dyslexic children (control group).

Dyslexia is a reading disorder; therefore, the motivation for the research was based on the fact that “dyslexic individuals have deficits in the phonological route of reading, which can lead to agreement errors in reading processing” (Mendes *et al.*, 2010, p. 48). This deficit is explained by problems in decoding reading in working memory, leading to an overload that increases the time taken to read a sentence. Furthermore, the number of studies on sentence processing with dyslexic subjects is limited, highlighting the need to explore how syntactic processing occurs through online psycholinguistic experiments, which can provide data on the exact moment processing takes place.

Sixteen children, all proficient readers aged 9 to 11 and enrolled in elementary school in Rio de Janeiro, participated in the experimental task. They were divided into two groups: dyslexic (target group) and non-dyslexic (control group) and completed a non-cumulative self-monitored reading task consisting of sentences, with a comprehension question at the end. In this type of task, the sentences are divided into segments that are presented one at a time to the participant, such that each new segment replaces the previous one. Thus, in the task design, the independent variables were defined as follows: “Factor 1: Normal/dyslexic group; Factor 2: Singular/plural agreement; and Factor 3: Local/non-local OR apposition” (Mendes *et al.*, 2010, p. 49). On the other hand, the dependent variables were the reading times of the critical segment (measured online) and the accuracy rate on the control question (measured offline). The comparison between these different measures allows the researcher to observe the phenomenon from different angles, understanding linguistic processing at different stages.

Following statistical analysis of the data, the results indicated that “there is a difference between the reading of dyslexic and non-dyslexic children in the distinct phases of reading processing: reflexive and non-reflexive processing” (Mendes *et al.*, 2010, p. 56). In this regard, in addition to rapid sensitivity to the agreement of relative clauses attached to complex noun phrases, dyslexic children exhibited longer reading times compared to children in the control group. However, these differences between the groups were not observed in offline processing, as indicated by the accuracy rate on the control question. Thus, Mendes *et al.* (2010) reinforce the idea that, in a school setting, dyslexic students Regarding the school context of dyslexics, this research reinforces the idea that dyslexics do not exhibit comprehension difficulties when reading texts; however, there will be a significant delay in performing this task.

Another language disorder was investigated by Alves et al. (2021), leading to the publication of the study *Coreferential Processing in Older Adults with and without Alzheimer's Disease*, which sought, through two self-monitored reading experiments, to compare older adults with and without Alzheimer's disease (AD) in terms of sentence-reading processing. To better understand the study's target population, the authors define AD as "a neurodegenerative disorder [...] a complex multifactorial disease, with impairments involving cognition, memory, and behavior" (Alves et al., 2021, p. 2), and outline the main diagnostic methods.

Alves et al. (2021) discuss the language changes that a person with dementia may exhibit, ranging from milder cases, where lexical, semantic, and pragmatic functions are affected, to more severe cases, in which there are changes in the articulatory and syntactic domains in the final stage of the disease. The authors also highlight the role of memory in cases of AD, since language production, comprehension, and other cognitive mechanisms are all related to memory.

In this context, experimental studies of language processing in patients with AD are essential for understanding the complexity of language from a neurological perspective. Among the phenomena that characterize language, researchers focus on the anaphoric processing of sentences, considering discursive prominence and working memory as variables that may influence this processing. These variables can interfere with anaphoric resolution, which can occur in different forms: pronoun, repeated noun, and empty category. Differences in anaphor processing can be explained by established theories such as Centrality Theory (Gordon et al., 1995) and the Information Load Hypothesis (Almor, 1999). In Centrality Theory, one of the most frequently reported effects in studies on anaphora is the Repeated Noun Penalty, which posits longer processing times for repeated nouns compared to full pronouns.

In light of the theoretical framework mentioned above, the authors argue that "the study of anaphoric processing in patients with AD may lead to advances in investigating which linguistic components are impaired and how they relate to cognitive aspects" (Alves et al., 202, p. 3). To this end, the researchers conducted two psycholinguistic experiments with older adults over 60 years of age, who had completed at least elementary school, and divided them into two groups: six older adults in the ISA group, who did not have Alzheimer's disease, and twelve older adults in the IDA group, who had the disease. Participants underwent a Mini-Mental State Examination that took into account their reported level of education.

Two online experiments were administered using the Psyscope software, employing the self-monitored reading technique, both with 8 experimental sentences. The first task aimed to compare the processing of lexical pronouns with that of repeated nouns in the object position. The second task, on the other hand, aimed to analyze coreferential sentences containing hypernyms and hyponyms in relation to their respective antecedents in the direct object position. Both tasks were administered to native speakers of Brazilian Portuguese. Thus, the dependent variables were the reading time for the anaphors and the accuracy rate on the control question.

The statistical results indicated that older adults with early-stage AD “showed the opposite result compared to older adults without neurological changes, demonstrating a faster recovery of repeated nouns than of pronouns, which confirms the hypothesis of working memory impairment, common in older adults with AD” (Alves *et al.*, 2021, p. 8). Furthermore, the Information Load Hypothesis (Almor, 1999) was confirmed only in older adults from the ISA group, who did not have Alzheimer’s disease and preferred anaphors with pronouns and hypernyms.

Finally, we will address stuttering as one of the types of language disorders, presenting one of the most recent studies in the field, conducted by Correia *et al.* (2023), titled *Word Class Processing in Adults with and without Stuttering: A Study on the Testability of the Integrated Theory of Fluency*. The study brought together the fields of Linguistics, Psycholinguistics, and Neurolinguistics with the aim of testing the principles of the Integrated Theory of Fluency, which posits verbal fluency as a linguistic ability.

The connection to speech production arises because stuttering is a fluency disorder that emerges as early as childhood. In this regard, the researchers discuss linguistic aspects of stuttering in light of the Integrated Fluency Theory proposed by Correia (2020), and conducted experiments with the aim of “testing the fundamental proposition of the Integrated Theory of Fluency through the investigation of event-related potentials (ERPs) elicited by open-class and closed-class words in adults with and without stuttering” (Correia *et al.*, 2023, p. 17). In other words, the research focused on understanding the characteristics that make the brain fluent and on identifying the neural processes involved in this neurophysiological dynamic.

Correia *et al.* (2023) conducted a mixed-methods study involving approximately 14 adults with stuttering (experimental group - AQQ) and 14 fluent adults (control group - AF), who were on average

24.6 years old, all native speakers of Brazilian Portuguese. The subjects underwent a preliminary assessment with speech-language pathologists specializing in fluency, during which information regarding each participant's medical history was verified.

Participants performed a silent reading task involving sentences, while their brain electrical activity was recorded using electroencephalography. The sentences appeared on the computer screen, and at the end of reading each one, the participant had to answer the following question: "Is this a good sentence in Portuguese?", by pressing the "yes" or "no" button. The task took an average of 50 to 60 minutes to complete.

Based on the online and offline measurements, the researchers statistically analyzed the data and obtained significant results regarding stuttering in adults. Initially, they were able to confirm that the Integrated Theory of Fluency has high potential for explaining stuttering, since verbal fluency "depends on optimal processes of identifying and accessing formal features, particularly the categorical feature; and the onset of stuttering may be related to difficulties in representing formal features in the mental lexicon and/or in accessing them during online computation" (Correia *et al.*, 2023, p. 14).

Furthermore, participants in the AQQ group (the experimental group) exhibited patterns different from those in the AF group, which resulted in difficulties in judging the plausibility of the experimental sentences. Thus, the researchers were able to identify a neural biomarker for stuttering, the P3a, indicating neural alterations as early as childhood. This is because the main difference between adults with and without stuttering was the brain electrical activity underlying the process of categorical identification of words. The study confirms what was proposed by Correia (2020), reinforcing the need for continued research exploring further aspects of stuttering.

The analyses conducted highlight the relevance of the Experimental Psycholinguistic approach to understanding language disorders, as summarized below.

Concluding Remarks

The aim of this study was to analyze the contributions of Experimental Psycholinguistics to the understanding of language disorders, based on the integration of theoretical foundations and empirical

evidence. By integrating theoretical foundations and empirical evidence, we sought to highlight the relevance of experimental methods in investigating linguistic processes in typical and atypical contexts.

Analysis of the selected studies revealed that, although they investigate different disorders, such as dyslexia, Alzheimer's disease, and stuttering, all point to specific alterations in linguistic processing. In the case of dyslexia, it was found that difficulties are concentrated in online processing, evidenced by longer reading times, without significant impairment in comprehension. Regarding Alzheimer's disease, the findings indicate impairments related to working memory, with an impact on coreferential processing. In the case of stuttering, the results suggest alterations in lexical access and representation processes, in addition to the identification of possible neural markers associated with the phenomenon.

There is a clear tendency to integrate Psycholinguistics with other fields of study, such as Linguistics and Neurolinguistics, given that language disorders affect different brain mechanisms. This interdisciplinary connection allows for a broader exploration of the complexity of disruptions in linguistic processes and supports the development of appropriate interventions that can improve patients' quality of life, enabling them to achieve functional communication in society.

Regarding the techniques employed, the importance of Experimental Psycholinguistics is evident as a field capable of articulating different levels of analysis, through the use of tasks such as self-paced reading and the recording of brain electrical activity via electroencephalography (EEG). In this sense, the contribution of this approach goes beyond the theoretical domain, as it enables the identification of patterns of language processing and their variations under different conditions, whether during real-time processing or in subsequent stages.

Finally, it is important to emphasize the need to expand research exploring the interface between Experimental Psycholinguistics and language disorders, particularly through the diversification of methodological techniques and the investigation of new linguistic phenomena, thereby contributing to the advancement of the field and to a more comprehensive understanding of the processes involved in human language.

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Acknowledgement: Not applicable.
Financing: Not applicable.
Conflicts of interest: The authors certify that they have no commercial or associative interest that represents a conflict of interest in relation to the manuscript.
Ethical Approval: Not applicable.
Contributor Roles: FERREIRA, Jullyane Glaicy da Costa Conceptualization, Writing-original draft, Writing-review & editing. FERRARI NETO, José Conceptualization, Writing-original draft, Writing-review & editing.

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