LINGUISTIC MODALITY EFFECTS IN SEMANTIC PROCESSING IN DEAF INDIVIDUALS

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ABSTRACT

This dissertation was developed in the context of semantic processing in deaf individuals. The main goal of this study was to explore linguistic modality effects on semantic processing in individuals with auditory sensory modality deprivation, i.e. deaf individuals.

Sensory systems are essential in order to perceive and conceptualize our semantic knowledge about the world and how we interact with the environment. Despite neurological studies that report that changes in the neural complex compensate the absence of a given sensory modality, existing studies that focus on the assessment of semantic processing in deaf individuals reveal low results of performance when compared with hearing individuals. Looking for the possible causes of this poor performance, it was verified that most existent studies analysing semantic processing in deaf individuals were performed using a written linguistic modality and not in the linguistic modality which is considered the most adequate to the sensory capabilities of the deaf, i.e. sign language.

Therefore, an exploratory study was developed focused on linguistic modality effects in semantic processing in deaf individuals and in comparison with a control group represented by hearing individuals.

To explore this new research proposal, three semantic tasks were developed which were comparatively analysed among three linguistic modalities (sign language, oral language and written language). The findings from this study suggest that there are significant effects from linguistic modality when semantic processing is performed between the two distinct modalities (sign and written linguistic modalities) used by the deaf individuals and also between the deaf group and hearing group (on sign, oral and written linguistic modalities).

These results reveal the relevance of linguistic modality when studying semantic processing, providing evidence that semantic processing is effected by the kind of linguistic modality used.

Keywords: deafness, semantic processing, linguistic modality, language, sign language.
RESUMO

Esta dissertação foi desenvolvida no âmbito do estudo do processamento semântico em sujeitos com perda ou privação da modalidade auditiva, ou seja, sujeitos surdos. O objetivo principal deste trabalho foi estudar os possíveis afeitos da modalidade linguística no processamento semântico em sujeitos surdos.

Todo o nosso conhecimento semântico do mundo, na sua perceção, concetualização e interação, é concebido através a informação processada pelos sistemas sensoriais que dispomos. Apesar de estudos neurológicos demonstrarem que o cérebro humano em privação de uma modalidade sensorial adapta-se anatômica e funcionalmente para compensar a ausência de uma específica modalidade sensorial, investigações realizadas com sujeitos surdos têm demonstrado que estes obtêm resultados inferiores em tarefas de processamento semântico em comparação com sujeitos ouvintes. Numa análise das possíveis causas deste fraco desempenho, foi verificado que grande parte dos estudos foram executados na modalidade linguística escrita, e não na modalidade linguística que tem sido considerada adequada às capacidades sensoriais disponíveis em sujeitos surdos.

Neste contexto, foi desenvolvido um estudo exploratório centrado na possível influência da modalidade linguística no processamento semântico entre sujeitos surdos e em comparação com sujeitos ouvintes.

Numa abordagem diferente do que é encontrado nos estudos existentes, em que se questiona e se compara duas modalidades linguísticas distintas (gestual e escrita) em sujeitos surdos, foram desenvolvidas três tarefas semânticas comparavelmente analisáveis em três diferentes modalidades linguísticas (língua gestual, língua oral e língua escrita). Os resultados obtidos neste trabalho revelam diferenças significativas quando o processamento semântico é executado na modalidade linguística gestual e escrita entre sujeitos surdos e um desempenho semelhante em comparação com sujeitos ouvintes, quando ambos os grupos executam as tarefas nas modalidades linguísticas que lhes são naturais (língua gestual e língua oral).

Os resultados encontrados revelam a importância da modalidade linguística no desempenho de tarefas semânticas.

Palavras-chave: surdez, processamento semântico, modalidade linguística, língua, língua gestual.
SUMÁRIO

Os estudos revelam que o nosso conhecimento semântico do mundo desempenha um papel central em todo o espetro da atividade cognitiva. Desde dos anos 80 que o estudo da estrutura e organização do conhecimento semântico tem sido objeto de interesse nos campos de investigação da psicologia e da neurociência cognitiva. Apesar de uma das maiores discussões concernir à organização e funcionamento do sistema, é indiscutível a questão da influência da experiência sensorial na conceptualização da estrutura do conhecimento semântico e no seu uso. Esta influência sensorial foi verificada após vários estudos realizados a sujeitos com lesões cerebrais ou com défices sensoriais, com especial atenção a sujeitos com perda ou privação da modalidade auditiva. Apesar de estudos neurológicos demonstrarem que o cérebro humano em privação de uma modalidade sensorial adapta-se anatômica e funcionalmente para se adequar ao ambiente, numa transformação conhecida como plasticidade neuronal, investigações realizadas com sujeitos surdos têm demonstrado resultados inferiores na execução de tarefas de caráter semântico em comparação com ouvintes. É neste contexto de processamento do conhecimento semântico em sujeitos surdos que a presente dissertação foi desenvolvida. O objectivo principal deste trabalho foi explorar a influência da modalidade linguística no processamento do conhecimento semântico em sujeitos com privação de modalidade sensorial auditiva, ou seja, sujeitos surdos.

A questão de abordar a influência da modalidade linguística na execução de tarefas de caráter semântico foi motivada pelo facto de os estudos encontrados com sujeitos surdos não darem devida atenção à importância ao tipo de modalidade linguística utilizada. Estudos que revelam um pior desempenho em tarefas de conhecimento semântico por parte dos surdos, em comparação com ouvintes, em testes executados por via de palavras escritas ou imagens, não tiveram em conta a modalidade linguística natural dos sujeitos em causa, apresentando-lhes sempre um input linguístico que pode não ser o mais adequado. Nos poucos estudos realizados com a modalidade linguística considerada adequada ao tipo de privação sensorial existente, isto é em língua gestual, os resultados obtidos foram semelhantes aos dos ouvintes. No entanto, nestes estudos raramente é feita a comparação direta entre a modalidade gestual e a modalidade
escrita, ficando em aberto se a melhoria do desempenho dos surdos está especificamente relacionada com a modalidade linguística ou com o material específico utilizado. Para além disso, nestes trabalhos foram, genericamente utilizadas análises linguisticamente pouco cuidadas no que respeita à realidade linguística das línguas gestuais, não permitindo uma comparação efetiva entre as duas modalidades linguísticas.

Assim, o estudo exploratório desenvolvido no âmbito desta dissertação de mestrado tem como objetivo estudar a influência da modalidade linguística em tarefas de processamento de conhecimento semântico em sujeitos surdos. A hipótese principal deste estudo é a de que quando um sujeito surdo executa uma tarefa semântica na sua língua natural, adequada às suas capacidades sensoriais, conseguirá um desempenho superior ao que terá quando executa uma tarefa semântica na língua escrita. Nesta lógica, os resultados encontrados quando comparamos o desempenho em tarefas semânticas, considerando as modalidades linguísticas naturais de cada grupo, isto é, surdos e ouvintes, não deverão apresentar diferenças significativas.

Para melhor compreensão dos objetivos deste trabalho segue-se uma sistematização das hipótese exploradas:

**Hipótese 1:** Os participantes surdos deverão ter melhores resultados em tarefas semânticas, quando as executam na língua que lhes é sensorialmente natural (língua gestual), quando comparado com o seu desempenho em língua escrita.

**Hipótese 2:** Os participantes surdos deverão ter resultados próximos em comparação com os ouvintes em tarefas semânticas executadas nas línguas naturais de cada um.

**Hipótese 3:** Os participantes surdos deverão ter piores resultados em tarefas semânticas executadas na língua escrita, em comparação com o desempenho dos ouvintes na mesma modalidade.

**Hipótese 4:** Os participantes ouvintes deverão ter resultados semelhantes em tarefas semânticas, numa comparação entre a língua que lhes é natural (língua oral) e na sua representante escrita (língua escrita).

No sentido de verificar e avaliar estas hipóteses, foram desenvolvidas três tarefas semânticas, nas três modalidades consideradas (língua gestual portuguesa, língua oral e língua escrita):
1. Tarefa de Fluência Semântica, que permite aceder à recuperação semântica através da indicação de uma categoria.

2. Tarefa de Associação Livre em 3 Palavras, que permite explorar a organização da informação taxonómica, através da indicação de uma palavra (exemplar).

3. Tarefa de Categorização Semântica, que permite explorar a organização do conhecimento semântico através da decisão sobre a pertença ou a não pertença a mesma categoria de um par de estímulos (exemplares).

O estudo exploratório foi realizado com uma amostra de dez participantes surdos, seis mulheres e quatro homens, que sofrem de surdez profunda, e que utilizam a Língua Gestual Portuguesa como língua natural. Para uma análise comparativa, estas tarefas também foram realizadas junto de um grupo de dez sujeitos ouvintes, seis mulheres e quatro homens.

Para análise dos dados recolhidos foram considerados critérios linguísticos que permitissem a comparação entre as diferentes modalidades. Para permitir o tratamento quantitativo as respostas foram analisadas de acordo com variáveis definidas para cada tarefa (ex. total de respostas corretas, clusters linguísticos e clusters semânticos).

As principais contribuições desta dissertação de mestrado salientam-se a dois níveis. Contribuições relacionadas com o desenvolvimento do desenho experimental:

1. A produção de testes de processamento semântico com três tipos de modalidade linguística (língua gestual, língua oral e língua escrita), que possibilita estudos comparativos entre sujeitos com modalidades linguísticas distintas.

2. A criação de uma análise fonológica à estrutura das línguas gestuais compariva à estrutura das línguas orais, que permite uma análise equivalente entre línguas de estruturas de modalidade fonológicas diferentes.

Por outro lado, os resultados obtidos da execução das tarefas de recuperação semântica condicionados às modalidades linguísticas têm contribuições para as áreas de investigação do processamento semântico em sujeito surdo:

1. Indicações de maior fluência semântica quando a modalidade linguística é natural às capacidades do sujeito surdo.
2. Recurso significante a clusters fonológicos e semânticos quando a modalidade linguística de execução da tarefa é natural ao sujeito surdo, tendo semelhanças com o desempenho de sujeitos ouvintes.

3. Sujeitos surdos têm um desempenho semelhante ao dos ouvintes em tarefas de processamento semântico, quando desempenham a tarefa na língua que lhes é considerada adequada às suas capacidades sensoriais disponíveis.

Os resultados permitem ir de encontro a uma hipótese ainda não abordada pelos estudos de conhecimento semântico em sujeitos surdos. A influência da modalidade linguística em tarefas de processamento semântico demonstra ser significativa no desempenho dos participantes. Neste sentido, é fundamental ter em conta o tipo de modalidade linguística em que se processam as tarefas relacionadas com o conhecimento semântico quando o estudo se centra no desempenho de sujeitos com défices de uma modalidade sensorial.

Esta dissertação de mestrado espera contribuir para que futuros estudos centrados no desempenho do processamento cognitivo com sujeitos com défices de uma modalidade sensorial tenham em consideração o tipo de modalidade linguística em que as tarefas semânticas são processadas, passando, assim, a ser um critério de análise a utilizar.
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1. INTRODUCTION

Individuals who experience sensory deprivation of one sense compensate the absence on the remaining sensory modalities. The sensorial deprivation induces brain’s neural and functional changes. Sensory systems are essential components of cognition, providing skills to perceive, integrate and interact with world environment. All apprehended information from the world is semantically categorized and organized in our semantic memory, allowing us to simplify the complex multiplicity of elements that come to us though the senses and that are filtered by our social and cultural experience.

The aim of this dissertation is to investigate the possible different effects of language-modality and sensory-modality absence in semantic processing that are usually confounded in the literature. Focusing on the central role language currently plays in understanding the world, it is questionable how this abstract system of signs can influence the semantic processing of world objects of deaf individuals.

This topic was chosen because, among the numerous amounts of research on the cognitive performance of deaf individuals, few are concerned with performance in semantic tasks, and those that do compare deaf semantic processing performance and neural activation with hearing individuals based on identifying and naming words or pictures use oral language to perform the tasks (MacSweeney et al., 2004, Ormel et al., 2010). Results demonstrate that deaf individuals show lower proficiency in recognizing and naming objects in comparison with hearing individuals (McEvoy et al., 1999, Ormel et al., 2010) and reveals heterogeneous conceptual network in association tests (Marschark et al., 2004). Nevertheless, they never take into consideration the two different linguistic modalities of deaf individuals, i.e. sign language and written language.

Observing these results, and bearing in mind the results of few studies, which show that second generation deaf individuals performing the tasks on their natural1 and first language had similar semantic retrieval as hearing individuals (Liben, 1978, 1979; Courtin, 1997; Marshall et al., in press; Vletsi et al., 2012), several questions arise: are

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1 In this dissertation, natural language is the term presented to designate the modality of language appropriate to the sensory capabilities of signers or speakers. Sign languages are the natural and most accessible modality languages for deaf individuals/signers, as oral languages are the appropriate ones for hearing individuals/speakers.
all real-world object categories constant across languages?; is there any significant effect of language sensory-modality in semantic processing?; in which way may the object definition be influenced by sensory-modality absence on perceiving and acting in context?; are the category classes of the deaf different from the hearing individuals?.

The effect of language modality in deaf individuals remains largely unknown. Therefore, the issue of linguistic modality is the aim of this dissertation. Thus, in order to verify the linguistic modality influence in semantic processing, deaf individuals were compared in different linguistic modalities (sign and spoken language) in three different semantic tasks (fluency, three-word free association and categorization). There was a control group of hearing individuals.

The main goal of this research is to find out if the semantic knowledge structure, organization and retrieval in deaf individuals, whose sign language is their first or natural language, is conditioned by linguistic parameters or only constrained by their available sensory capacities in the absence of auditory modality. Hence, in order to better understand the relationship of language and semantic processing in deaf individuals, research in these areas will be closely analysed in depth in this chapter.

1.1. Language and Deafness

Language is the available system in the brain that processes the transformations of our knowledge of the world (objects, concepts, events, ideas, etc.) through a visual or acoustic output signal. “As we come to understand the neural basis for the brain’s representation of external objects, events, and their relations, we simultaneously gain insight into the brain’s representation of language and into the mechanisms that connected the two.” (Damásio & Damásio, 2000: 478). Research on language is done in distinct levels and in several fields, now involving the mapping of neural circuits that supports the levels and stages of knowledge in language transformations, the understanding of the relation between input and output systems, as well as the study of the linguistic structures.

The well-known classical findings following the observation of subjects with brain lesions, hypothesised that language processing was completely covered by two areas of the human brain: Broca’s area and Wernicke’s area (Berker et al., 1986; Bogen &
Thus, syntactic processing was supported by Broca’s area and Wernicke’s area supported semantic processing, both in the left hemisphere (LH).

It has been pointed out that neural activity occurs in the RH during language tasks, sometimes in areas homologous to LH language areas, indicating that the RH is not specialized in language processing as the LH is, but contributes to interpreting input and organizing the representation of language, demonstrating the existence of bilateral language processing (Bookheimer, 2002; Jung-Beeman, 2005; Fonseca et al., 2009). In addition, research using PET scans on brain lesions (Damásio et al., 2002) indicates that the left interior temporal lobe is associated with naming tasks for all categories and that recognition tasks activate both hemispheres. This research demonstrates that word retrieval depends on more neural parts than the two classical language areas, showing the possibility that neural component systems are different for each task, i.e. word retrieval versus conceptual retrieval.

Normal processing of language in the brain is still a subject of extreme relevance, and despite an enormous bulk of research, the search for an integrated model is still a matter of interest (Grimaldi, 2011).

I will now specifically approach the language studies with deaf participants.

Until the 1980s, brain studies assumed that language systems and properties were organized on the basis of the sounds of speech. The LH was skilled in processing linguistic information in the form of auditory-oral modality. Thus, “the link between biology and linguistic behaviour has been identified with the particular sensory modality in which language has developed.” (Bellugi et al., 1993: 403). One of the first studies focusing on linguistic processing with a neural basis based on different language background modality was Poizner et al. (1991) and Bellugi et al. (1993), based on experiments from more than a decade earlier (Neville & Bellugi, 1978). This research tested aphasic deaf patients who had acquired brain injuries in the left or right hemisphere. It was revealed that patients with RH injuries involving non-language spatial disorders preserved sign processing intact, with different results from patients with damage in the LH. As shown before, signers who had localized damage in frontal regions of the LH showed difficulties in word-formation in ASL (Broca’s aphasia) while those with damage in the left temporal lobe presented complications in the comprehension of ASL (Wernicke’s area). Afterwards, others studies corroborated this analysis (Hickok et al., 2001; Marshall et al., 2004). These
pioneer studies promoted the study of sign languages, as complex structural linguistic systems with neural processing just like “natural and real languages”.

Sign and spoken languages appear to be supported by the same cortical substrate. Neville et al. (1998) in a study on cerebral organization during sentence processing using fMRI in English and ASL showed that hearing and deaf individuals displayed extensive activation in homologous areas. And despite the fact that the critical language function area in left perisylvian regions is located near the auditory processing area, language processing is not controlled by the auditory input modality. Bearing in mind the cross-modal plasticity phenomenon, there is activation of the auditory cortex in people with hearing loss (Fine et al., 2005, MacSweeney et al., 2004). Research on cross-modal plasticity has focused on deaf individual’s neural behaviour (Bavelier & Neville, 2002; Finney et al., 2001), which demonstrates that when acoustic input deprivation exists, there is a cross-modal reorganization of the auditory cortex to provide the neural substrate with compensatory visual functions which activate single visual functions in parts of reorganized auditory cortex (Lambertz et al., 2005). Thus, when deaf individuals process visual information with linguistic input, their activated brain regions correspond to hearing processing (Fine et al. 2005, MacSweeney et al., 2004).

In research containing electrophysiology and neuroimaging analysis, deaf individuals show two neural phenomena: using visual-evoked potentials, an increase in answers to visual stimulus in the visual cortex is observed (Neville et al., 1983; Neville & Lawson, 1987), or an increase in attention and perception functions by the visual system. Functional Magnetic Resonance Imaging (fMRI) has verified that the auditory cortex is activated by visual stimulus in deaf individuals (Finney et al., 2001; Fine et al., 2005).

Other studies focused on language processing in alternating experiments between sign language and written language (Corina et al., 1998, Hickok et al., 1998) where written English was presented word-by-word at a time without phonological features such as stress and prosody, while ASL was presented sentence-by-sentence with all phonological values present, demonstrates that the RH is more activated in deaf brains than hearing individuals’ brains when processing the representative form of their natural language, the written form. Another analysis comparing sign and spoken language (MacSweeney et al., 2002b) found similar neural systems for both languages,
with the recruitment of both hemispheres and no differences in areas of the RH with regard to distinct languages modalities.

The research data illustrate a significant similarity in the neuroanatomy of signed and spoken languages, suggesting that the neural supporting areas of language are predominantly modality-independent.

Language is a communication system innately acquired by humans and made up of rules and particular features. For decades, sign languages were considered an incomplete form of communication, as rudimentary, simple languages and not as a structured linguistic system. Following Stokoe’s research (1960), where it was demonstrated that signs are composed of small meaningful units using minimal sign pair analysis, sign languages began to be observed and studied as complex structural linguistic systems.

Sign languages such as LGP are linguistic systems with the typical behaviour of natural languages such as oral languages, sharing with them universals linguistic features, besides their differences in production and perception modality – visual-spatial modality in sign languages and auditory-oral modality in spoken languages.

As was demonstrated above, with the exception of language processing in accordance with input stimulus modality, sign languages are processed in similar neural areas that oral languages are.

Writing exists in contrast to all cognitive, neurobiological and linguistic characteristics of a natural language. Humans do not innately acquire writing. This way of communication is a social convention made to represent natural spoken languages and a period of learning is required to acquire the ability to write. Writing is constructed by orthography to represent the words of natural spoken language, but by combining orthographic words it just possible according to the syntactic and semantic rules of natural language, to construct an understandable sentence (Delgado-Martins, 1996).

After a reported case by Dejerine in 1892 of a patient who lost his ability to read letters and words although his visual field was intact, neuroimaging studies have identified an area in the left visual cortex (the lateral fusiform gyrus in the ventral occipito-temporal cortex) called the visual word form area (VWFA), which is the area critical for reading words (Cohen et al., 1999; Dehaene & Cohen, 2011) and where segregated activation has been found for phonological and semantic processing.
(Poldrack et al., 1999). A recent study on deaf individuals reveals that they also activate semantic processing in the left hemisphere when reading words and that they also activate the VWFA. However, activation of this area is limited to semantic segregation, and even though the left hemisphere is activated for reading words, phonological access is incomplete during the word reading task (Emmorey et al., 2011). Once more, it is further evidence that research between deaf and hearing individuals based on written language is unequal and ineffective for understanding the semantic processing in deaf individuals. I will now proceed with a review of semantic knowledge, particularly in deafness.

1.2. Semantic knowledge and Deafness

A few cognitive models were proposed to address representation and organization of semantic knowledge. The traditional model concentrated on an abstract conceptual structure with relations among and between concepts and percepts or actions (Griffiths et al., 2007). This model, proposed by Collins & Quillian in 1969, focused on explaining phenomena such as reaction time to verify conceptual propositions, such as «A canary is a bird», «A canary can fly», and the decay of propositional knowledge with aging or brain damage (Warrington, 1984; Griffiths et al., 2007). This first approach was confirmed by Warrington (1975) based on a study with three patients. However, to explain the fact that these patients lose semantic information according to a gradient which goes from the most specific to the most general information, the author proposed an amendment to the effect that access to information has to be done in general in a level from general to the more specific.

As a result of neuropsychological data, Collins & Loftus (1975) abandoned the idea of hierarchical organization. Instead, they proposed that information is organized in semantic memory as a network, in which the elements whose meanings are closely related are located near each other, and have stronger connections. (Griffiths et al., 2007). This model assumes that when a concept is processed, activation is spread over a network, becoming less effective as it moves away from the concept activator. Ellipses represent concepts and links between concepts, the smaller the link-line, the stronger the link between concepts (Ibid). According to this model, it is possible to evaluate priming effects, observing that words sharing semantic relations have faster response times in decision tasks than those that are not semantically related, because
when a word is activated it also activates other relational words. In practice, this model does not concern itself with the mappings, concepts or associative relations between words. In fact, language is just a tool to conduct relevant experiments by linguistic stimuli and responses.

In the meantime, to fill the gaps of attribute definitions from the classic model, Rosch (1975, 1978) developed the prototype model based on the thesis that, in the classical model, categories are defined only by the properties shared by all members of the class, with the result that no member best exemplifies the category than others. The fundamental principle of Rosch’s model holds that the categories are organized around central prototypes. A representative example of a category would be one that shares more features with other members of the same class and, on the other hand, shares few (or no) features with items from outside the class. Rosch’s ideas have had a great impact on the cognitive sciences and, for the first time, language was approached as a component of category organization, and not treated simply as a means of communication for eliciting target answers.

The explanations offered by classic and prototype models are not entirely satisfactory. It is very difficult to draw clear lines between the views of each model. While the classic model has difficulties in explaining the effects of typicality on the one hand, the prototype model is not able to satisfactorily explain the organization of categories. Following Rosch’s approach, language has evolved from being an experimental tool to data analysis based on the perspective that memory systems support online linguistic processing, such as word-association (e.g., Nelson, McEvoy, & Schreiber, 1998), semantic priming (e.g., Till, Mross, & Kintsch, 1988), effects of semantic context in free recall (e.g., Roediger & McDermott, 1995), etc.

The importance of these cognitive models in semantic knowledge structure is recognized, exposing simple semantic representations with semantic spaces or holistic spreading activation networks. However, since the advent of neuroimaging techniques has deepened our knowledge about memory and accelerated semantic processing research by providing clinical and experimental results, these results have led researchers to reformulate or abandon certain storage models of the brain, to distinguish several separate memory systems and to adopt a more dynamic and flexible approach to modelling human semantic knowledge. In general, these advances have demonstrated the inherent limitations of a single-discipline approach to semantic processing research.
The employment of techniques such as positron-emission tomography (PET), functional magnetic resonance imaging (fMRI) (both mentioned above), event-related potential (ERP) and magnetoencephalography (MEG) enable cognitive behaviour be directly researched by observing how the brain works on various cognitive tasks. More recently, with the parallel brain functions observation, studies focus on the organization and structure of semantic knowledge, pointing out the existence of a large and distributed network of semantic representations, covering the ventral and lateral temporal cortex, parietal cortex and frontal cortex. There are two cortical areas that have been exposed as critical areas to semantic information processing: the left inferior prefrontal cortex for the retrieval of semantic representations (Wagner et al., 2001), and the middle and superior temporal gyros for concept representation (Chao et al., 2002).

Identification of the neural processes underlying semantic representations is a key challenge in cognitive neuroscience. The general idea is that semantic systems are organized under shared object properties, which are generalized across concepts belonging to a particular category (animals, tools, clothes, etc).

Cognitive neuroscience studies have revealed that neurological impairments in specific brain areas lead to fairly predictable semantic memory deficits. By adopting the techniques of neuroscience (PET, fMRI, ERP, MEG), it is possible to observe the brain directly as it works on innumerous cognitive tasks, contributing to our understanding of category knowledge processing in the brain.

Category representation is defined and researched by cognitive neuroscience according to two main different approaches: specific-category representation and attribute/feature-specific representation. The first approach emerged in the 1980’s, when Warrington & Shallice (1984) reported on patients with selective impairment for one particular semantic category whilst others categories – specific-category representation - were left intact. Through neuroimaging methods it has been demonstrated that there are differences in category-related brain activity among the different categories, showing that there are a set of neurons responsible for specific category representations, located in a certain area of the brain, which responds to a particular category and which are not be activated by the input of exemplars from a different category (more recently Martin (2007) and Blinder et al. (2009). In accordance with these studies, it is thereby possible to consider that brain damage in one area responsible for one particular category would suspend the knowledge
associated with that category. Corroborating this claim, various researches has verified impairment in retrieving exemplars or features from one type of category in patients suffering from a category-specific disorder while other categories are saved (Martin, 1996, Gainotti, 2000). The most common categories involved in this impairment are living things, such as animals, and artefacts/man-made objects, such as tools and clothing (Capitani et al., 2003).

The general idea is that a category-specific disorder occurs when a brain injury or disease disrupts information about the object category, thus creating problems in defining and distinguishing members from a single category, while other types of categories remain unaffected. The most frequently reported and widely studied dissociation has been between knowledge of living things and artefacts, where patients with dysfunction in retrieving members from the category of living things do not have the same difficulty with artefacts, and vice versa (Chao et al., 1999, Noppeney et al., 2006, Mahon et al., 2007). Research on functional neuroimaging has revealed that the brain is active in the fusiform gyrus, left middle temporal gyrus, and left premotor cortex areas when the subject is identifying and processing pictures of artefacts, such as tools, in normal brains as well as those with a category-specific disorder (Damasio et al., 1996, Martin et al., 1996, Mummery et al., 1996, 1998, Martin & Chao, 2001, Phillips et al., 2002). The brain areas associated with living things, such as animals, seems to be the fusiform gyrus, the medial occipital cortex, and the superior temporal sulcus, i.e. in visual association areas (Martin, 1996, Rossin et al., 2002) in healthy and category-specific disorder brains (Gainotti, 2000).

Even with current studies, there are alternative explanations of the evidence supported by more functional neuroimaging techniques. Attribute/feature-specific representation, the second cognitive neuroscience approach, demonstrates agreement on the existence of different brain regions for different types of objects in recognition and naming tasks, but emphasizes the evidence that “sensory- and motor-based object properties are stored within sensory and motor systems, respectively” (Martin, 2007: 25).

Feature-specific category representations propose that object representations are based on information related to perceptual and functional attributes of objects stored in semantic systems, and that all this information is coded in respective sensory or motor areas. Testing a patient with semantic impairment using a developed naming-to-definition task, Gainotti & Silveri (1996) observed a notably better performance with
non-perceptual definitions than with visually based definitions, but did not detect differences with inanimate objects. From this study, the authors derived the idea that there are different types of stored information, and in this case it was the visual information that was specifically damaged.

It is important to consider therefore that there are patients with just one type of selective semantic impairment while some patients show more than one type of selectivity. For example, Basso et al. (1988) studied a patient with semantic dementia, which presented animate concept impairment but maintenance of inanimate concepts. In addition, the same patient presented poorer results when semantic attributes were visual rather than oral, such as in spoken names. This patient showed two types of specific impairment: category-specific and attribute/feature-specific impairment.

The feature-specific category representation approach suggests that brain activations are related to automatically stored information about objects (object form, visual aspect, biological and non-biological motion, and motor movements when using the object). In Chao et al. (1999) activation was observed in the lateral fusiform gyrus when subjects where processing human and animals faces. The same activated region was more active when subjects had to view or verify properties of animals rather than tools,. Moreover, studies with new statistical pattern recognition methods have found active patterns from multiple categories (Cox & Savoy, 2003, Hanson et al., 2004), rebutting the category specific model.

PET scanning studies have shown that visual brain areas are more active while living things are being named, while those related to motor functions are more active while tools are being named (Martin et al., 1996). Such studies argue that sensory modality influences the organization of information in semantic organization is the only pattern to store objects representation. In spite of that, there are no evidences that modality-based establish that living things are processed in different parts of the brain from artifacts.

There is another semantic impairment approach that suggests that the type of modality input stimulus influences the performance of access to semantic information. This approach is primarily based on the description of a patient whose ability to perform semantic tasks was better when animals were presented in spoken form rather than as a picture (McCarthy & Warrington, 1988). Studies using neuroimaging techniques (Coltheart et al., 1998, Simanova et al., 2010) based on semantic tasks involving the presentation of an object in different modalities to patients with semantic memory
impairment as well as to healthy individuals also reveal some differences in the results depending on the given input modalities.

The general conclusion is that to receive information about the world, we are provided with sensory-motor systems which, based on their physical capabilities, determine our interaction with an object and enable the extraction of its attributes in order to define, represent and categorize such attributes in the knowledge structure of the brain. The question is what occurs if the brain is deprived of input from one modality-specific sensory?

Once cognitive and neuroscience studies have demonstrated, through studies of patients with selective semantic impairment and neuroimaging in healthy individuals, that it is feasible for semantic representations of objects to be based on an individual’s sensory and motor experiences (perceptual and non-perceptual information), the question arises as to whether deaf individuals store this information in the same way as hearing people, given that deaf individuals lack one type of sensory modality. Therefore I will now specifically approach the semantic knowledge studies with deaf participants.

As previously pointed, studies on deaf individuals provide a better understanding of the perceptual and neural consequences of modality-specific sensory deprivation in human brains. Deafness is a deficit in a specific sensory modality. A person who suffers from this deficit lacks the auditory modality. An extraordinary quality of the brain is its capacity to respond to change. It has been neurologically verified that absence of one sensory modality promotes the development of neural reorganization of the remaining sensory modality systems. This brain’s ability to reorganize neural network architecture in order to adapt to environmental needs is referred to as neuroplasticity (Elbert & Rockstroh, 2004).

Evidence is found in Nguyen & Murphy (2003), which reveals that hearing children between 4 and 7 years of age do not categorize in a restricted form, as suggested by traditional literature. Instead, children of early ages have taxonomic, script, and evaluative categories available to them. In addition, it is well known that these ages are a critical period for the improvement of language acquisition, including complex
rules of morphology and syntax, expansion of vocabulary, semantic and phonological development, elaboration of speech acts, and for the maturation of skills for reading and writing (Johnson and Newport, 1989; Newport, 1990). Other studies corroborate this evidence, showing that there is a parallel critical period for the development of the visual and linguistic systems in deaf children (Mayberry, 1998), confirming the existing development pattern in hearing children. Factors such as limited phonological information available to deaf individuals influence reading skills to deaf and poor semantic knowledge reveals poor vocabulary skills (Marschark et al., 2002), emphasizes the bilingual factors language skills. Bilingual capabilities provide a vast semantic knowledge, which combined with cultural influences can affect semantic categorization (Peña et al., 2002; Unsworth et al., 2003), being aware that a bilingual child will learn two words for the same referent.

In contrast with evidence, that neural and cognitive abilities of deaf individuals are sufficient for processing semantic knowledge, several semantic studies comparing deaf and hearing individuals demonstrated a poorer performance by the first group but with similar neural localization. Comparative research focuses on verbal concept knowledge in deaf and hearing individuals adults through word semantic association tasks demonstrating similarities with regard to unrelated sound words and differences with sound-related words (McEvoy et al., 1999). With similar differences, the study by MacSweeney et al. (2004) on related and unrelated lexical word decision tasks using ERP recording and analysis showed that neural systems supporting semantic processing are largely unaffected by language experience during controlled reading of familiar (unrelated) words, but when automatic processing is required (related priming), the impact of language experience become evident. A more recent comparative finding from Ormel et al. (2010), based on the semantic categorization among bilingual deaf children and hearing children through two semantic-categorizations tasks revealed limited semantic improvement across grade levels for deaf children, in particular when using words.

These studies point towards a lower proficiency in semantic knowledge among deaf children and adults. However, it is important to recognize that all the tasks leading to these findings tested recognition, association and decision-making using words or pictures. Even if world objects are presented in these forms, it is important to bear in
mind that the natural and accessible language for deaf individuals is sign language, and none of these studies has used it to test their cognitive functioning. It is widely recognized that the abstract and conceptual representation of world objects is translated into a phonological word form involving semantic and linguistic components (semantic conceptualization and phonological encoding) (Levelt et al., 1999, Indefrey & Levelt, 2000). Visual word recognition, however, involves phonological, semantic and orthographic knowledge (Binder et al. 2003). The literature reveals the fundamental role of phonology in word recognition and reading comprehension of hearing individuals (Unsworth & Pexman, 2003; Rahman & Werner, 2003). Bearing in mind all the phonological and lexical access required to achieve semantic representations from words recognition, studies with deaf individuals assumed that they would use semantic knowledge to provide reading support and word recognition when their phonological knowledge was limited (Kyle & Harris, 2006). To explore the taxonomic organization of the mental lexicon among deaf and hearing college students, two experiments were developed using single word association and verbal analogies, the results of which pointed to a similar general organization for both groups of individuals, while category associations were stronger among hearing students with deaf individuals demonstrating a heterogeneous conceptual network association, in which the lack of lexical knowledge was underlined (Marschark et al., 2004). In this experiment, deaf individuals were better at analogies providing a category member (e.g. apple, banana) rather than a category term (e.g. fruits, animals).

Experiments in which deaf individuals performed using sign language are only available in a few studies. Initial research developed by Liben et al. (1978) focused on the influence of formational properties of sign language in the organization of long-term memory, constructing free recall tasks with items to be categorized in sign language or their English-word equivalents by sixteen deaf college students. The results showed a large clustering of scores when participants performed in sign language. However, based on spontaneous clustering of formational similarities, it was concluded that fluent deaf signers, though possessing knowledge of the formational structure of signs, do not spontaneously use them as grounded in mnemonic organization in long-term memory. This study tested the influence of handshape (sign phonological parameter) in categorization. Although the conclusions
presented a non-spontaneous procedure to achieve semantic knowledge, it is important to emphasize that at that time sign languages were not sufficiently described phonologically to realize that a sign contained more than handshape, i.e. hand configuration is not the only correspondent to the oral-phoneme. Nowadays, it is well-known that sign languages have more important parameters, such as localization, movement and facial expressions (Sandler & Lillo, 2006; Moita et al., 2011), with phonological values for each parameter that can be used as a strategy for clustering (e.g. selected fingers, final localization, etc.). A later study, lead by Liben (1979), analysed the free recall of semantic taxonomy through drawing stimuli which was given to two groups of (deaf and hearing) children, aged 9 to 13, to be semantically categorized in sign language or English-word equivalents. After a baseline memory trial, half of the children of each group trained strategies on semantic clustering. Contradicting what was expected based on other research, deaf children exhibited semantic clustering as much as the hearing group, although their recall scores were expressly lower than those of hearing children, including the half that had been trained. Continuing to focus on the effects of sign language on cognitive processes of categorization, Courtin (1997) tested second-generation deaf children with a forced-choice paradigm to select schematic and categorial alternatives in association with sign language characteristics. Results revealed that both deaf and hearing children identify the generic label from the category in linguistic conditions and exhibit similar performance on semantic categorization tasks. The author concludes that deaf children’s categorization processing differs from that of hearing children with regard to cognitive skills, justifying the view that the association between signifier and signified in the formational properties of linguistic conditions of sign languages “refers more or less directly to its meaning: it is at the intersection between prototypical level and intentional category” (Courtin, 1997: 169), and that the linguistic properties of oral language does not present the same kind of associations. Although the sign-meaning relationship is questionable from a linguistic perspective, there are numerous signs constructed on the basis of abstract phonological elements, just as words are in oral languages. Thus, it is important to highlight similar performance results.

Recently, two studies (Marshal et al., in press, Vletsi et al., 2012) that focused on mental lexicon organization in deaf individuals, found similarities results with hearing individuals. Mental lexicon is defined by literature and among studies as a complex
structure where words are organized in terms of phonology, semantic and syntax language’ features, as well other non-linguistic aspects such as culture, experience (Level, 1989). Marshall et al. (in press) research based on fluency tasks analysed were modality could influence in the organization of the signed lexicon on deaf adults, signers of British Sign Language (BSL), using two semantic and phonological fluency tasks. The results demonstrate that deaf adults organize the lexicon of sign languages, expressly clustering with the phonological parameters of handshape and location, just as studies have shown that hearing adults do the same with the phonological parameters of spoken languages. Other recent research, a pilot study (Vletsi et al., 2012) with five deaf adults centred on an assessment of phonological (3 handshapes) and semantic fluency (animals, fruits and objects) in sign languages, based on the previously mentioned research by Marshall et al. (in press), analysing the performance of Greek Sign Language (GSL) signers. Despite the small sample of deaf signers, it was shown similarities with the type and number of responses comparing with BSL signers.

Considering these findings, and noting that the vast majority of the previous existing semantic research on deaf individuals has been performed with stimuli presented as pictures, words and spoken modalities, it is of great relevance to contribute to disentangle the effects of the auditory sensory deprivation of those of the linguistic modality in the performance of semantic tasks by deaf individuals. The small number of studies focuses on the mental lexicon and semantic processing in deaf individuals showing good performances when using their natural modality language, emphasizes the need to explore the influence of modality on semantic and lexical retrieval.

As a final synthesis, I propose that research between deaf and hearing individuals based on written language is unequal and ineffective, and that is of great relevance to help to disentangle the effects of the auditory sensory deprivation of those of the linguistic modality in the performance of semantic tasks by deaf individuals, by explicitly comparing deaf participants in different linguistic modalities.

To test this, the experiments for this dissertation were performed in three modalities: sign language, spoken language and written words. These conditions allowed for an
assessment of the possible influence of linguistic parameters on the structure of semantic knowledge in deaf adults, regarding the recognition, access and recall of objects and categories.
2. **METHOD**

This exploratory study has attempted to capture the linguistic modality effects on semantic processing in deaf individuals performing three cognitive tasks. The following describes the hypotheses and the methods used to conduct this study.

2.1. **Hypotheses**

In order to meet the main objective of this exploratory study, the focus is on the influence of linguistic modality in semantic processing in deaf individuals. Based on what is described in the literature, four hypotheses were formulated.

**Hypothesis 1**
Deaf individuals have better results when perform semantic tasks in their natural modality language in comparison with the results in the written modality language.

**Hypothesis 2**
Deaf individuals have similar results in comparison with hearing individuals when both groups perform semantic tasks in their natural modality languages (sign language for deaf and oral language for hearing individuals).

**Hypothesis 3**
Deaf individuals have poorer results in comparison with hearing individuals when both groups perform the semantic tasks in written language modality.

**Hypothesis 4**
Hearing individuals have similar results between the performances of semantic tasks in their natural modality language (oral language) and in its written representation (written language modality).

To test the results of these hypotheses, three cognitive tasks were designed involving semantic processing activities, according to the literature, and a new proposal for direct comparison of linguistic information within the responses among the different linguistic modalities, was developed.
2.2. Experimental design

To assess the possible influence of sensory-modality and consequently linguistic parameters in the structure of semantic processing in deaf adults, three tasks were created to compare deaf and hearing individuals and three linguistic modalities were used, Portuguese Sign Language (LGP), Oral Portuguese (OP) and written Portuguese (WP).

2.2.1. Sample

There were two groups of participants in the three tasks: 10 deaf individuals and 10 hearing individuals, four men and six women respectively. The experimental group is constituted by 10 deaf individuals from different ages, all students attending a degree in LGP from the Catholic University of Portugal in Lisbon, with good proficiency in LGP and in WP (reading and writing). The evaluation of language proficiency in deaf individuals was verified through entrance exams for attending the graduation. Only deaf individuals with a score of 15 or higher on a classification scale from 0 to 20 were selected. A proficiency criteria of Portuguese was only required for deaf individuals since it is known that, in general, deaf individuals are more prone to have difficulties with orthography and all underlying components of the grammar (semantic, syntax, morphology, etc.) related to written Portuguese. All of the deaf participants are fluent in LGP, since it is a requirement for attending the degree in LGP and are active members of the deaf community.

Beyond proficiency in LGP and WP, other selection criteria for deaf participants included: (a) type of deafness, i.e. deaf individuals should have profound deafness; (b) daily language must be LGP; and (c) LGP should be one of the languages used at home. The age of LGP acquisition was registered but was not an exclusion criteria. It is well known that deaf children’s first language is usually the language of their parents but is considered to have been acquired without all the necessary information according to the characteristics of the language (e.g. phonological information). In our sample, for three deaf participants, Portuguese was their first acquired language, nevertheless all of the selected participants use LGP as their daily language, and considered to be more comfortable with LGP (table 1).
The control group was represented by 10 hearing university students, Portuguese native speakers. The individuals from this group were selected after the selection of the deaf group, with the goal of matching the ages of the two groups. The global selection criteria for the hearing group were: (a) they should be university students; (b) they must be native Portuguese speakers; (c) their main daily language must be Portuguese; and (d) they have had no contact with LGP. A proficiency test was not required of the control group, as being university students using their native and natural language, it was expected that they would have good proficiency in Portuguese.

The age average of the control group was similar to those of the deaf group (table 2).

All participants (deaf group and control group) filled out a questionnaire mentioning all the requested criteria before the three tasks were conducted (see questionnaires in appendices A, B and C).

### 2.3. General Materials and Procedures

This is a three-part study and each of the tasks was divided to be performed in two language modules: *Portuguese Sign Language- Written Portuguese* for deaf participants and *Oral Portuguese- Written Portuguese* for hearing participants. This meant that, for the group of deaf individuals, one half of each task was instructed and answered in LGP and the other half in WP and for the group of hearing participants,
half of each task was performed in OP and the other in WP. Each group of ten individualss was randomly split into two smaller groups of five participants. The ones that performed part A of the task in LGP (for deaf participants) /OP (for hearing participants) executed part B in WP, and the other five participants performed the tasks in reverse order, i.e. part A in WP and part B in LGP/OP. To ensure that instructions in LGP were well performed for the participants and that the sign responses were clear, an LGP professional interpreter was asked to carry out the instructions.

The distinction between spoken and written Portuguese is based on the psycholinguistic knowledge that natural language is a result of general cognitive processes used by humans in all their conscious mental activities, which are innate to humans. Written languages are a social convention used to represent oral languages and are acquired by rational learning (Delgado-Martins, 1996). WP predominantly represents the phonological oral form of the Portuguese language, and both task groups were exposed to this way of communication, in spite of the differences in their cognitive processing depending on their sensory-modality capacities to decode those written codes. The decision to split the tasks into two halves according to the language utilized was made to allow for the parallel analysis between deaf and hearing individuals on their performance using a common method of communication (writing), as mentioned before, notwithstanding some limited processing differences (Emmorey et al. 2011). The answers were always given in the same linguistic modality (LGP/OP or WP) in which the task was instructed, with WP being the linguistic modality common to both groups.

For the first time, the semantic organization of deaf individuals is approached using their natural language and concerning their sensory-modality capabilities in parallel with the natural language of hearing individuals, adding the possibility of analysing their performance in the same tasks via a linguistic modality common to both groups.

2.3.1. Stimuli

According to the revised literature, the construction of the semantic stimuli used in the task was based on two categories: living things and artefacts. As studies show, it is of interest to consider these two types of categories, since they are processed in different neural parts of the brain (Chao et al. 1999, Noppeney et al. 2006, Mahon et al. 2007),
exhibiting differences in the way they are treated (Martin 1996; Rossin et al. 2002; Gainotti, 2000).

Each of these main categories has 4 sub-categories: (i) living things (marine animals, terrestrial animals, fruits and vegetables); (ii) artefacts (furniture, school and office supplies, clothes and kitchenware). No studies have been found regarding high frequency categorial exemplars that focus on the performance and organization of the semantic knowledge of deaf individuals. Thus, to assist in the construction and selection of categories and exemplars for the present tasks, categories were selected with the familiarity criterion, taking into consideration common categories frequently encountered in the daily life of deaf and hearing individuals. Based on Pinto (1992), the following subcategories were chosen: terrestrial animals, marine animals, fruits, vegetables, furniture, school and office supplies, clothes and kitchenware.

Bearing in mind that categorial exemplars do not have the same status and that people remember and access the typical and familiar ones faster than other more unusual exemplars (Ibid.), it was essential to use stimuli with high occurrences in these tasks containing lexical access and semantic memory goals. For example, dish or glass are occur more frequently than grater in kitchenware tasks. In this sense, the selection of categorial exemplars for this dissertation was essentially grounded in Pinto 1992, a study on frequency production and the typicality of categories and categorial exemplars, based on Battig & Montague (1969).

The selected stimuli were used to construct the three tasks: category fluency task, three-word free association task and semantic categorization task. Before establishing the last version of used tasks, a pre-test was carried out on two deaf individuals to check whether the tasks were suitable for the type of information it was required to analyse semantic processing. After these pre-tests, the instructions for the three-word free association tasks were modified to guide the deaf participants to focus more on a single associated sign and not on related events or on the detailed description of attributes of the object.

Participants were tested individually in a quiet room with a professional LGP interpreter to give the task’s instructions and to help with the translation of the signed responses. OP and LGP responses were all written down with the exception of the Category Fluency Task, which in addition to being registered in a specific task document were also video-recorded.
2.4. Task 1 – Category Fluency Task

Verbal Fluency tests are frequently used in clinical and experimental research in neuropsychology. In general, the task is to produce the greatest number of words from a restricted category or phonological segment and within a given time limit. There are several types of tasks that measure verbal fluency: per letter in orthographic responses, phonological segments in verbal responses and semantically in category domains. These type of tasks, consequently assess language function (vocabulary size, naming), response speed, mental organization, search strategies and long-term memory all of which are considered useful tools to analyse the capacity of semantic association and the fluency of cognitive performance.

This type of oral, orthographic, and now signed, test is used to define the status of lexical and semantic memory by observing the assessment strategies to answer the instructions.

2.4.1. Materials and Procedure – Category Fluency Test

As has been shown, the categories selected were based on two main categories: living things and artefacts. As with the other two tasks, the fluency test was also divided in two parts: test A with terrestrial animals, vegetables, school and office supplies and kitchenware as categories, and the test B with marine animals, fruit, furniture and clothes as categories. The categories always corresponded to the same part of the test, the only modified stimulus was the language performed.

All participants were tested individually in a quiet room. Each individual was instructed to generate as many words as possible for each category. The instructions to deaf and hearing individuals were the same, only the action verb was changed depending on the language or language modality used: “Gestue/Diga/Escreva o nome de todos os animais terrestres que se lembre.” – “Sign/Say/Write the name of all terrestrial animals that you can think of.”.

When deaf participants signed, all signs were written down to ensure that all were registered. Additionally, to improve the phonological analysis, the performances of signing responses in this task were also video-recorded. When the task was performed in WP, the task was presented on paper in printed-form and each categorial task was
viewed and performed one at a time as with the LGP and OP sections (see appendix D).

To perform the task, for each category were given 60 seconds to deaf and hearing individuals.

2.5. Task 2 – Three-word Free Association Task

This second task was designed to explore how deaf individuals organize taxonomic information. Three-word free associations were given by deaf and hearing individuals in response to a selected set of category members, in two language modules. In general, in a word free association task, common responses given by vast numbers of individuals are assumed to reflect both high levels of familiarity and strong associations with the stimulus. On the basis of earlier findings, the evaluation of the free association test’s responses can be verified in two ways: infrequent responses are assumed to be less familiar to the test group and/or weakly associated with the stimulus; stimuli that produce strongly interconnected sets of responses are assumed to be familiar and to be representative of well-organized knowledge, whereas stimuli that produce weak-agreement responses or that many individuals fail to respond to are assumed to be less familiar and to represent less organized concepts (Chaffin 1997).

By comparing the responses of different groups of individuals with different available sensory-modalities and distinct natural languages, it is possible to measure knowledge differences that may underlie differential cognitive performance in such areas as memory, problem solving, reading and writing.

2.5.1. Materials and Procedure – Three-Word Free Association Test

The present task used one exemplar from each category of the main two classes to elicit three words in free association with the exemplar. The selection of the stimuli was based on the frequency of occurrence tables in Pinto (1992). Exemplars that were in the top six of the corresponding category of the frequency list were selected. For each part of the test one of each exemplar was selected: (i) part A contained *foca* (seal), *elefante* (elephant), *laranja* (orange), *cogumelo* (mushroom), *caneta* (pen), *faca* (knife); (ii) part B contained *tubarão* (shark), *macaco* (monkey), *melancia* (watermelon), *cenoura* (carrot), *caderno* (exercise book), *copo* (glass).
The instructions were always the same for each language version, altering only the action verb corresponding to the language: “Gestue/Diga/Escreva as primeira três gestos/palavras que se lembra quando vê/ouve/lê a gesto/palavra-alvo. Como por exemplo, a gesto/palavra relógio poderá lembrar horas, tempo, despertador – “Sign/Say/Write three signs/words that come to mind when you see/hear/read the following target sign/word. As an example, with the sign/word watch you may recall hours, time, alarm clock.”.

After having performed the pre-tests, and throughout the application of this task with deaf individuals, it was always felt the need to make a previous remark that what was asked for were isolated signs and not events related to the object: “É pedido que produza gestos isolados que relaciona com o gesto-alvo. Não é pedido que fale de um acontecimento relacionado com o objeto ou que o descreva.” – “It is requested that you produce isolated signs connected to the sign-target. You are not asked to talk about an occurrence associated with the object.”.

The instructions were always produced in the same language of the targeted response language, (see appendix E).

This three-word free association test was performed without a time limit, the goal being to answer with the three words requested.

2.6. Task 3 – Categorization Task

It is expected that with these three tasks it is possible to analyse and verify the influence of participants’ linguistic modality and experiential knowledge on semantic memory organization, concerned with their sensory-modality capabilities and attest if the differences in the structural linguistic system are both the main cause of structural dissimilarities in semantic retrieval and categorization with hearing individuals, as literature reveals.

2.6.1. Materials and Procedure – Categorization Task

The participants were provided with thirteen slides and each slide had one pair of pictures of category exemplars.

The stimuli consisted of real pictures taken from a Google web search, outlined in white and projected on a slide with a black background. Picture dimensions were
manipulated to correspond to the real size differences among different objects, for example, the picture of bed was bigger than chair. All pictures belonged to six different semantic categories used in the previous tasks from the two main classes of living things and artefacts. The selected exemplars were chosen from the first six exemplars presented in the categorial frequency list from Pinto (1992), except when two or more lexical forms were found that in reality name the same object. For example, in Portuguese tacho and panela corresponds to the same kitchenware object ‘pot’. Table 3 provides a list of all stimulus pairs.

<table>
<thead>
<tr>
<th>Terrestrial Animals</th>
<th>Gato (Cat)</th>
<th>Cavalo (Horse)</th>
<th>Vaca (Cow)</th>
<th>Cão (Dog)</th>
<th>Leão (Lion)</th>
<th>Coelho (Rabbit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Animals</td>
<td>Peixe (Fish)</td>
<td>Tubarão (Shark)</td>
<td>Golfinho (Dolphin)</td>
<td>Lula (Squid)</td>
<td>Polvo (Octopus)</td>
<td>Lagosta (Lobster)</td>
</tr>
<tr>
<td>Fruit</td>
<td>Ananás (Pineapple)</td>
<td>Pera (Pear)</td>
<td>Laranja (Orange)</td>
<td>Maçã (Apple)</td>
<td>Banana (Banana)</td>
<td>Morango (Strawberry)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Batata (Potato)</td>
<td>Alfase (Lettuce)</td>
<td>Cebola (Onion)</td>
<td>Tomate (Tomato)</td>
<td>Couve-flor (Cauliflower)</td>
<td>Cenoura (Carrot)</td>
</tr>
<tr>
<td>Furniture</td>
<td>Sofá (Sofa)</td>
<td>Cómada (Chest of Drawers)</td>
<td>Mesa (Table)</td>
<td>Armário (Wardrobe)</td>
<td>Cama (Bed)</td>
<td>Cadeira (Chair)</td>
</tr>
<tr>
<td>School &amp; Office Supplies</td>
<td>Agrafador (Stapler)</td>
<td>Marcador (Marker)</td>
<td>Caneta (Pen)</td>
<td>Lápis (Pencil)</td>
<td>Furador (Hole Punch)</td>
<td>Corretor (Correction Fluid)</td>
</tr>
<tr>
<td>Clothes</td>
<td>Saia (Skirt)</td>
<td>Camisa (Shirt)</td>
<td>Calças (Trousers)</td>
<td>Meias (Socks)</td>
<td>Boxers (Boxers)</td>
<td>Casaco (Jacket)</td>
</tr>
<tr>
<td>Kitchenware</td>
<td>Prato (Dish)</td>
<td>Copo (Glass)</td>
<td>Tacho (Pot)</td>
<td>Colher (Spoon)</td>
<td>Frigideira (Pan)</td>
<td>Faca (Knife)</td>
</tr>
</tbody>
</table>

Table 3: Selected category exemplars represented by stimuli pairs.

Some stimuli were randomly paired and, in order to create the categories, some were paired based on one of their functional features (for example, the object orange was paired with a glass) or semantic relations (for example, chair was paired with bed). After the stimulus pairs were constructed, it was establish which were the correct pairs and which were the categories from each stimulus pair or from each item.
The task consisted in deciding whether the stimulus pairs belonged to the same category and in naming the belonged category/ies (of the pair or of each one), with the instruction: “Gestue/Diga/Escreve se os objetos que visualiza são ou não da mesma categoria. Nomeie a que categoria pertence o par ou cada um dos objetos.” – “Sign/Say/Write if the pair of objects belong to the same category. Name the category of the pair or of each object.”. As in the other tasks, the task instructions were given in the language version of the required language response, (see appendix F). Before presenting the stimuli, deaf adults perform an example of the task to verify if the instructions were clearly understood.

The categorization task was performed without a time limit, the goal being to name the categories of presented pairs of pictures.

It is expected that with these three tasks, that access different aspects of semantic processing, we can analyse and verify the influence of participants’ linguistic modality and experiential knowledge on semantic knowledge organization, concerned with their sensory-modality capabilities and attest if the differences in the structural linguistic system are both the main cause of structural dissimilarities in semantic retrieval and categorization with hearing individuals.
3. ANALYSIS PROCEDURES

In the following, it is described the analysis procedure of the exploratory study conducted.

This study is based on three semantic tasks, which attempt to capture linguistic modality effects during semantic processing in deaf individuals. For the first time, linguistic modality was observed in a comparative analysis between deaf and hearing individuals, where the obtained responses were analysed based on their linguistic units (phonological and lexical) and semantic category clusters. Concerning the numerous procedures used to analyse the obtained data, I will present the classification procedures and rating results.

3.1. Classification Procedures

The collected data from the three tasks of this study (fluency task, three-word free association task and categorization task) were analysed according to four types of comparisons regarding the established hypothesis (see page 17 in methods): (1) linguistic modalities performed by deaf participants – LGP vs. WP; (2) between distinct sensory-modality languages of the deaf and hearing group – LGP vs. OP; (3) between the same linguistic modality (WP) performed by the two groups; OP; and (4) between the same linguistic modality in two version OP-WP by hearing participants (figure 1).

![Figure 1: The four comparative analyses in this study.](image_url)

The first phase of the data analysis was the validation of the given responses. Aside from the following descriptions about how linguistic and semantic classification
procedures were determined and adjusted to classify the data, it is important to define which exclusion and inclusion criteria were applied in validating the data. Firstly, responses were glossed using the equivalent Portuguese word, with the recognition of fingerspelling as well. The criteria used to validate the responses were: (a) a response and any inflectional variations were treated as one response (e.g. fruit, fruits); (b) a response and its derivatives were counted separately (e.g. poison, poisonous); and (c) repeated words were considered. The exclusion criteria were: (a) intrusions, i.e. items that clearly do not corresponded to the given stimuli category, were not taken into account (e.g. dolphin, when it was asked to give names of terrestrial animals); (b) concerning the required linguistic task, images were not accepted in place of written words in the responses of deaf individuals. Such errors were only found in the fluency task.

After the data validation, two distinct classes (linguistic and semantic) were established to classify the connections between stimuli and responses among the four analysable possibilities. The objective was to identify which strategy was most used in the number of signs or words produced. The responses from the two first experiments (fluency test and three-word free association test) were analysed and classified according to two cognitively accessed classes when retrieving world referents: (1) linguistic classification to find phonological and lexical clusters and relations between the items, (2) semantic classes to capture the changing meaning connections among the responses. The third experiment was analysed according to the correct or incorrect responses given and the type of semantic category assigned to the pair of images or to each single image.

3.1.1. Linguistic Classification Procedures

In order to analyse the linguistic clusters presented in the obtained responses, it is fundamental to identify the phonological and lexical aspects of the working languages. For this purpose, the verified phonological and lexical types of linguistic clusters were enumerated and comparative variables between the two languages (LGP and OP) were determined.

Despite the difference in sensory-modality, LGP, like other sign languages, is constituted by sub-lexical morphological structures (Stokoe 1960) that are represented
by phonological segments - handshape, location (place of articulation), movement and facial expression (Moita et al. 2011, 2012) – and phonological syllables (Sandler & Lillo-Martin 2006; Sandler 2008). The phonological segments of SP are represented by consonants and vowels and their connections create phonological and prosodic syllables (Mateus & Andrade 2000). For this study, in addition to these phonological segments and syllables, the lexical components of compounds were also considered to evaluate their linguistic influence on cognitive tasks.

But firstly, since the greatest difference between sign and oral languages is their sensory modality, which results in distinct phonological structures, it is fundamental to provide a brief description of LGP phonology and sign language syllabification. Besides the visual perception of sign languages, another factor that characterizes their motor production is the three possible components of hands, face and body.

Application of LGP phonological structure in the analysis is based on the recent systematic approach of the phonological structure of signs in LGP (Moita et al. 2011, 2012), grounded in the three sequentially combined major categories from the Hand-Tier Model (Sandler, 2012; Sandler & Lillo-Martin, 2006). Each sign language tends to use only a limited number of handshapes, locations and movements. Given all current models, the Hand-Tier model is, so far, the one that linguistically presents the most reasonable answers to sign behaviour in LGP. Bearing in mind that no linguistic model is completely satisfactory for any language, there are always unexplained aspects to work on. The analysis and description of a language is an on-going study. In this context, the three major categories of phonological LGP will be briefly presented:

- **Handshape** is probably the most visible main segmental parameter in the articulation of the sign. By observing the parameters between contrastive lexical units in LGP, Moita et al. (2012) collected the largest possible number of handshapes used in LGP leaving for later the judgement and assessment of what has phonological or phonetic value. In the same study this phonological parameter was divided into two sub-parameters: (a) finger selection; and (b) finger position. The internal movement, which is defined by the change of handshape, is also included in this phonological structure. This phonological parameter occurs simultaneously in the production of the others parameters.
• **Location** refers to the body parts or space that surrounds the signer where sign articulation can be performed. This phonological parameter is described by: (a) two distinct locations in the lexical sign performance in which the articulator moves from start to end location; and two multi-associated sub-parameters, (b) point of contact and (c) mode of contact.

• **Movement** corresponds to the continuous path of the articulator from one location to another in different and limited ways, resulting in the medial position between the points of location. Two defining features of this parameter were founded in LGP: (a) direction, which is traced by the turn of the path that causes the articulator during the articulation of the sign; and (b) the articulation mode that is defined by the way the movement is performed.

Underling these phonological articulatory differences between sign and spoken languages, it is observable that phonological segments in sign languages occur sequentially and simultaneously (Sandler 2012; Sandler & Lillo-Martin 2006), and not just sequentially like the phonological segments in spoken languages (Mateus & Andrade 2000). Despite these differences, sign languages have phonological and prosodic units within the signs, which can be labelled as syllables, constituting the highest phonological units within the words of sign languages (Sandler 2008).

A syllable in sign language is defined by two phonological segments corresponding to the handshape and movement parameters (Brentari 1998; Sandler 2008): (a) internal movement, which is marked by the change of handshape; (b) path movement, which is the course between the start and end location; (c) the occurrence of both internal and path movement simultaneously. The sign syllable structure is evident in the onset and rhyme, due to the physical articulatory elements. It is not possible to have two different locations before the nucleus, since the nucleus element can be the path movement from one location to another, nor is it possible to have two different handshapes preceding the nucleus, since the changing of handshape (internal movement) can be an element of the nucleus. For the same reason, these phenomena would also not be possible in the coda position. In spoken languages, syllables usually have a vowel as a required constituent which defines its nucleus or central element. This nucleus can be preceded or followed by one or more consonants (figure 2). Different spoken languages have their constraints about the occurrence of consonants in the onset and coda, and in the number of syllables in a word.
This is the first comparative analysis focusing on linguistic modality effects in semantic retrieval between sign language and spoken language. Hence, it is the first phonological analogy between phonological segments and syllables from different modality languages for the purpose of comparable analysis.

![Diagram of syllable structures]

*Figure 2: The syllable structures of each language modality. The first figure represents the syllable structure of sign language, and the second corresponds to that of spoken languages.*

The lexical analysis was based on two elements in compounds: (a) the initial lexical element in the compound; and (b) the last lexical element in the compound. A compound is a word formed by two or more root words, for example *bedroom*, *football*, etc.

Firstly, to obtain a correlated classification between the phonological and lexical elements from both languages, clusters with these elements were identified in the responses, i.e. when two or more signs or words were sequentially performed with a particular phonological segment, syllable or lexical component. The types of phonological clusters found were: first segment (S1), first syllable (SI), final syllable (SF). The types of lexical clusters found first lexical component (COMPI) and final lexical component (COMPF). It is important to note that WP is typically conditioned by the phonological production of SP. After this, an analogy was established between the phonological and lexical elements of both modalities languages (sign and spoken languages):

→ S1 cluster is defined by the start location or first handshape that matches with the first segments of SP (first letter of the word). Although LGP’s syllable structure is not defined in the literature with an onset position or a possible first element in the
rhyme (since there is no rhyme), this decision was based on the possible elements of
the sign nucleus, since those segments are initially performed by the start location
from path movement or by the first handshape from internal movement. For example,
there is a phonological cluster S1 in LGP signs corresponded to LEÃO ‘lion’ and
TIGRE ‘tiger’ via the handshape claw.

→ SI cluster corresponds to the initial syllable of both languages’ lexical
components: first path movement and/or first internal movement in LGP signs and the
first onset plus rhyme elements in SP words. For example, there is a phonological
cluster SI in LGP signs corresponding to POLTRONA ‘armchair’ and SOFÁ ‘couch’
via the path movement.

→ SF cluster represents the final syllable of both languages’ lexical units: final
path movement and/or final internal movement in LGP signs and the final onset plus
rhyme elements in SPs word. For example, there is a phonological SI cluster between
LGP sign responses corresponding to TIGRE ‘tiger’ and PANTERA ‘panther’ via the
final path movement.

→ COMPI cluster is defined as the initial lexical component in a compound. For
example, there is a phonological cluster COMPI in LGP signs corresponding to
TUBARÃO BRANCO ‘whith shark’ and TUBARÃO MARTELO ‘hammerhead
shark’ via the first signed lexical component TUBARÃO.

→ COMPF cluster is determined by the final lexical component in a compound.
For example, there is a phonological cluster COMPF in LGP signs corresponding to
OURIÇO-DO-MAR ‘sea urchin’ and ESTRELA-DO-MAR ‘starfish’ by the final
signed lexical component MAR.
Thus, to each of these three phonological values (S1, SI and SF) one or more phonological segment values were matched regarding their phonological structure and occurrence in the sign. It is important to underline that the phonological structure of a sign is not only sequential but also simultaneous, therefore it is possible to join more than one type of segment.(table 4).

<table>
<thead>
<tr>
<th>LGP Phonological Segments/Syllables/Lexical Components</th>
<th>SP Phonological Segments/Syllables/Lexical Components</th>
<th>SP/ WP Phonological Segments/Syllables/Lexical Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIGN’S FIRST HANDSHAPE</td>
<td>WORD’S FIRST SEGMENT</td>
<td>S1</td>
</tr>
<tr>
<td>SIGN’S FIRST LOCATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIRST PATH MOVEMENT</td>
<td>WORD’S INITIAL SYLLABLE</td>
<td>SI</td>
</tr>
<tr>
<td>+ FIRST INTERNAL MOVEMENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FINAL PATH MOVEMENT</td>
<td>WORD’S FINAL SYLLABLE</td>
<td>SF</td>
</tr>
<tr>
<td>or/plus FINAL INTERNAL MOVEMENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INITIAL LEXICAL COMPONENT</td>
<td>INITIAL LEXICAL COMPONENT</td>
<td>COMPI</td>
</tr>
<tr>
<td>FINAL LEXICAL COMPONENT</td>
<td>FINAL LEXICAL COMPONENT</td>
<td>COMPF</td>
</tr>
</tbody>
</table>

Table 3 The phonological correlation between segments, syllables and lexical components from each language (LGP and SP) and their represented symbols used in the phonological analysis.

3.1.2. Semantic Classification Procedures

Semantic clustering was coded to verify if there are semantic differences between different modality languages in retrieving world objects. All responses with potential semantic clustering were coded and the same criteria was used in both modality languages. To obtain comparative semantic clustering results from the responses, the types of semantic clustering in both groups’ responses were verified and then the classification of the clusters was established. The identified semantic clusters of the fluency task responses were different for each given semantic category stimuli (figure 3):
The coded semantic clusters from the three-word free association task were the same for all semantic category exemplar stimuli:

→ **CATEGORY**, when the assigned word was the category from the exemplar stimulus. For example, *vegetables* as an associated word from the stimulus *carrot*.

→ **COLOUR**, when the assigned word was related to the colour of the object. For example, *red* as an associated response from the stimulus *watermelon*.
→ **CONSTITUENT**, when the assigned word belonged to some physical part of the given exemplar. For example, *trunk* as an associated item from the stimulus *elephant*.

→ **DERIVATIVE**, when the assigned word represented one derived item from the stimulus. For example, *juice* as an associated response from the stimulus *orange*.

→ **EXEMPLAR**, when the assigned word was associated with an exemplar from the same stimulus category. For example, *pencil* as linked to the stimulus *pen*.

→ **HABITAT**, when the assigned word corresponded to the habitat or the locale which is normally where the given stimulus is located. For example, *sea* or *zoo* as associated items with the stimulus *seal*.

→ **MATERIAL**, when the assigned word was related to the type of material that constituted the given stimulus. For example, *metal* or *iron* as associated items to the stimulus *knife*.

### 3.2. Semantic Classification in Categorization Task

Analysis of the third test, the categorization task, was based on different variables. Classification of the responses was based on semantic decisions: right and wrong responses and assigned categories. As specified in the methods chapter, the participant was instructed to answer whether the stimulus pairs belonged to the same category and to name the category. Thus, the conducted analysis was:

(a) if the first answer was in accordance with presented stimulus pairs category/ies, the response was marked as right;

(b) if the first answer was right but the assigned categories were not in accordance with the stimulus pairs, the response was marked as right but with incorrect categories;

(c) if the first answer was not in accordance with stimulus pairs, the response was marked as wrong.
4. RESULTS

In the following chapter, the results are presented based on four the variables resulting from the analysis procedure: number of responses, linguistic clusters, semantic clusters, and semantic decisions. The comparative results are presented in order of the proposed hypotheses. In addition, the statistical methods used and the descriptions of representative ratings are presented.

4.1. Statistical Methods

The study was designed for comparative research, and therefore, standard inferential statistics were used to analyse the data. Firstly, the normality of all responses ratings were checked with the normality Shapiro-Wilk test. After taking into account the validated responses, parametric and non-parametric tests were carried out according to the type of comparison data: (a) T-Student Test (parametric) and Mann-Witney test (non-parametric), when the comparison was between independent samples; (b) T-Test (parametric) and Wilcoxon Test (non-parametric), when the comparison was between two related samples.

Results related to the number of responses and clusters are presented with the following values: Mean (M), Standard Deviation (±SD), Minimum Values (Min.), and Maximus Values (Max.). Statistical comparisons on paired samples are presented based on p-value.

The results are presented separately in three parts according to the three experimental tasks. Categorial fluency task was analysed based on the variables: number of responses, linguistic clusters and semantic clusters. Thre-word free association task was examined based on the variables: linguistic clusters and semantic clusters. Semantic categorization Task was analysed based on the variable semantic decisions.

4.2. Hypothesis 1

*Deaf individuals have better results when they perform semantic retrieval tasks in the natural modality language, which is adequate to their modality capacities, in comparison with the results performed in the written language.*
To substantiate the hypothesis, the results of LGP responses and the responses in WP from the deaf group were compared. In this comparison, the goal was to verify if there were differences depending on linguistic modality.

### 4.2.1. Category Fluency Task Results

The first aim of comparison was to assess the impact of linguistic modality between the given responses for each language performed by deaf individuals in the category fluency task, according to the number of response words, linguistic clusters and semantic clusters. The comparisons between LGP and WP in the deaf group were verified using the Wilcoxon Signed Ranks test. Comparisons showed significant differences between the total number of given words in LGP and WP (p < 0.04). The comparison based on the linguistic and semantic cluster results reveal significant differences between linguistic clusters from the different modality languages (p < 0.01). Despite these significant differences between LGP and WP in a number of given words and linguistic clusters, the semantic clusters reveals no significant differences in the use of semantic clusters between LGP and WP in deaf individuals (p > 0.05). (table 5).

<table>
<thead>
<tr>
<th></th>
<th>Deaf Group (n=10)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LGP</td>
<td></td>
<td></td>
<td>WP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M ±SD</td>
<td>Min. - Max</td>
<td></td>
<td>M ±SD</td>
<td>Min. - Max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nb of given words</td>
<td>65,90 ± 10,18</td>
<td>49 - 78</td>
<td></td>
<td>50,30 ± 7,10</td>
<td>44 - 66</td>
<td>p &lt; 0.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linguistic Clusters</td>
<td>10,10 ± 2,96</td>
<td>4 - 14</td>
<td></td>
<td>6,50 ± 3,10</td>
<td>4 - 14</td>
<td>p &lt; 0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semantic Clusters</td>
<td>12,80 ± 2,20</td>
<td>9 - 16</td>
<td></td>
<td>10,20 ± 1,56</td>
<td>7 - 14</td>
<td>p &gt; 0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 4: Comparison of the number of given words, linguistic clusters and semantic clusters between LGP and WP in deaf individuals’ performance in the category fluency task.*
4.2.2. *Three-word Free Association Task Results*

To examine the linguistic modality in deaf individuals between LGP and WP during the semantic retrieval performance in a semantic free association task, the linguistic and semantic clusters were compared using the method of the Wilcoxon Signed Ranks test. Comparisons revealed no significant differences between either of the compared elements: linguistic clusters between LGP and WP (p>0.29) and semantic clusters between LGP and WP (p>1.0) (table 6).

| Deaf Group (n=10) |  |  |  |  |
|------------------|------------------|------------------|
|                  | LGP              | WP               |  |
| **Linguistic Clusters** | **M±SD** | **Min.-Max** | **M±SD** | **Min.-Max** | **P** |
| Linguistic Clusters | 2.70 ±1.76      | 1 - 6            | 2.00 ±1.56 | 0 - 5       | p>0.29 |
| Semantic Clusters  | 10.00 ±3.90      | 4 - 14           | 9.90 ±3.03 | 10 - 12     | p>1.0  |

*Table 5: Comparison of linguistic clusters and semantic clusters between LGP and WP in deaf individuals’ performance in the three-word free association task.*

4.2.3. *Categorization Task Results*

The assessment of results from the categorization task performed by the deaf individuals aimed to verify whether or not semantic organization principles are affected by linguistic modality. The comparison between the two performed linguistic modalities (LGP and WP) were based on correct answers (Corr. Ans.) using the T-Test. The results show no significant differences between the compared elements: Corr. Ans. (p>0.29) (table 7).
### Deaf Group (n=10)

<table>
<thead>
<tr>
<th></th>
<th>LGP</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M ±SD Min. - Max</td>
<td>M ±SD Min. - Max</td>
</tr>
<tr>
<td>Corr. Ans.</td>
<td>11,30 0,82 10 - 12</td>
<td>10,80 0,91 10 - 12</td>
</tr>
</tbody>
</table>

**Table 6:** Comparison of correct answers (Corr. Ans.), correct answers with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors) between LGP and WP in deaf individuals’ performance in the categorization task.

The comparison results from errors responses from the categorization task are only presented by their Mean (M) and Standard Deviation ±SD since the occurrences are too low to be significantly valued. The errors responses are: the correct answer with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors) (table 8).

<table>
<thead>
<tr>
<th></th>
<th>LGP</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M ±SD Min. - Max</td>
<td>M ±SD Min. - Max</td>
</tr>
<tr>
<td>Corr. Ans. + Cat. Err.</td>
<td>0,30 0,67 0 - 2</td>
<td>0,30 0,70 0 - 2</td>
</tr>
<tr>
<td>Errors</td>
<td>0,40 0,51 0 - 1</td>
<td>0,67 0,82 0 - 2</td>
</tr>
</tbody>
</table>

**Table 7:** Mean, Standard Deviation, and Minim and Maxim Results on LGP and WP performance in the categorization task by deaf individuals, correct answer with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors).

### 4.3. Hypothesis 2

*Deaf individuals have similar results in comparison with hearing individuals when both groups perform semantic tasks in their natural modality languages (sign language for deaf and spoken language for hearing individuals).*

To test the hypothesis, the results of the performed data on natural languages by each group (LGP by deaf group and OP by hearing group) were compared. In this comparison, the goal was to examine if there are differences between two languages that are distinct in their modality, but adequate in terms of the sensory capabilities of each group.
4.3.1. Category Fluency Task Results

To examine the effect of natural languages in both groups, the results from the data obtained in the category fluency task were compared. The comparisons between LGP and OP results from both groups were related using the Mann-Witney test. The comparison was based on the number of given words, linguistic clusters and semantic clusters from both groups. The compared results showed significant differences in the results from the linguistic clusters used (p<0.001). The comparisons of the number of given words and semantic clusters between the two groups do not show significant differences: LGP/OP number of given words (p>0.45) and LGP/OP and semantic clusters (p>0.79) (table 9).

<table>
<thead>
<tr>
<th></th>
<th>Deaf Group (n=10)</th>
<th>Hearing Group (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LGP</td>
<td>OP</td>
</tr>
<tr>
<td>M</td>
<td>±SD</td>
<td>Min. - Max</td>
</tr>
<tr>
<td>Nb of given words</td>
<td>65.90 (10.18)</td>
<td>49 - 78</td>
</tr>
<tr>
<td>Linguistic Clusters</td>
<td>10.10 (2.96)</td>
<td>4 - 14</td>
</tr>
<tr>
<td>Semantic Clusters</td>
<td>12.80 (2.20)</td>
<td>9 - 16</td>
</tr>
</tbody>
</table>

Table 8: Comparison of the number of given words, linguistic clusters and semantic clusters between the deaf group and hearing group in the category fluency task performed in LGP and OP.

4.3.2. Three-word Free Association Task Results

To examine the performance in LGP and OP in the three-word free association task between the deaf group and hearing group during the semantic retrieval, the linguistic and semantic clusters used were compared. The comparisons were conducted using the Mann-Witney test. Comparisons revealed no significant differences between either group: LGP/OP linguistic clusters between the deaf groups and hearing group (p>0.16) and LGP/OP semantic clusters between the deaf groups and hearing group (p>0.79) (table 10).
### Table 9: Comparison of linguistic clusters and semantic clusters, between the deaf group and hearing group in the three-word free association task performed in LGP and OP respectively.

<table>
<thead>
<tr>
<th></th>
<th>Deaf Group (n=10)</th>
<th>Hearing Group (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LGP</td>
<td>OP</td>
</tr>
<tr>
<td></td>
<td>M ±SD Min. - Max</td>
<td>M ±SD Min. - Max</td>
</tr>
<tr>
<td>Linguistic Clusters</td>
<td>2.70 ±1.76 1 - 6</td>
<td>1.70 ±1.33 0 - 4</td>
</tr>
<tr>
<td>Semantic Clusters</td>
<td>10.00 ±3.90 4 - 14</td>
<td>9.70 ±3.26 4 - 15</td>
</tr>
</tbody>
</table>

4.3.3. **Categorization Task Results**

The assessment of results from the categorization task performed by the deaf group and hearing group in LGP and OP aimed to verify whether or not semantic organization principles are affected by distinctly acquired linguistic modalities using the T-Student Test. The comparison between the two groups were based on correct answers (Corr. Ans.) (p>0.39) (table 11).

### Table 10: Comparison of correct answers (Corr. Ans.) between the deaf group and hearing group in the categorization task performed in LGP by the deaf group and OP hearing group.

<table>
<thead>
<tr>
<th></th>
<th>Deaf Group (n=10)</th>
<th>Hearing Group (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LGP</td>
<td>OP</td>
</tr>
<tr>
<td></td>
<td>M ±SD Min. - Max</td>
<td>M ±SD Min. - Max</td>
</tr>
<tr>
<td>Corr. Ans.</td>
<td>11.30 ±0.82 10 - 12</td>
<td>10.19 ±0.99 10 – 12</td>
</tr>
</tbody>
</table>

The comparison results from errors responses of the categorization task are only presented by their Mean (M) and Standard Deviation ±SD since the occurrences are too low to be significantly valued. The errors responses are: the correct answer with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors) (table 12).
Table 11: Mean, Standard Deviation and Minim and Maxim Results in the categorization task in LGP by the deaf group and OP hearing group, correct answer with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors).

<table>
<thead>
<tr>
<th></th>
<th>Deaf Group (n=10)</th>
<th>Hearing Group (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LGP</td>
<td>OP</td>
</tr>
<tr>
<td><strong>M ±SD Min. - Max</strong></td>
<td><strong>M ±SD Min. - Max</strong></td>
<td></td>
</tr>
<tr>
<td>Corr. Ans. + Cat. Err.</td>
<td>0.30 ± 0.67 0 - 2</td>
<td>0.20 ± 0.42 0 - 1</td>
</tr>
<tr>
<td>Errors</td>
<td>0.40 ± 0.51 0 - 1</td>
<td>0.90 ± 0.87 0 - 2</td>
</tr>
</tbody>
</table>

4.4. Hypothesis 3

*Deaf individuals have poorer results in comparison with hearing individuals when both groups perform the semantic tasks in the written language modality.*

To verify the hypothesis, the results of the performed data on WP between both groups (deaf group and hearing group) were compared. In this comparison, the goal was to verify if there are differences depending on linguistic modality.

4.4.1. *Category Fluency Task Results*

To assess the effect of the same linguistic modality in the written language between two groups which acquired and used this language modality in distinct ways, the results from data obtained from the category fluency task were compared. The comparisons between WP results from both groups were related using the Mann-Witney test. The comparison was made based on the number of given words, linguistic clusters and semantic clusters from both groups. The compared results showed significant differences between deaf and hearing groups in the WP linguistic clusters used (p<0.001). The comparisons of number of WP given words and WP semantic clusters between the two groups do not show significant differences: number of given words (p>0.39) and semantic clusters (p>0.12) (table 13).
### 4.4.2. Three-word Free Association Task Results

To assess the performance in WP in the three-word free association task between the deaf group and hearing group during semantic retrieval, the linguistic and semantic clusters were compared. The WP results from both groups were related by using the Mann-Witney test. Comparisons revealed no significant differences between both groups: WP linguistic clusters between the deaf groups and hearing group (p>0.16) and WP semantic clusters between the deaf groups and hearing group (p>0.68) (table 14).

|                         | Deaf Group (n=10) | Hearing Group (n=10) |
|-------------------------|-------------------|----------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|                         | WP                | WP                   |                  |                  |                  |                  |                  |                  |
|                         | M ±SD             | Min. - Max           | M ±SD            | Min. - Max       | P                |
| Nb of given words       | 50,30             | 7,10                 | 44 - 66          | 57,80            | 4,63             | 51 - 64          | p>0.39           |
| Linguistic Clusters     | 6,50              | 3,10                 | 4 - 14           | 7,80             | 2,39             | 4 - 12           | p<0.01           |
| Semantic Clusters       | 10,20             | 1,56                 | 7 - 14           | 12,10            | 2,55             | 8 - 17           | p>0.12           |

*Table 12: Comparison of the number of given words, linguistic clusters and semantic clusters between deaf group and hearing group in the category fluency task performed in WP.*

### 4.4.3. Categorization Task Results

The assessment of results from the categorization task performed by the deaf group and hearing group in WP intended to verify whether or not semantic organization principles are affected by distinctly acquired linguistic modalities, using the T-Student
Test. The comparison between the two groups (deaf group and hearing group) was based on correct answers (Corr. Ans.) (p>0.79) (table 15).

<table>
<thead>
<tr>
<th></th>
<th>Deaf Group (n=10)</th>
<th>Hearing Group (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WP</td>
<td>WP</td>
</tr>
<tr>
<td>Corr. Ans.</td>
<td>10.80 ±0.91</td>
<td>10.90 ±1.10</td>
</tr>
<tr>
<td></td>
<td>10 - 12</td>
<td>9 - 12</td>
</tr>
<tr>
<td></td>
<td>p&gt;0.82</td>
<td></td>
</tr>
</tbody>
</table>

*Table 14: Comparison of correct answers (Corr. Ans.) between deaf group and hearing group in the categorization task performed in WP.*

The comparison results from errors responses of the categorization task are only presented by their Mean (M) and Standard Deviation ±SD since the occurrences are too low to be significantly valued. The errors responses (IBID) are: the correct answer with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors) (table 16).

<table>
<thead>
<tr>
<th></th>
<th>Deaf Group (n=10)</th>
<th>Hearing Group (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WP</td>
<td>WP</td>
</tr>
<tr>
<td>Corr. Ans. + Cat. Err.</td>
<td>0.30 ±0.67</td>
<td>0.20 ±0.42</td>
</tr>
<tr>
<td></td>
<td>0 - 2</td>
<td>0 - 1</td>
</tr>
<tr>
<td>Errors</td>
<td>0.70 ±0.82</td>
<td>0.50 ±0.85</td>
</tr>
<tr>
<td></td>
<td>0 - 2</td>
<td>0 - 2</td>
</tr>
</tbody>
</table>

*Table 15: Mean, Standard Deviation and Minim and Maxim Results in the categorization task in WP by the deaf group and hearing group, correct answer with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors).*

4.5. Hypothesis 4

*Hearing individuals have similar results between the performances of semantic tasks in their natural modality language and in written language modality.*

To substantiate the hypothesis, the results of OP responses and the responses in WP from the hearing group were compared. In this comparison, the goal was to verify if there are differences depending on linguistic modality.
4.5.1. Category Fluency Task Results

To assess the impact of linguistic modality between the given responses from each linguistic modality performed by hearing individuals in the fluency task, the number of given words, linguistic clusters and semantic clusters in both modality languages was compared. The comparisons between OP and WP in the hearing group were verified using the Wilcoxon Signed Ranks test. Comparisons showed no significant differences between the total number of given words (p<0.23), linguistic clusters (p<0.35) and semantic clusters (p<0.30) in OP and WP. (table 17).

<table>
<thead>
<tr>
<th>Hearing Group (n=10)</th>
<th>OP</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>±SD</td>
</tr>
<tr>
<td>Nb of given words</td>
<td>61,00</td>
<td>9,54</td>
</tr>
<tr>
<td>Linguistic Clusters</td>
<td>6,90</td>
<td>1,85</td>
</tr>
<tr>
<td>Semantic Clusters</td>
<td>13,20</td>
<td>3,73</td>
</tr>
</tbody>
</table>

Table 16: Comparison of the number of given words, linguistic clusters and semantic clusters between OP and WP in hearing individuals in the category fluency task.

4.5.2. Three-word Free Association Task Results

To examine the linguistic modality in hearing individuals between OP and WP during the semantic retrieval performance in a semantic free association task, the linguistic and semantic clusters used were compared employing the method of the Wilcoxon Signed Ranks test. Comparisons revealed no significant differences between either of the compared elements: linguistic clusters between OP and WP (p>0.38) and semantic clusters between OP and WP (p>0.68) (table 18).
### Hearing Group (n=10)

<table>
<thead>
<tr>
<th></th>
<th>OP</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M ±SD Min. - Max</td>
<td>M ±SD Min. - Max</td>
</tr>
<tr>
<td>Linguistic Clusters</td>
<td>1.70 ±1.33 0 - 4</td>
<td>1.10 ±1.28 4 - 15</td>
</tr>
<tr>
<td>Semantic Clusters</td>
<td>9.70 ±3.26 4 - 15</td>
<td>9.00 ±3.23 3 - 13</td>
</tr>
</tbody>
</table>

*Table 17: Comparison of linguistic clusters and semantic clusters between OP and WP in hearing individuals performance in the three-word free association task.*

#### 4.5.3. Categorization Task Results

The assessment of results from the categorization task performed by the hearing individuals aimed to verify whether or not semantic organization principles are affected by linguistic modality. The comparison between the two performed linguistic modalities (OP and WP) were based on correct answers (Corr. Ans.), using the T-Test. The results show no significant differences between the compared elements: Corr. Ans. (p>1.00) (table 19).

<table>
<thead>
<tr>
<th></th>
<th>OP</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M ±SD Min. - Max</td>
<td>M ±SD Min. - Max</td>
</tr>
<tr>
<td>Corr. Ans.</td>
<td>10,19 ±0,99 10 - 12</td>
<td>10,90 ±1,10 9 - 12</td>
</tr>
</tbody>
</table>

*Table 18: Comparison between OP and WP in deaf individuals’ performance in the categorization task by comparing correct answers (Corr. Ans.).*

The comparison results values from errors responses of the categorization task are only presented by their Mean (M) and Standard Deviation ±SD since the occurrences are too low to be significantly valued. The errors responses are: the correct answer with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors) (table 20).
Deaf Group (n=10)

<table>
<thead>
<tr>
<th></th>
<th>OP</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>±SD</td>
</tr>
<tr>
<td>Corr. Ans. + Cat. Err.</td>
<td>0.20</td>
<td>0.42</td>
</tr>
<tr>
<td>Errors</td>
<td>0.90</td>
<td>0.87</td>
</tr>
</tbody>
</table>

*Table 19: Mean, Standard Deviation and Minim and Maxim Results on OP and WP performance in the categorization task by deaf individuals, correct answer with error in the assigned category (Corr. Ans. + Cat. Err.) and errors (Errors).*
5. DISCUSSION AND CONCLUSION

In the following chapter, a summary of the work developed in this master’s dissertation is presented. Afterwards, the main results of this study are succinctly described along with their contextualization within the literature on the topic of semantic retrieval in deaf individuals. Finally, critical evaluations of this study are made and future directions are proposed.

5.1. Summary of thesis work

The main goal of this study has been to explore linguistic modality effects on semantic retrieval in individuals with sensory modality auditory deprivation, i.e. deaf individuals. In order to analyse this influence, three semantic retrieval tasks were developed to be accomplished by the participants. These tasks were constructed to explore, define, analyse and compare semantic retrieval and the organization of semantic knowledge in deaf individuals, taking into account their sensorial experience and their natural language modality.

The main contributions of this (master’s) dissertation are presented on two levels. On the experimental design level, cognitive semantic retrieval tasks were designed to include three types of language modality and the creation of a phonological syllable structure of sign languages similar to that of spoken languages, allowing an equivalent analysis between different phonological structures of distinct modality languages.

The exploratory study focused on the issue of addressing linguistic modality effects in the performance of semantic retrieval tasks given the fact that current studies do not grant due attention to the relevance of sensory modality on \textit{which-the}? processing when deaf individuals perform tasks. Driven by the main goal, an exploratory study was designed and conducted to examine four proposed hypotheses (briefly presented in this section): (1) deaf individuals have better results when perform semantic tasks in their natural modality language in comparison with the results in the written modality language; (2) deaf individuals have similar results in comparison with hearing individuals when both groups perform semantic tasks in their natural modality languages (sign language for deaf and oral language for hearing individuals); (3) deaf individuals have poorer results in comparison with hearing individuals when both groups perform the semantic tasks in written language modality; (4) hearing
individuals have similar results between the performances of semantic tasks in their natural modality language (oral language) and in its written representation (written language modality).

The linguistic modality responses of ten deaf individuals and ten hearing individuals were assessed and compared based on their total number of responses, linguistic clusters, semantic clusters and semantic decisions.

5.1.1. *Summary of results*

In the following section, it is presented an overview of the focal findings from each proposed hypothesis.

Regarding that what accounts as comparative results in tasks such as categorial fluency task and categorization tasks are the produced number of responses or the total number of produced variables, it is clear that the present findings confirm the proposed hypothesis. The significance of linguistic clusters effects in semantic processing was not so clear.

- **Hypothesis 1**
  Findings based on the comparison of LGP and WP in deaf individuals showed that performances in LGP were higher in total number of responses and linguistic clustering in categorical fluency test. Assessment on the remaining tasks showed no significant differences between the results of LGP and WP. The findings corroborate the hypothesis.

- **Hypothesis 2**
  Comparisons between deaf individuals and hearing individuals performing semantic tasks on their natural languages showed no significant differences between the three accomplished tasks, except on the linguistic clustering in categorical fluency task. Linguistic clusters were more productive by deaf individuals. The findings corroborate the hypothesis.
Hypothesis 3
Comparisons on WP performance between deaf group and hearing group showed significant differences on WP linguistic clustering in categorial fluency. The remaining tasks demonstrated no significant differences on the assessed results. The findings were unclear, the hypothesis needs further research.

Hypothesis 4
Findings based on the comparison of OP and WP in hearing individuals demonstrated that there are no significant differences on the performance in those two linguistic modalities. The findings corroborate the hypothesis.

5.2. Contextualization of results
In this section, it will be interpreted the findings related to the four hypotheses based on the variables: number of given responses, linguistic clusters, semantic clusters and semantic decision. The interpretations of results are contextualized with literature reports, and in particular cases, detailed comparisons are made. As a matter of organization, the results are discussed according to each semantic task, and not displayed in the order of the established hypothesis of this study.

5.2.1. Category Fluency Task Findings
Previous studies indicate that the number of responses produced on sign languages to categorial fluency tasks by deaf individuals not differ from what is normally reported on tests made by hearing individuals (Liben et al. (1978); Marshal et al., in press; Vletsi et al. 2012). The findings from this exploratory study show similar report with these researches, showing that linguistic modality effects the performance on semantic tasks, even when the studies’ goals are different. When observing the productivity of variables used by deaf individuals on those studies, phonological clusters and semantic clusters, it is reported that there is a higher productivity in semantic clusters (Marshall et al. in press). In the present study, a comparison between productivity of linguistic clusters and semantic clusters in LGP by deaf individuals on the categorial fluency task, it is revealed significant differences
(p<0.02) but with higher productivity on linguistic clusters (see results in page 41), contradictory with the reports of the previous studies. And, looking to the findings on hypothesis 3, where it is compared productivity of semantic clusters produced on natural languages between deaf group and hearing group, it is shown no significant differences on those type of clusters.

Despite the inexistent previous studies focus on the comparison of the performance of deaf individuals between LGP and WP, this study demonstrates significant differences with higher values on signed performance (p<0.04) in the number of responses. This finding emphasizes the linguistic modality effects on semantic processing, evidencing that current researches between deaf and hearing individuals based on written language is unequal and ineffective for understanding the semantic processing in deaf individuals. Comparing the three tasks, fluency task is the one which demonstrate significant differences in the performance of deaf individuals between sign language and written language and in the comparison between the both group of individuals. I speculated that these results are displayed on this task resultant to the production of an unlimited number of words without restricted semantic constraints.

5.2.2. Three-word Free Association Task Findings

On cognitive tasks concerned with taxonomic organization (Marschark et al. 2004), it is reported that lexical knowledge is similar in both groups in terms of overall organization. In the present study no significant differences were verified between the semantic clusters produced by both analysed groups either. The same study (Marshcark et al., 2004) reports strongest relation between category names and exemplars by hearing individuals and asymmetries in the exemplar-category relation by deaf individuals. Although present dissertation goals are concerned about with linguistic modality on semantic processing and not focus about the semantic organization in detail, it was held a comparison of the results from the seven semantic variables used to classify the semantic cluster (appendix XX). The results demonstrate no significant differences between deaf group and hearing group in both linguistic modalities. These findings can not be directly compared with Marshcark et al. (2004) study, since the present study presents more semantic
variables. However, present study demonstrates similar performance between the experimental groups in written modality.

Focusing on the main goal of this master dissertation, in the general findings, this three-word free association task did not reveal significant results, showing no differences between LGP and WP associated words.

5.2.3. Categorization Task Findings

The findings from this study, reveals no significant differences between LGP and WP semantic decisions and between deaf group and hearing group in the same task, contradicting what was report by Ormel et al. (2004) about the comparison of semantic categorization with written words between deaf and hearing individuals.

It was not made a semantic assessment from the assigned categories of this task, concerning the small sample, but with a qualitative interpretation, it could be speculated that deaf individuals demonstrate semantic categorization based on the physical attributes and functional features of the objects. It is important to remind that this is a speculation and further analysis and theoretical framework is required.

5.2.4. Critical evaluation of the exploratory study

The size of the sample is one of the limitations of this exploratory study. To assessment and compare cognitive behaviour between participants with consistent results, the number of subjects should be higher. One of the criteria for the selection of deaf participants was their proficiency in written Portuguese, which may have influence the analysis between deaf and hearing individuals. Nevertheless, to have an equal comparison between deaf and hearing groups on written language, it is important that both groups are fluent on that linguistic modality.

Another limitation is related to the proposed linguistic analysis, which not includes the second articulatory element in sign language phonology. This omission resulted from the lack of linguistic information about this phonological element and therefore the difficulty of creating an analogy with phonological elements from spoken languages.

To enrich the findings from this analysis it should have been recorded the reaction times of each group of individuals.
5.2.5. *Future Directions*

Following the main hypothesis of this exploratory study, I propose a future study addressed in detail to the types of phonological and semantic clusters in deaf individuals during semantic processing in order to better explore where in linguistic clusters. Considering the unclear effects of linguistic clusters during the semantic processing, I would develop a free recall task to describe the linguistic clustering and to provide more semantic processing data.

Regarding that the developed linguistic classification analysis is based on the universal properties of sign languages, I propose a comparative study between deaf individuals with different sign languages, to explore the performance of semantic processing among individuals with the same linguistic modality (sign language) and absence in sensory modality, but with different culture and experiences.
REFERENCES


MacSweeney, M., Woll, B., Campbell, R., McGuire, P. K., David, A.S., Williams, S.
et al. (2002). *Neural systems underlying British Sign Language and audio-visual English processing in native users.* Brain, 125, 1583–1593.


APPENDIX
A. LEGAL CONSENT

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Mara Susana Pereira Moita, aluna do Mestrado em Ciências Cognitivas da Universidade de Lisboa pretende investigar tarefas de categorização, para dissertação, no âmbito deste mesmo Mestrado.

EU ______________________________________________________________

 tomei conhecimento deste estudo e concordo que a minha participação será feita através de uma entrevista – que será filmada.

Fui esclarecido(a) sobre os aspectos que considero importantes e tenho total liberdade para recusar a minha participação na pesquisa ou abandoná-la no seu decurso. Fui também informado que tenho direito de pedir à investigadora esclarecimento de dúvidas no que concerne a minha participação e as linhas orientadoras do Projecto.

A investigadora garantiu-me que as respostas serão utilizadas para o estudo na sua dissertação, assim como para a sua divulgação.

Assim, declaro aceitar participar na investigação para a dissertação no âmbito do Mestrado em Ciências Cognitivas.

_____________________                                             __________________________
Assinatura do(a) entrevistado(a)               Assinatura da investigadora principal
B. DEAF GROUP QUESTIONNAIRE

Ficha do Informante

Nº do Informante: ________

Nome: ________________________________________________________________

Sexo: ___________  Idade: ______

Escolaridade: __________________________________________________________

Profissão: ____________________________________________________________

Tipo de surdez:  Profunda ______  Congénita ______  Adquirida ______

Idade de contacto com a LGP: ______

Idade de contacto com a LP : ______

Idade de contacto com o Português Escrito : ______

Língua utilizada na fase de crescimento: LGP_____  LP_____  Outra_______

Língua utilizada em casa: LGP_____  LP_____  Outra_______

Língua utilizada no quotidiano: LGP_____  LP_____  Outra_______
C. CONTROL GROUP QUESTIONNAIRE

Ficha do Informante

Nº do Informante: ________

Nome: ________________________________________________________________

Sexo: _________  Idade: ______

Escolaridade: __________________________________________________________

Profissão: ____________________________________________________________

Idade de contacto com a LP: ______

Idade de contacto com o Português Escrito: ______

Língua utilizada na fase de crescimento: LP ______  Outra ______

Língua utilizada em casa: LP ______  Outra ______

Língua utilizada no quotidiano: LP ______  Outra ______

Já teve algum contacto com a LGP: ______
D. CATEGORY FLUENCY TASK

Tarefa de Fluência (Língua Gestual Portuguesa/Língua Portuguesa)

**Enunciado**: Gestue/diga o nome de todos os *animais terrestres* que se lembre.

**Enunciado**: Gestue/diga o nome de todos os *legumes* que se lembre.

**Enunciado**: Gestue/diga o nome de todos os *objetos escolares ou de escritório* que se lembre.

**Enunciado**: Gestue/diga o nome de todos os *utensílios de cozinha* que se lembre.
Tarefa de Fluência (Português Escrito)

Escrava o nome de todos os animais marinhos que se lembre.

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
Escreva o nome de todas as frutas que se lembre.
Escreva o nome de todos os **objetos de mobília** que se lembre.
Ecreva o nome de todos as **peças de vestuário** que se lembre.
Tarefa de Fluência (Língua Gestual Portuguesa/Língua Portuguesa)

**Enunciado:** Gestue/Diga o nome de todos os **animais marinhos** de que se lembre.

**Enunciado:** Gestue/Diga o nome de todas as **frutas** que se lembre.

**Enunciado:** Gestue/Diga o nome de todos os **objetos de mobília** que se lembre.

**Enunciado:** Gestue/diga o nome de todos os **peças de vestuário** que se lembre.
Tarefa de Fluência (Português Escrito)

Escreva o nome de todos os **animais terrestres** que se lembre.


Escrava o nome de todos os legumes que se lembre.
Escreva o nome de todos os **objetos escolares ou de escritório** que se lembre.
Escreva o nome de todos os **utensílios de cozinha** que se lembre.
E. THREE-WORD FREE ASSOCIATION TASK

Tarefa de Associação Livre

**Enunciado:** Gestue/Diga as primeiras 3 palavras que se lembra quando ouve a palavra-alvo.

Como por exemplo, a palavra relógio poderá lembrar horas, tempo, despertador.

tubarão

macaco

pá

melancia

cenoura

caderno

copo
**Tarefa de Associação Livre**

Escreva as primeiras 3 palavras que se lembra quando lê a palavra-alvo.
Como por exemplo, a palavra relógio poderá lembra horas, tempo, despertador.

<table>
<thead>
<tr>
<th>foca</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>elefante</td>
<td></td>
<td></td>
</tr>
<tr>
<td>martelo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>laranja</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cogumelo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>caneta</td>
<td></td>
<td></td>
</tr>
<tr>
<td>faca</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tarefa de Associação Livre

Enunciado: Diga as primeiras 3 palavras que se lembra quando ouve a palavra-alvo.

Como por exemplo, a palavra relógio poderá lembrar horas, tempo, despertador.

foca

elefante

martelo

laranja

cogumelo

caneta

cafa
Tarefa de Associação Livre

Escreva as primeiras 3 palavras que se lembra quando lê a palavra-alvo.

Como por exemplo, a palavra relógio poderá lembrar horas, tempo, despertador.

tubarão

macaco

pá

melancia

cenoura

caderno

copo
F. SEMANTIC CATEGORIZATION TASK

Tarefa de Categorização

Como por exemplo:
Tarefa de Categorização

Escreva se os seguintes pares de elementos correspondem à mesma categoria.

Escreva sempre a categoria a que pertence cada par ou cada elemento apresentado.

Como por exemplo:

[Imagens de camelos, hipopótamos, mesa, cão, saia e armário]
- Jeans
- Socks
- Cauliflower
- Tomato
- Carrots
- Knife
- Stockpot
- Plate