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Coreferential processing in elderly with and without Alzheimer's disease

Processamento correferencial em idosos com e sem doença de Alzheimer

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Keywords

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Language
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ABSTRACT

Purpose: To compare coreferential processing in elderly people with and without Alzheimer's disease in Brazilian Portuguese. **Methods:** Twelve elderly people without Alzheimer's (EA) and six elderly people with Alzheimer's disease (EWA) participated in the study. The Mini-Mental State Examination was used for cognitive screening of participants. Two experiments were performed using the self-monitored reading technique to analyze coreference processing. Each contained eight experimental phrases and 24 distracting phrases, one of them using repeated pronouns and names and the other using hyponyms and hypernyms. After reading, questions were asked related to the content of the sentences. The main variable of interest was reading time, measured after the presentation of anaphoric resuming. **Results:** In the first experiment, there were statistically significant results. The EA group processed the pronouns more quickly than repeated names. The volunteers of the EWA group were quicker in resuming repeated names. In the second experiment, the results show that the EA group showed preference for hypernyms in anaphoric resumption, whereas the EWA group did not present significant differences between conditions. **Conclusion**: Elderly people without pathology processed pronouns and hypernyms more quickly compared to retrievals with repeated names and hyponyms, respectively, due to the smaller amount of semantic traits necessary to identify the antecedents in those conditions, as well as syntactic and discursive prominence. Elderly people with AD read names more readily than pronouns. There was no difference in anaphoric processing involving hyponyms and hypernyms, which may result from impaired working memory.

Descritores

Doença de Alzheimer
Linguagem
Fonoaudiologia
Psicolinguística
Semântica

RESUMO

Objetivo: Comparar o processamento correferencial, em idosos com e sem a Doença de Alzheimer, no Português Brasileiro. **Método:** Participaram 12 idosos sem Alzheimer (ISA), e 06 idosos com a Doença de Alzheimer (IDA). O Mini-Exame do Estado Mental foi utilizado para triagem cognitiva dos participantes. Dois experimentos foram realizados utilizando a técnica de leitura automonitorada para analisar o processamento da correferência, cada um contendo oito frases experimentais e 24 frases distratoras, um deles utilizou pronomes e nomes repetidos, já o outro utilizou hipônimos e hiperônimos. Após a leitura, foram realizadas perguntas relacionadas ao conteúdo das frases. A principal variável de interesse foi o tempo de leitura aferido após a apresentação das retomadas anafóricas. **Resultados:** No primeiro experimento, foram encontrados resultados estatisticamente significantes, no grupo ISA os pronomes foram processados mais rapidamente do que nomes repetidos, e no grupo IDA, os voluntários foram mais rápidos na retomada do nome repetido. No segundo experimento, os resultados demonstraram que o grupo ISA apresentou preferência, na retomada anafórica, pelos hiperônimos, já o grupo IDA não apresentou diferenças significativas entre as condições. **Conclusão:** Os idosos sem patologia processaram mais rapidamente pronomes e hiperônimos, quando comparados a retomadas com nomes repetidos e hipônimos, respectivamente, pela menor quantidade de traços semânticos necessários para identificar os antecedentes naquelas condições, assim como pela proeminência sintática e discursiva. Nos idosos com DA, os nomes foram lidos mais prontamente que pronomes, e não houve diferença no processamento anafórico envolvendo hipônimos e hiperônimos, podendo decorrer do comprometimento na memória de trabalho.

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INTRODUCTION

Alzheimer's disease (AD) is a neurodegenerative disease. Currently, it represents the most common form of dementia in the elderly. It is characterized as a complex multifactorial disease, with impairments that involve cognition, memory, and behavior. The clinical diagnosis of dementia syndrome considers the patient's history, neuropsychological tests, imaging tests, and longitudinal evaluation of symptoms using a clinical phenotype combined with information from biomarkers. There are challenges associated with the diagnostic process and the development of effective treatments to reverse this clinical condition[1].

Elderly people with AD can present several cognitive changes, such as deficits in episodic memory, working memory, and executive function. These cognitive deficits begin early during a period of mild cognitive impairment, which is the stage between the expected cognitive decline of normal aging and the most severe decline observed in AD, and appear to be a sign of progression to the disease[2].

Language deficits usually become visible from the initial stage of the disease. The different stages show specific patterns of linguistic difficulties, affecting different domains differently. Deficiencies in lexical, semantic, and pragmatic functions of language are typically present in mild AD since they depend more on cognition. The articulatory and syntactic domains of language production remain intact until the final stages of the disease. Regarding syntax, losses involve the reduction of syntactic complexity and agrammatism. In such individuals, language and memory are closely related, since linguistic functioning requires memory functions, so that difficulties in speech production, understanding, and memory functions overlap[3].

An important aspect to be considered in these individuals is linguistic processing. It can be understood as the process of understanding and producing verbal language in our daily lives. In its complexity, it requires a set of mental procedures. Regardless of whether the route is oral or written, cognitive skills related to language are at work[4].

Anaphoric processing involves the use of anaphors, which are linguistic expressions whose meaning depends on an earlier part of the sentence or speech, called an antecedent. As they commonly refer to the same element as the statement, anaphor and antecedent are considered coreferential[4]. The reference to an element previously mentioned in the sentence can be established through the use of anaphoric retrieval, that is, expressions that establish coreference with their previously introduced antecedent. Therefore, discursive prominence and working memory affect the processing of anaphoric expressions. Anaphoric retrieval requires a comparison process to identify the antecedent, a process that is highly sensitive to the relevance of different elements in the sentence. The effects of discursive prominence in the resolution of the reference are universally reflected in human language by the distribution of anaphoric forms according to the salience of their referents[5].

One of the central issues regarding anaphoric processing is the various forms of anaphoric retrievals used in languages and the possibility that some of these forms are more efficient than others in terms of processing and cost of working memory. Retrievals can, for example, present themselves as pronouns, repeated names, empty categories, or even through nominal symbols (NS) that can establish a retrieval from a relationship of hypernymy or hyponymy with its antecedent. In this perspective, two theoretical conceptions are important to this discussion: the centralization theory[6] and the informational load hypothesis[7].

Centralization theory has as one of its principles the efficiency of pronouns in establishing correlations with structurally and discursively more prominent entities[6]. The information load hypothesis also proposes that anaphoric retrieval are processed and read more quickly when its antecedent is prominent in the discourse (in the position of the subject).

The information load hypothesis, pragmatically proposed to analyze the use of different types of anaphoric retrieval, relates the cost of processing an anaphoric retrieval with an information load measurement, which is associated with the semantic distance between the antecedent and the retrieval, in addition to taking into account syntactic prominence. Therefore, the more prominent the antecedent, the less functionally adequate it is to use a repeated name and, therefore, one would opt for a pronoun that would thus have a lower information load than the repeated names in this context[7].

Studies have shown that, considering adults without pathologies[8-11] and children[12], pronouns are more efficient than names repeated in several languages and that hypernyms are more efficient than hyponyms[5] in individuals without pathologies in certain syntactic-discursive circumstances. The processing of hypernyms is also facilitated in relation to hyponyms in Brazilian Portuguese in healthy adults[13]. There are divergent results in the repeated name penalty in Brazilian Portuguese reported by research with adults without pathologies. Some studies have systematically reported the occurrence of this phenomenon. Pronouns are processed more quickly than repeated names either in the subject position or in the object position[3,13-16]. However, there are studies that have not found such differences[17-20].

Regarding this divergence, a study reported that depending on methodological and linguistic factors, such as how to measure reading time, whether only the retrieval or the entire sentence and whether there is one or more of a potential human antecedent in the tested stimuli, there may or not be repeated name penalty, that is, the phenomenon seems to be multifactorial. According to the arrangement between the controlled factors and the stimuli, the results could go in one direction or the other[21]. Therefore, in this research, we adopted a perspective between stimuli and factors previously adopted[3,15], thus ensuring control of factors that have produced results indicating the presence of repeated name penalty in adults without no type of language disorder or deficit.

The little scientific production on coreferential processing in individuals with neurological disorders was one of the motivating aspects for researching the topic in elderly people with Alzheimer's. Based on this motivation, the research in English was a starting point for the study of coreferential processing[5,7], which has a similar research group, i.e., elderly people with Alzheimer's disease. These studies used a methodology called cross-modal, a procedure that uses a combination of more

than one sensory modality. They have shown that, although the speech of patients with Alzheimer's is characterized by a frequent and inappropriate use of pronouns, the use of repeated names become more functional due to the deficit in working memory that influences the coreferential processing in reading. The experimental results in patients with AD have shown that these subjects had more problems in establishing the coreference when anaphoric retrievals were made with pronouns than when they were made with repeated names.

In this sense, the study of anaphoric processing in patients with AD may allow advances in the investigation of which components are impaired in linguistic terms and what relationship they establish with cognitive aspects. Therefore, this study aims to analyze and compare language processing through co-reference in elderly people with and without Alzheimer's disease speakers of Brazilian Portuguese.

METHODS

This study is quantitative, experimental, and transversal. This investigation sought to conduct psycholinguistic experiments aiming to obtain empirical evidence from experimental techniques and focusing on the processing of coreference in the reading of coordinated sentences. The study was conducted in a Long-Stay Institution and in the Laboratory of Linguistic Processing, linked to the Postgraduate Program in Linguistics of the *Universidade Federal da Paraíba*, both located in the municipality of João Pessoa-PB.

Sample

To be included in the research, volunteers should be chronologically aged 60 years or older with a level of education of at least complete elementary school because participants must be able to fluently read the experimental and distracting phrases. They should not be or not have been affected by any neurological, motor, or psychiatric disease that could interfere in the results, since the research seeks analysis with healthy elderly (EA) and elderly with AD (EWA). Finally, the elderly should not be affected by visual and/or hearing impairment that would interfere with the understanding of the performance and/or reading the experimental phrases. In addition, when submitted to the Mini-Mental State Examination (MMSE)[22], as a cognitive screening test - considering the cutoff points according to educational level[23] - the elderly should present a score of good cognitive performance in the EA group and mild cognitive decline in the EWA group, which makes them able to understand and participate in experimental tasks. In the case of the EA group, the volunteers should also present a diagnosis of initial Alzheimer's disease in their medical records.

The mean of the MMSE scores was 26.5 in the EA group and 18.0 in the EWA group. The mean age of the participants was 72.8 years. Considering education levels, most participants had completed high school (44.44%), and the rest completed elementary school (27.78%) and higher education (27.78%).

All participants were instructed as for the research objectives and methods of participation, in addition to signing an Informed Consent. To start data collection, it was necessary the approval of the Research Ethics Committee of our institution through the approval certificate no. 665/10 and cover page no. 384581.

Considering the eligibility criteria, six elderly people with a diagnostic hypothesis of Alzheimer's disease at the initial phase and 12 elderly people without neurological pathologies were included in the study. Six were institutionalized and six were non-institutionalized. In view of the clinical, behavioral, and socialization conditions of the elderly in long-stay institutions, the experiments were applied to both groups of elderly people (institutionalized and non-institutionalized). However, it is important to emphasize in advance that regardless of whether the elderly in the control group were institutionalized or not, they were analyzed together, as we found that the response times in the experiment did not show statistically significant differences.

Instruments

The research was conducted through two psycholinguistic experiments. The first experiment aimed to compare the processing of lexical pronouns with that of the names repeated in an object position in Brazilian Portuguese, both with retrievals of antecedents also in the object position. Through this experiment, we sought to test the hypothesis that pronouns in non-prominent positions, such as that of direct object in Brazilian Portuguese, but in the same position and syntactic function as the antecedent (structural parallelism), establish a coreference in a natural and efficient way with an antecedent also in the object position.

Based on a study previously conducted on Brazilian Portuguese[4], in the current experiment, the experimental phrases were reapplied to analyze the coreferential processing of elderly people with and without Alzheimer's disease under the conditions of pronoun retrieval (PR) and repeated name (RN) in the object position. We sought to measure the recovery time of elderly with and without AD in both conditions based on the independent variables group and type of retrieval, and on the dependent variables right answers index and reading time of critical segment.

The material consisted of eight experimental phrases and 24 distracting phrases presented to all research participants. The experimental set was composed of two conditions, one with the retrieval being a pronoun (a) and the other with a repeated name (b), as the example below shows.

a. The detectives/ investigated/ **Isa/** in Italy/ but/ did not/ track / **her/** in/ Japan.

b. The detectives/ investigated/ **Isa/** in Italy/ but/ did not/ track / **Isa/** in/ Japan.

In the second experiment, the processing of the coreference established from hypernymy noun phrases and hyponym noun phrases, in relation to their respective antecedents in a direct object position, was analyzed. We sought to prove the hypothesis that hypernyms are processed more quickly than hyponyms in BP by elderly people without neurological changes, as well as compare these results with the performance obtained by elderly people with Alzheimer's.

The following variables were manipulated: the independent variable was the type of noun phrase used in anaphoric retrieval (hyponym or hypernym), and the dependent variables were reading time, measured after the presentation of anaphoric retrievals (segment eight) and right answers rate in answers to the questions presented at the end of sentence reading. Eight experimental phrases and 24 distracting phrases were read. They were reapplied from a study previously conducted in Portuguese[4], and randomized in both conditions, one with the retrieval being a hyponym (c) and the other a hypernym (d), as explained below.

c. The biologists/ spotted/ **a reptile**/ in/ river/ but then/ scared/ **the alligator**/ in/ the bank.

d. The biologists/ spotted/ **a reptile**/ in/ river/ but then/ scared/ **the animal**/ in/ the bank.

In both experiments, after the fragmented reading of experimental phrases, a final question arose related to its content. It allowed a possible analysis on the effective establishment of a coreference between the retrievals and the antecedents of phrases.

Q: c. Did the biologists see the alligator?

d. Did the biologists see the animal?

Procedures

Initially, the test for cognitive screening of elderly volunteers was performed using the MMSE test of language and memory. After this step, the participants underwent two online experiments using the software *Psyscope* for Mac[24] to investigate in action cognitive processes in the understanding of words and phrases. In this sense, psycholinguistic experiments were conducted using the self-monitored reading technique.

The self-monitored reading technique is a technique in which the sentence is fragmented into several segments and the participant must control his own reading time for each segment, which appears on the computer screen, by pressing the indicated keys. The time is also recorded by the computer itself. At the beginning of each experimental exercise, the elderly were subjected to training using phrases that were not in the experiment to assess understanding in relation to the task that should be performed, as well as to perceive the existence of some difficulty that could make participation in the activity impossible. In this study, the text was divided into ten segments presented one at a time on a computer screen. The participant would have to press a key to read the next segment. The measurement of main interest was reading time of the critical segment of anaphoric retrieval (segment eight), since from that time on, the effects of independent variables can be evaluated.

Analysis

For the interpretation of data, a descriptive and inferential statistical analysis was performed to verify the studied variables making use of tests for a comparative analysis between groups (elderly without and with Alzheimer's) considering the time of reading in the conditions (repeated name, repeated pronoun, hypernym, and hyponym) and the right answers rate for answers to final questions. Statistical analysis was performed using the *Statistical Package for Social Sciences* (SPSS) 20.0 and Action 2.4. Normality of the data was confirmed through a Shapiro-Wilk test, ANOVA, T test, and Chi-square tests (X^2), considering a significance level of $p<0.05$.

RESULTS

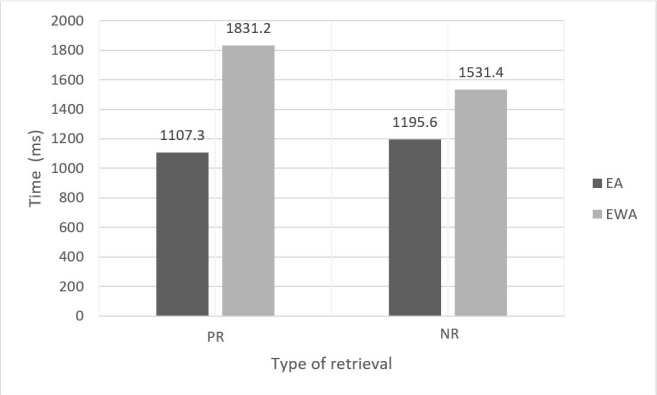
Figure 1 shows the mean response times in milliseconds by which the elderly in the control group (EA) and the elderly in the experimental group (EWA) read the critical segment under the experimental conditions with pronoun (PR) or with repeated name (RN), measured by self-monitored reading technique.

The statistical analysis was significant for a main effect of group [ANOVA $F(3.68) = 56.6$ $p<0.00000$], and effects of interaction between group and type of retrieval [ANOVA $F(3.68) = 22.37$ $p<0.00000$]. On the other hand, there was no main effect of type of recovery [ANOVA $F(3.68)=0.07$ $p=0.78$].

To observe whether there was an effect of type of retrieval per group, a statistical analysis of each group was conducted in isolation. Based on this analysis, the control group showed a significant difference in the means of PR and RN conditions. The reading time of retrievals with pronouns was faster than that of retrievals of repeated names, as T test shows [$T(11) = 3.36$, $p<0.002$].

In the experimental group of elderly people with AD (EWA), in contrast to the control group, the reading times of retrieval with repeated names were significantly faster than the reading times of retrieval with pronouns [$T(5) = 2.199$, $p=0.0381$].

Table 1 shows the number of right answers and errors in the final response of experimental phrases, which aim to confirm whether individuals made coreferences during the reading of experimental phrases, which had a pronoun or a name repeated in the critical segment. It is important to note that the absolute value of number of responses becomes different because it has a control group with twice the number of individuals in relation to the experimental group.



Caption: EA = Elderly without Alzheimer's disease; EWA = Elderly with Alzheimer's disease; PR = Pronoun repetition; NR = Name repetition

Figure 1. Reading times of anaphoric retrieval of elderly with and without Alzheimer's disease in experiment 1

Table 1. Answers to interpretative questions by elderly without and with Alzheimer's disease in experiment 1

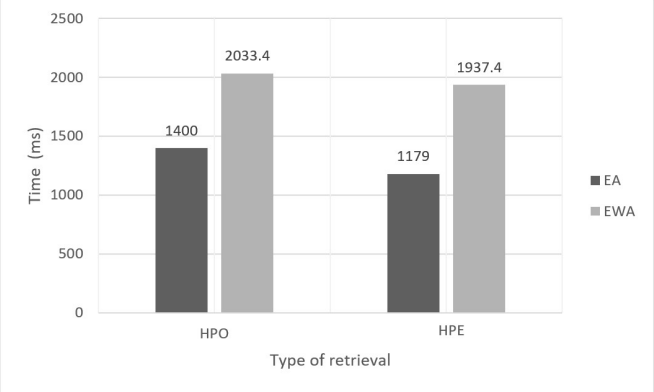
ANSWER	EA GROUP	EWA GROUP	P-value
Right	95 (98.96%)	41 (85.42%)	**p= 0.9**
Wrong	01 (1.04%)	07(14.58%)	
Total	96 (100%)	48 (100%)	

Intergroup comparisons, Chi-square test; p<0.05
Caption: EA = Elderly without Alzheimer's disease; EWA = Elderly with Alzheimer's disease

Table 2. Answers to interpretative questions by elderly without and with Alzheimer's disease in experiment 2

ANSWER	EA GROUP	EWA GROUP	P-value
Right	72 (75%)	34 (70.83%)	**p= 0.4**
Wrong	24 (25%)	14 (29.17%)	
Total	96 (100%)	48 (100%)	

Intergroup comparisons, Chi-square test; p<0.05
Caption: EA = Elderly without Alzheimer's disease; EWA = Elderly with Alzheimer's disease



Caption: EA = Elderly without Alzheimer's disease; EWA = Elderly with Alzheimer's disease; HPO = Hyponym; HPE = Hypernym
Figure 2. Reading times of anaphoric retrieval of elderly with and without Alzheimer's disease in experiment 2

According to statistical analysis using the Chi-square test, there was no significance in the response index of the variable group (X^2= 0.016, p=0.9). In view of the number of right answers and errors of the researched groups regardless of the presence or absence of the neurological clinical condition (AD), the volunteers showed a good performance in answers. This demonstrates that probably the elderly performed the coreference, even with different reading times between the PR and RN conditions. As in the MMSE, the offline task captured a good performance of the elderly with and without AD in activities that involve linguistic aspects. However, this did not happen with activities that involved cognitive aspects.

The elderly with Alzheimer's disease showed a greater impairment in the domain related to working memory in the MMSE compared to those without the pathology. On examination, there was a significant effect between groups in all items associated with cognitive aspects, including the working memory component assessed by immediate memory tests [ANOVA F(0.08) = 21.3, p<0.01], with lower averages for the EWA group (2.3) compared to the EA group (3.0).

In relation to experiment 2, Figure 2 shows the analysis of means of recorded times of the critical segment under the experimental conditions of type of retrieval (hyponym or hypernym). The significant result was a group main effect [ANOVA F(3.68) = 25.09, p<0.05], with no main retrieval effects [ANOVA F(3.68) = 1.75, p<0.18], nor effects of interaction between the variable group and type of retrieval [ANOVA F(3.68) = 0.19, p<0.65].

However, Figure 2 also shows that when analyzing each investigated group in isolation, the difference in the mean reading times of the conditions HPO and HPE in the volunteers of the control group (EA) were the expected, that is, when the retrieval was a superordinate noun (hypernym) in relation to the antecedent, the reading times were significantly shorter than the reading times with the retrieval by hyponyms, thus demonstrating that hypernyms are read more quickly than hyponyms when establishing coreferences [T(11) = 2.0786, p<0.05].

The reading times of the HPE and HPO conditions, recorded in elderly with AD, unlike the control group, did not obtain a significant difference in the performance of the retrieval time between HPO and HPE, according to data obtained by T test [T(5) = 0.341, p<0.43]. The elderly with AD, in addition to having a high mean recovery time, were not sensitive to any of the conditions.

Table 2 shows the index of right answers and errors in answers to the final questions that appear after the experimental sentences. The objective is to confirm whether the individuals made coreferences or not during the reading of the tested phrases that, in this experiment, presented anaphoric retrieval with hyponyms and hypernyms. This analysis also allows a perception of the participation of semantic aspects in the interpretation of the sentence and in the relation to the anaphoric retrieval.

According to statistical analysis using the Chi-square test, there was no significance in the response index of the variable group (X^2= 0.67, p=0.4). The experimental findings show that regardless of whether the coreference is with a hypernym or a hyponym, participants with AD, when reading experimental phrases, did not show preference for any of the conditions.

DISCUSSION

In this study, starting from the results of the first experiment and considering the values of reading time of anaphoric retrieval of the control group, as in other studies, there was repeated name penalty, as according to the centralization theory[6], which has as one of its principles the efficiency of pronouns in establishing co-referentiality. The same analysis criterion does not apply to what elderly people with AD showed. Unlike the control group, the elderly were quicker to retrieve the repeated name than to retrieve the pronoun. This may be due to changes in working memory, as some studies argue by analyzing individuals with AD[5] and children with attention deficit hyperactivity disorder (ADHD)[25]. The authors argued that these significant differences in anaphoric retrieval, in which the subjects process the repeated name more quickly during reading than the pronoun, are the result of an impaired working memory.

The present study corroborates the findings of several national studies that used a similar methodology[3,13,14]. The elderly in

the control group showed faster reading times of retrieval of antecedents with lexical pronouns compared to reading time means of the retrievals of antecedents with repeated names. Thus, the elderly without language changes incur in repeated name penalty in the object position and not only in the subject position. This contrasts with the centralization theory. Anaphoric retrievals are processed more quickly than their antecedents, even though they are not in focus, contrary to what is indicated by the information load hypothesis and in accordance with the results found by another research previously carried out in Brazilian Portuguese[4].

Diverging from the results found for the control group, the understanding of pronouns in elderly people with AD is compromised by the decrease in the activation of the referent in working memory, making these individuals more efficient in establishing coreference with repeated names. By assuming a direct influence of working memory on this inversion of processing pattern of anaphoric retrieval, we corroborate other studies[5,25] that captured a greater speed in reading times of anaphoric retrieval of repeated names than pronouns in elderly with AD (English as a first language) and in children with ADHD, respectively. In these two pathologies, there are records of difficulties in working memory, as already explained.

During the natural aging process, there is a relative preservation of vocabulary and syntactic processing, but changes in memory may occur. They are present in the use of communicative strategies related to the pragmatic adequacy of the situation present in everyday dialogue. However, it is worth mentioning that such strategies are related to difficulties in accessing the lexicon, as well as difficulties in other cognitive components, whether they are different types of memory, attention, and executive functions. Such same characteristics are observed with more pronounced degrees in individuals with Alzheimer's disease and mild cognitive impairment, especially hesitation and circumlocution. It is possible to argue a direct relationship between this semantic and discursive impairment and working memory[26].

Neurophysiologically, we can expect the influence of deteriorated semantics to change working memory, or in the reverse process, that Alzheimer's disease, by triggering changes in working memory, can interfere with the semantic aspects of the affected subjects. In our results, which have a high value in the number of correct answers to the final questions, there was a possible evidence that the semantic system is preserved at least at the initial stage of the disease. On the other hand, as already mentioned, the elderly with AD presented faster reading times to retrieve repeated names than pronouns, that is, repeated names facilitated the coreferential processing, which is the opposite of what occurs with the control group.

In both cases, as evidenced by the memory test contained in the MMSE, in the individuals with AD there are indications that, due to the impairment in working memory, these elderly people have a greater ease to activate the antecedents related to the respective anaphoric retrievals when they are repeated names, since differently from pronouns, names can reactivate all features related to antecedents.

The results of experiment 2 presented by the elderly in the control group confirm the information load hypothesis, which identifies the phenomenon at the time when the less explicit anaphoric retrievals evoke a more general conceptual representation of the referent, which represents the preference of volunteers without pathology for hypernyms, because hyponyms that have a greater information load make it difficult to establish a coreference, and sometimes they seem to be interpreted as a new discursive entity.

As in research in English[7] and in Brazilian Portuguese[3,13], by investigating subjects without neurological changes the current experimental results also recorded significant differences in the reading time means of retrievals of antecedents with hypernyms compared to the reading time means of retrievals of antecedents with hyponyms.

In the case of elderly people with AD, in addition to taking longer to trigger anaphoric retrieval, there was no statistically significant difference both two conditions (HPO and HPE). In relation to these individuals, it is proven that language suffers a direct influence from the progressive decline in intellectual capacities due to the disease, which extends beyond the semantic-lexical domain, which is in turn believed to be the result of changes in working memory.

In view of the above, we believe that at the initial phase of Alzheimer's disease, the impairment begins in the working memory and that this in turn will interfere with the semantic system at the following phases of the degenerative disease. We sought evidence of this prediction when we analyzed the responses of final sentences of this experiment (offline processing) by the index of right answers that were presented by elderly with AD.

The number of correct answers and errors presented by researched groups clearly shows that regardless of the presence or absence of Alzheimer's disease, the elderly performed well in their responses (offline). Thus, there was the establishment of a correlation between retrieval and precedent at this stage, even though there are differences between the PR and RN conditions in terms of reading times.

Regarding the number of right answers and errors in the responses of the second experiment, the numbers indicate that regardless of whether the coreference is hypernymic or hyponymic, when participating in the offline activity, the elderly established a coreference with the available antecedent. It is important to emphasize that the response rates of the elderly with Alzheimer's disease (at the initial phase) had no significant difference compared to the elderly in the control group, that is, they did not show any problems in understanding the semantic relationships necessary for the establishment of coreferences, different from what occurred in *online* processing measured via reading time of retrievals.

Finally, there were no significant differences between the reading time means of the hyponym and hypernym conditions of elderly with AD. In view of all the results presented, individuals with Alzheimer's disease at the initial phase do not show impairment in aspects of the semantic system, but in working memory. As Alzheimer's disease is a degenerative pathology, this impairment in working memory tends to worsen and consequently to increase the dysfunction of the semantic system.

The absence of a significant difference between the experimental conditions (HPO and HPE) in anaphoric retrieval is due to impairment in working memory. In these cases, the elderly with Alzheimer's disease may need more time to be able to process and relate the semantic traits capable of reactivating the respective antecedents either by hyponyms or hypernyms. This is different from what happened in the results between pronouns and repeated names because the repeated names promote at no additional cost the reactivation of all traits corresponding to the respective antecedents.

In this sense, it is worth presenting the results of a longitudinal study that considered aspects of language to identify an early marker of AD. Lexical recovery was investigated in three language tests (naming, verbal fluency, and written description) and compared between participants with AD and healthy individuals. The results indicated that the group with Alzheimer's showed a progressively greater decline in lexical performance and that lexical recovery deficits in written discourse serve as an early indicator, differentiating the performance between the two groups between seven and nine years before the death of individuals[27].

The authors suggested that impaired attention, executive functions, and working memory can influence word recovery in AD. Since, working memory plays a crucial role, as it provides temporary storage and processing of information necessary to successfully perform tasks. This allows a systematic and effective search for words, flexibility to change a search strategy whenever necessary, and monitoring of lexical recovery processes[27]. In other words, the difficulties presented by these individuals are related to existing memory deficits, which impair access to the lexicon and retention of information in memory during the execution of tasks, and not purely to a semantic difficulty.

Based on the theoretical supports described and the data shown, we also sought to subsidize the clinical area of language by suggesting speech therapy intervention strategies. The first suggestion is that in the tests of language and cognition assessment, an online activity can be performed with the use of anaphors and antecedents, in which individuals who demonstrate a better performance in retrieving pronouns than repeated names may not have an impaired working memory. On the other hand, those who have a preference for repeated names can characterize trends of changes in this aspect.

The second suggestion would be the relationship of results of the first activity with a semantic evaluation activity (understanding short sentences, for example), if the subjects presented, in addition to the preference for repeated names, a low semantic performance. This could be characteristic of an advanced stage of Alzheimer's disease, since individuals with AD at the mild phase would tend not to show underlying semantic changes.

The third suggestion would be to insert into speech therapy therapeutic planning, clinical sessions dedicated to the application of phrases with anaphors, and antecedents with repeated names to stimulate the speed of processing, since the retrieval of repeated names is more accessible for the population with AD.

Finally, at the initial phase of Alzheimer's disease, we suggest activities that use the semantic level, which stimulate this field that still seems to be preserved, so that individuals with AD develop a longer functional language time and a better quality of life. From these aspects, the speech therapist can also offer guidance to caregivers aiming to facilitate the family and social life of these individuals.

It is worth noting that in clinical practice, diagnoses are not concluded based on one or two clinical signs and symptoms, but on a set of factors. In view of the activities previously proposed, the results obtained in their applications will be added to other factors to determine clinical findings and confirm the hypotheses and adaptations of the most favorable therapeutic procedures. In this study, the limitation was the failure to conduct a broader cognitive assessment of participants with more substantial data that could assist in the discussion of the concepts raised here.

CONCLUSION

The elderly diagnosed with Alzheimer's disease at its initial phase show an opposite result to that of elderly without neurological changes. This demonstrates more speed in the retrieval of repeated names than pronouns, which allows confirming the hypothesis of impaired working memory, which is common in elderly people with AD. Only in elderly without neurological pathologies is the basic assumption of the informational load hypothesis confirmed in relation to more explicit retrievals that evoke a more general conceptual representation of the referent, preferring the establishment of correlations with pronouns and hypernyms. In both groups, there is a good level of right answers to the final questions. This indicates a satisfactory understanding and less losses associated with the semantic domain in the processing of coreferences.

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Author contributions

GÂSA was responsible for the conception and design of the study; data acquisition, analysis and interpretation; in addition to writing the article; JFC was responsible for the final critical review of the version to be presented for publication; MML was responsible for the critical review of relevant intellectual information and research guidance.