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Portuguese Adaptation of the Dutch Linguistic Intraoperative Protocol: Syntax and Naming Assessment in Awake Brain Surgery

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Adaptação Portuguesa do *Dutch Linguistic Intraoperative Protocol*: avaliação da Sintaxe e Nomeação em Craniotomia em Paciente acordado

Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Terapia da Fala realizada sob a orientação científica do Doutor Luís Miguel Teixeira de Jesus, Professor Coordenador com Agregação da Universidade de Aveiro.

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Palavras-chave Linguagem; Avaliação; Sintaxe; Nomeação; Tumor Cerebral; Glioma de baixo grau; Craniotomia em paciente acordado

Resumo

Uma vez descoberta a ligação entre o falar e o cérebro, surgiu interesse em estudar a base neuronal associada à Linguagem. Este estudo tem como foco a avaliação das funções cerebrais associadas à Linguagem em pacientes com gliomas de baixo grau, um tipo de tumor cerebral. Estes pacientes, submetidos a craniotomia acordada, são avaliados pré, pós e intra cirurgia, aquando do uso de electroestimulação intraoperatória (EEI), com o objetivo de otimização da resseção tumoral, evitando sequelas com impacto na Linguagem. O *Dutch Linguistic Intraoperative Protocol (DuLIP)*, foi desenvolvido na Holanda e consiste numa bateria de testes para avaliação da Fonologia, Semântica, Sintaxe e Articulação neste âmbito. Em Portugal não existe nenhum instrumento validado com este propósito pelo que foi criada uma versão portuguesa, o DuLIP-EP. O processo incluiu uma adaptação cultural e a aplicação à população portuguesa para recolha de dados normativos. O DuLIP-EP resultou num protocolo de 18 tarefas. Na presente dissertação, o foco recai na área da Sintaxe e na tarefa de Nomeação. Para adaptar culturalmente o DuLIP, algumas mudanças tiveram de ser executas face à sua versão original, nomeadamente, na escolha das imagens e frequência das palavras usadas. Após a aplicação a 144 participantes, foi elaborada a análise estatística e averiguada a existência de diferenças significativas entre as pontuações obtidas por tarefa e as variáveis: idade, sexo e nível de educação (anos de estudos). Na área da Sintaxe, foi estudada a relação entre a presença de frases na voz ativa/passiva e a taxa de acerto, assim como a influência do nível de educação na capacidade de processamento deste tipo de frases. À semelhança do estudo original, diferenças significativas foram encontradas no que concerne à idade e anos de estudo. O grupo jovens/alta educação tem, globalmente, uma melhor performance. Não foi encontrada relação entre o nível de educação e a performance na prova que engloba frases na voz ativa/passiva. Como futuro trabalho, planeia-se alcançar um idêntico número de participantes e itens por tarefa, por forma a alargar o número de comparações ao estudo original, sendo também importante a aplicação do DuLIP-EP a casos clínicos.

Keywords Language; Assessment; Syntax; Naming; Brain Tumours; Low-grade Glioma; Awake Brain Surgery

Abstract

A renewed interest in studying the neural basis of Language has emerged since a clear relationship between speaking and the brain tissue was established. This study is focused on the assessment of language functions in patients with a specific kind of brain tumour, a low-grade glioma (LGG). These patients, who are submitted to an awake brain surgery, are assessed pre-, post- and intra-surgery, while using Direct Electrical Stimulation (DES), so that the neurosurgeon can optimise the extent of the resection and avoid language deterioration. The Dutch Linguistic Intraoperative Protocol (DuLIP) was developed in the Netherlands, consisting of a test battery for evaluating Phonology, Semantics, Syntax and Articulation. Since in Portugal there is no validated instrument to serve this purpose, the DuLIP was adapted to European Portuguese (EP). The process included a cultural adaptation and the collection of normative data from the Portuguese population. The DuLIP-EP consists of a total of 18 tasks. The focus of the present Thesis is only Syntax and Naming skills. To culturally adapt DuLIP, some changes had to be introduced regarding image choice and words frequency. After applying the battery test to 144 participants, a statistical analysis was performed aiming to find differences in scores per task, regarding gender, age and education level (years of study). Related to Syntax, a relationship between active/passive voice sentences and accuracy rate was analysed, as well as the influence of education level on the capacity of processing these sentence types. Similar to the original study, significant differences were found considering age and years of study. Younger and highly educated participants performed better across all the tasks. No association was found regarding education level and performance on the task where active/passive voice sentences were presented. Future work aims to achieve an identical number of items per task, a wider sample collected in all regions of Portugal, in order to perform a larger number of comparisons than the original study. It would also be important to apply DuLIP-EP to some clinical cases.

Abbreviations and acronyms

ACE - Addenbrooke's Cognitive Examination

AG – Angular Gyrus

ATL – Anterior Temporal Lobe

CLUL – Centro de Linguística da Universidade de Lisboa

CRPC - Reference Corpus of Contemporary Portuguese

DES – Direct Electrical Stimulation

DuLIP – Dutch Linguistic Intraoperative Protocol

EEG – Electroencephalography

EEI – Electroestimulação Intraoperatória

EP – European Portuguese

IFG – Inferior Frontal Gyrus

INE – Instituto Nacional de Estatística

LGG – Low-grade Glioma

LIFG – Left Inferior Frontal Gyrus

LMTG – Left Middle Temporal Gyrus

MEG – Magnetoencephalography

MMSE – Mini Mental State Examination

MRI – Magnet Resonance Imaging

PMG – Posterior Midfrontal Gyrus

PSFG – Posterior Superior Frontal Gyrus

PSTG – Posterior Superior Temporal Gyrus

PSTS – Posterior Superior Temporal Sulcus

SMG – Supramarginal Gyrus

SOV – Subject-object-verb

STG – Superior Temporal Gyrus

STG – Superior Temporal Gyrus

SVO – Subject-verb-object

TPJ – Temporoparietal Junction

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1. INTRODUCTION

When researchers first discovered the relation between speaking and the brain tissue, a renewed interest in studying the neural basis of Language emerged, since this is a processing that is a trait of human species (Friederici, 2011). However, there are many factors that can damage or change this process. One of those, is a brain tumour like, i.e., meningioma, glioblastoma or a low-grade glioma (LGG) (Ohgaki, 2009). This study focuses on LGGs, a slow growing tumour which causes progressive lesions (Duffau, 2005). To evaluate and map the areas and pathways of the brain, in these cases, related to speech and language, direct electrical stimulation (DES) is used. This technique has become a common clinical routine in order to assess the functional role of restricted cortical and subcortical regions to avoid neurological impairment and improve the patient's quality of life (Duffau, 2016).

To perform a precise assessment, The Dutch Linguistic Intraoperative Protocol (DuLIP) was developed. The DuLIP is a tests battery that includes specific and sensitive tasks that aim at language testing and the assessment of preservation of language functions while an awake brain surgery for tumour resection is performed. This language assessment includes the linguistic areas of phonology, semantics and syntax, a motor speech assessment (performing diadochokinesis). It was originally developed in the Netherlands by Witte et al. (2015), to evaluate pre-, intra-, and post-operative language skills in patients with low-grade gliomas.

In Portugal, there is still lack of validated instruments to assess language skills during surgery. The aim of this study was to translate the whole Dutch test battery to European Portuguese (EP). In addition, this study intended to culturally adapt the DuLIP to the Portuguese general population in order to create a new Portuguese version (DuLIP-EP). This protocol includes a battery of phonologic, semantic, syntactic and articulation tasks, that are applied to the patients according to their tumour localisation. In the presented study, there is a special focus on Syntax, an important linguistic area that is crucial to processing sentences and naming skills, one of the principal assessment areas during surgery and that is used both in left and right hemisphere intervention.

The DuLIP-EP was developed around the original 18 tasks. After applying the battery test to 144 participants, differences in scores per task regarding gender, age and number of years were analysed. Concerning Syntax, the influence of passive vs. active voice sentences in hit rate was studied, as well as the influence of education level (years of study) on the specific Syntactic task assessing this sentence type. About Naming, the quantity and pertinence of the synonymous used was analysed. As requested by the original authors, the maximum number of the original stimuli in order to keep it as similarity as possible to the original protocol.

1.1 The Brain

The brain is organised in a distributed complex network underpinning sensorimotor, visuospatial, language, cognitive and emotional functions (Duffau, 2018).

According to Friederici (2011), different brain regions, not only in the left hemisphere, but also in the right hemisphere have been identified to support language functions. Therefore, any lesion or growing process on these areas, like a brain tumour, can cause impairments in many different domains of Language or even in motor speech.

Awake brain surgery is a standardised procedure to perform brain tumours resections. Wahab et al. (2011) claim that they have been performing them for over 70 years. During an awake brain surgery, cortical and subcortical mapping can be used to identify and preserve eloquent brain areas. This allows maximal tumour resection and reduces the risk of inducing permanent deficit. Despite the existence of more approaches, Wahab et al. (2011) refer that asleep-awake-asleep approach is the most traditional technique for this type of surgeries. This was the technique used by Witte et al. (2015), the original authors of the Dutch Linguistic Intraoperative Protocol (DuLIP). With the advances of more sophisticated neuronavigation systems and the development of improved anaesthetic techniques, awake brain surgery has become a fast, safe and effective procedure which patients appear to tolerate well. A large team is required to perform this kind of surgery, including many medical and medical related specialties. A variety of techniques of sedation, analgesia and anaesthesia have been described and well established.

In order to guide this kind of interventions, imaging techniques are used. Historically, the advent of electroencephalography (EEG), magnetoencephalography (MEG), magnet resonance imaging (MRI) and especially functional MRI (fMRI) allowed *in vivo* monitoring of cognitive functions, which played an important role increasing the number of brain-based Language studies. Wu et al. (2014) refer that, in the last decade, Language fMRI has been used extensively for both clinical and research purposes. However, the reliability of language functional MRI has always been widely questioned.

In the past decade, an increasing number of authors have advocated the use of direct electrical stimulation (DES) intraoperatively, especially in neuro-oncology (Mandonnet et al., 2010). Direct electrical stimulation consists in a biphasic electrical current (60Hz, 1msec, 1 to 4mA) that can mimic genuine temporary lesion, by inducing it virtually, not only at the level of cortex, but also at the axonal level when the electrode is applied directly in contact with the white matter fascicles. Direct electrical stimulation is highly non-local, since the electrical current enters the whole network that sustains a function. If the patients stop moving, speaking or produces wrong response, the surgeon avoids removing the stimulated site (Duffau, 2016). In surgery, patients perform several sensory-motor, visuospatial, language, cognitive or emotional tasks while the surgeon temporarily disrupts discrete cerebral structures using DES.

Duffau (2016) considers DES as being able to improve patient’s quality of life since neurological impairment can be avoided thus preserving language abilities, because the surgeon can optimise the extent of the resection. Oncological or epileptological outcomes are therefore improved, due to an individual mapping and preservation of critical structures. This is possible with precise brain previews that map cortical and subcortical regions. According to the same author (Duffau 2016), DES mapping of the neural pathways offers a unique opportunity to investigate the function of the connectomal anatomy for the first time in the history of cognitive neurosciences. Borchers et al. (2012) also claims that DES can be used to directly study simultaneously anatomical and functional connectivity. Using this technique, real-time anatomo-functional correlations are performed in awake patients who undergo brain surgery, especially at the level of the subcortical fibres. Various models have been proposed, paths and connections, yet, none seem to cover every component of language processing (Friederici, 2011).

There are, however, some intrinsic limitations about the use of DES such as the possibility of brain function reorganisation before surgery (Duffau, 2016). Nevertheless, since LGG are slow-growing tumours, DES still has considerable value for investigating brain processing (Duffau, 2016). Similarly, Wu et al. (2014) claim that is there a possibility of recruiting perilesional or remote areas within the ipsilesional hemisphere and/or contra-hemispheric homologous areas which can indicate that brain plasticity may affect the accuracy of the probabilistic map.

A neuroarchitectonic view of the human cortex published by Korbian Brodmann (1909) in the beginning of 20th century, provided detailed information about subdivisions of region of the Language network. Based on the distribution of different types of neuroreceptors in the cortex and the connectivity-based parcellation approach, brain regions were subdivided according to their specificity. It is clear nowadays, that the language-key cortex includes Broca's areas located in the inferior frontal gyrus (IFG, markes at orange dots in Figure 1) and Wernicke's area in the superior temporal gyrus (STG, in blue) (Friederici, 2011).

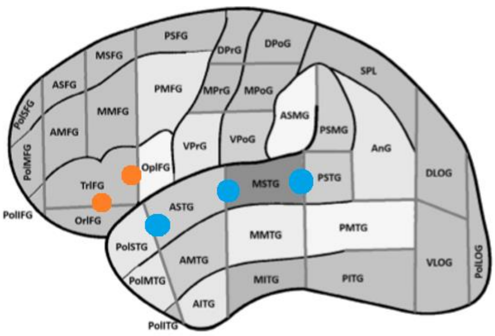

Figure 1 - Anatomic brain areas and delimitations: The inferior frontal gyrus - IFG (orange) and superior temporal gyrus - STG (blue) are highlighted in order to situate the critical structures related do Language. Adapted from Chou et al. (2018).

Recent studies like the one published by Ries et al. (2019) show that human language is organised along two main processing streams connecting posterior temporal cortex and inferior frontal cortex in the left hemisphere, travelling dorsal and ventral to the Sylvian fissure.

In their study, while developing DuLIP, Witte et al. (2015) could distribute assessment tasks per cortex sites. Regarding frontal regions, the inferior frontal gyrus (IFG) is related to articulatory processing and some syntactic features like verb generation. The posterior midfrontal gyrus (PMG) is linked with action naming, while the supplementary motor area (posterior superior frontal gyrus - PSFG) to language initiation, observed in tasks like sentence completion and fluency. Motor related functions, like verbal diadochokinesis and repetition of words, are mostly commanded by the precentral gyrus. Temporal regions, most accurately, the posterior superior temporal gyrus (PSTG) are responsible for semantics, auditory comprehension and naming living objects. The middle posterior superior temporal sulcus has a connection to phonological skills. The lexical interface (linking phonological and semantic information) and naming non-living objects is under the middle inferior temporal gyrus domain. The capacity of famous face naming, and so, naming tasks related, is determined by the anterior middle temporal gyrus. Parietal regions like the supramarginal gyrus (SMG) and angular gyrus (AG) are both linked to reading skills and, the first one, to some naming and semantics.

In the next section, more details will be given about syntactic and naming functions (the focus of this Thesis), related to different brain regions.

Considering the brain location related to a specific Language task, DuLIP was specially designed and constructed to assess patients with low-grade gliomas (LGG), where tumours can be located in any of the mentioned areas. Gliomas account for more than 70 percent of all brain tumours, and of these, glioblastoma is the most frequent and malignant histologic type. Other LGG include germ-cell tumours, meningiomas, lymphomas, pituitary tumours, and craniopharyngiomas (Ohgaki, 2009). Low-grade gliomas are in general relatively slow-growing primary brain tumours with a very heterogeneous clinical behaviour (Pignatti et al., 2002). The Cancer Genome Atlas Research Network (2015) highlights its highly invasive nature and the impossibility of complete neurosurgical resection. Therefore, the best treatment policy for these tumours is still unclear. Some physicians advocate early and extensive surgery or early radiation therapy, whereas others tend to postpone treatment until functional deficits are present (Pignatti et al., 2002).

Pignatti et al. (2002) studied age, largest diameter of the tumour, tumour crossing the midline, histology subtype, and presence of neurologic deficits before surgery as the prognostic factors for survival in LGG. Wu et al. (2014) emphasise that an LGG, which is a slow-growing tumour, allows the brain many years of functional plasticity which can compromise the accurate brain mapping.

1.2 Language

1.2.1 Naming abilities

Naming ability is a crucial milestone in language acquisition (Swan & Goswami, 1997 cited in Fecteu, Agosta, Oberman & Pascual-Leone, 2011). According to Spezzano & Radanovic (2010), it is one of the most important abilities in linguistic processing. Naming of different semantic and grammatical categories differ in their lexical properties and have distinct neuroanatomical substrates. The naming process by visual confrontation requires three stages: First the identification of the represented object, which activates its mental structural representation; second, its semantic representation has to be assessed to allow the object to be recognised; finally, the activation of its phonological representation - in this third stage the name of the picture or object is retrieved and uttered (Spezzano & Radanovic, 2010).

Baldo et al. (2013) have also shown that picture naming involves several cognitive processes, from visual perception/recognition, to conceptual/semantic processing, to lexical selection and retrieval and, finally, to articulation which is the planning and execution of an articulatory motor plan. The ability to retrieve a name associated with an object, has attributed to posterior portions of the left lateral temporal lobe and to the anterior temporal cortex. This reinforces the idea that linguistic abilities are organised into multiple processes within subsystems that interact with each other, while maintaining some degree of independency (Matchin et al., 2019).

Studies (Baldo et al. 2013) in patients with naming deficits showed that, besides portions of the left anterior and posterior middle temporal gyrus (MTG) and superior temporal gyrus (STG), MTG was the only remaining active portion when isolating brain regions specific to lexical-semantic retrieval, excluding visual cognitions and motor speech areas. They concluded that this area plays a critical role in the core ability to retrieve a name associated with an object or picture. Recent findings by Strijkers et al. (2017), indicate that word planning recruits almost simultaneously frontal and temporal regions. A low performance in picture naming seems to be specifically associated with damage to the left middle temporal gyrus (LMTG), suggesting a critical role of this region in word production (Baldo et al., 2013). Controlled aspects of lexical retrieval/ selection have been associated with frontal areas, particularly with the left inferior frontal gyrus – LIFG (Riès et al., 2016).

LGG's patients can show speech arrest, sentence comprehension interference, verb generation and with visual naming difficulties, during dominant frontal stimulation, outside of Broca's area, primary motor, or premotor cortices (Cervenka et al., 2012).

In order to study and assess Naming abilities, Snodgrass & Vanderwart (1980) and Boston Naming Test (Goodglass et al., 1983) are the two most popular and common validated image data bases used (Spezzano & Radanovic, 2010). The aim is to name black-and-white line drawings presented on a white background (Cervenka et al. 2012; Radanovic et al. 2004).

1.2.2 Syntax

Although a variety of approaches using brain imaging methods have sought to characterise the regions implicated in syntactic processes, how the human brain computes and encodes syntactic structures remains largely unknown (Matchin et al., 2019). Yet, Broca's area has been shown to be a crucial area for speech and language skills regarding their activation when processing syntactically complex sentences. Many studies in different Indo-European languages have investigated the neural substrate of syntactic processes by varying syntactic complexity. It is important to mention that it is quite difficult to dissociate Syntax from Semantics since there are some models and authors that have shown they interact at any time (Friederici, 2011).

Electrophysical measures indicate that within the brain networks, syntactic processes of local structure building precede the assignment of grammatical and semantic relations in a sentence (Friederici, 2011). Matchin et al. (2019) found that in fMRI, increased activation for combinatorial syntactic and semantic processing is typically observed in a set of left hemisphere brain areas: The angular gyrus (AG), the anterior temporal lobe (ATL), the posterior superior temporal sulcus (PSTS), and the inferior frontal gyrus (IFG).

Friederici (2011) considers that the brain activation in IFG increased systematically as the syntactic complexity increases and that the processing of syntactically complex sentences recruits Broca's area. The function of pars opercularis and triangularis (parts of Broca's area) seems to variate across different languages. However, the evidence of the important role of these areas has been shown in canonical comparatives in various languages, including European Portuguese (Matos & Brito, 2002).

According to Friederici (2011), one way to investigate the different syntactic stages is to introduce violations in natural sentences which tap either the initial or the later syntactic processing stage. Another way of investigating local syntactic structure building is to use artificial grammars which lack semantic relations, for example, introducing a word category error within a prepositional phrase by putting a verb instead of a noun after the preposition. Other studies (Bastiaansen et al. 2010), have shown that one can examine syntactic sentence-level by asking participants to read sentences that are either correct, contain a word category violation, or are built with random word sequences devoid of syntactic structure.

Thothathiri et al. (2012) identified the lesion distributions associated with errors in interpreting semantically and syntactically reversible sentences like <The man was served by the woman>. They found a strong correlation between damage to the left temporoparietal junction (TPJ), including AG, and deficits in correct argument assignment.

In addition, the finding that the IFG is also sensitive to syntactic structure in the absence of lexico-semantic information is consistent with studies of natural and artificial grammar learning that reported increased activation in Broca's area for phrase structure violations (Pallier et al. 2011).

Summarising, our knowledge base about brain control of Language abilities continues to increase but there are still uncertainties to figure out and, for sure, others will arise. Globally, there is an agreement between authors in the crucial areas related do Syntax and Naming skills. As pointed out by Dick (2013), "*It is within this framework that the field will continue to make promising strides toward a comprehensive neurobiology of language*".

Duffau (2012) reminds us that all the stimuli used to assess a patient, no matter the stimulated area and function associated, job, hobbies, personal likes and projects should be included besides the standard measures. For example, syntax should be carefully evaluated in a writer, spatial cognition in a dancer and judgment capacity in a lawyer.

1.3 While in Portugal

There is still lack of validated instruments to assess language skills during awake surgery in Portugal. In fact, as shown in Spena et al. (2017) study, in Portugal this technique is used in a small scale compared with the other 19 countries presented. Some data regarding the Portuguese practice in Garcia de Orta's Hospital in Almada is presented, such as the inexistence of a Speech and Language Therapist during surgery. In fact, according the same authors (Spena et al. 2017), the existence of this professional is only considered in four places: Madrid, Nice, Poitiers and Paris. It is known that there are other Hospitals in Portugal where this kind of surgery is performed, however, only Anaesthesiology studies have been published (Oliveira et al. 2011; Silva et al. 2014).

1.4 Study goals

Since the final purpose of this study was to expand the knowledge and support the clinical practice in this field, so that the Portuguese population could benefit from it, some questions have emerged from the previous literature review. Some of them are quite similarly studied in the original study, others, will allow us to add new information about the performance of general Portuguese population. Therefore, this study aimed to answer the following questions:

- Are there significant performance differences between gender?
- Are there significant performance differences across age groups?
- Are there significant performance differences when years of education are considered as a factor?
- Is there any relation between error rate and sentence type (active/passive voice) in Syntactic Judgment I items?
- Does the education level (years of education) influence the performance on Syntactic Judgment I task?

2. METHOD

The development of the Portuguese version of DuLIP (DuLIP-EP) required both qualitative and quantitative methodological procedures, in order to compare demographic data and statistically analyse the results (Fortin, 1999).

2.1 Adaptation

First, it was necessary to elaborate a battery of tasks based on a literal translation of the original study, as requested by the authors of DuLIP. Since the literal translation was not suitable for all the stimuli, part of it had to be culturally adapted so that it would be appropriate to the Portuguese population knowledge and lifestyle. This process was performed by the author of this Thesis, her supervisor, two additional speech and language therapist and two of the DuLIP original authors.

The selection of the Portuguese translated materials was first guided by the availability of validated (for the Portuguese adult population) open access images. Since Snodgrass & Vanderwart's (1980) image database is one of the most commonly used in this scientific field and one of the databases used by Witte et al. (2015) to develop DuLIP, a Portuguese validated image database, based on it, by Ventura et al. (2003), was used. In Ventura et al. (2003), some of the total items presented in the original version were excluded since some of them were found to be hard to interpret or difficult to recognise by the Portuguese population, i.e., images like a <miter>, <barn> and pair of the traditional Dutch clogs were not contemplated. For that reason, to develop DuLIP-EP, only a subset of the original images from Snodgrass & Vanderwart (1980) was used. Consequently, the image related words used in the score form were, as much as possible, the literal translation of the original DuLIP. The remaining words were adapted according the images analysed by Ventura et al. (2003). Additionally, the resulting materials were adjusted and adapted according to variables such as frequency, imageability, age of acquisition, prevalence and word class. Leitão et al. (2010) has shown that word familiarity and age of acquisition can affect the naming performance. The authors (Leitão et al. 2010) assume that the concept of familiarity and prevalence are related to word frequency, reflecting the exposal to a certain word. Thus, a word is familiar to us as much it appears in our life. Regarding age of acquisition, the authors postulate that the process of early learned words is quicker compared to words learned more lately. Word frequency data was also analysed using a tool developed by the Linguistic Centre at the University of Lisbon (CLUL), the Reference Corpus of Contemporary Portuguese (CRPC). As with the original study, most of the words have a high frequency, but low frequency words are contemplated considering its importance in the assessment procedure as well.

Other specific criteria, such as complexity levels, number of phonemes, number of syllables and syllabic structure, were used to build the Portuguese version of the repetition task (Phonology area). Regarding Semantics and Syntactic areas, that involve the use of sentences, other criteria such as time and verbal mode, order of syntactic constituents, number of words, passive/active voice sentences, were taken in account. To validate the final version of DuLIP-EP, test administration, registration and correction of the items were discussed by the six researchers involved. These discussions were particularly important when uncertainties emerged regarding the scoring process, so that a consensus could be found.

As a result, DuLIP-EP was developed consisting of a total of 18 tasks encompassing the Linguistic areas mentioned above – phonology, semantics, syntax and articulation. All these tasks have the same assessment goal as the original (Witte et al. 2015). It was assumed that, after the application phase, if an error rate above a certain value was found in a specific item, that item should be excluded. This cutline was defined considering the use of the same methodology as the original authors regarding picture-naming agreement (80%) and, other, considering Sbordone and Saul (2000) guidelines (90%). An error was registered when wrong responses, responses given out the time-frame time and no responses at all, where provided by the participants.

Focusing on each assessment area, Syntax and Naming abilities are described in detail below. Semantics is explored in detail in Cardoso (2019) and Phonology and motor speech evaluation in Alves (2019).

Despite being related to Semantics, Naming skills were assessed and analysed separately through a task of object naming, given its clinical importance and transversality. For that, black and white drawing were presented in a white backgrounded PowerPoint presentation, using a laptop computer as well as for the remaining tasks requiring a visual output. Identically to the original study, the image size and simple line black and white drawings were kept since studies refer that they are easier to recognise, process and name. Some of those studies were developed by Reis et al. (2006) where they mentioned that there is no difference in the recognition of coloured versus black and white images in literate adults; Bierdeman and Ju (1988) have shown that the line drawings have an advantage over the colour slides and Glaser (1992) claimed that picture naming is performed slower than reading the corresponding word, whereas a simple drawing naming requires a similar amount of time to elicit as reading the related word thus, it can be concluded that simple drawing naming is faster and easier. Items will be changed if less than 80 percent of the participants correctly name the presented image, as defined in the original study. Still focusing on the naming skills, the use of synonyms was counted and analysed after calculating the accuracy rate – if a unique synonym was systematically used rather than the original literal translation in more than 80 percent of the collected data for a specific image (using the same cutline for the exclusion of items), the image related word was changed in the score form, for that synonym. This change was made believing that it is culturally more frequent and significant to the general population.

In this study, only object naming is considered, since verbs are assumed to be more complex to name. Verbs present greater semantic and grammatical variety and are more difficult to identify according to their classifications as action verbs (e.g., <push>), process verbs (e.g., <happen>), action-process (e.g., pronoun followed by the infinitive of the verb), state (e.g., <desire>) and auxiliary (such as an auxiliary verb followed by an infinitive) (Spezzano & Radanovic, 2010). The original DuLIP study has a specific task called Action Naming, where this ability is tested.

Syntactic tasks constitute the Syntactic Judgment I & II, Verb generation and Syntactic Fluency sections of DuLIP. The aim of Syntactic Judgment I & II is to assess the awareness in frontal areas by discriminating between correct and incorrect sentences, in 25 items per task, considering different type of errors. Following the premise that studies based on widely used neuropsychological batteries that have reported hit rates of 90% and have been considered valid to discriminate brain-damaged patients from normal controls (Sbordone and Saul, 2000), this was the cutline used in order to eventually exclude some items.

In Syntactic Judgement I, word order errors in the sentence can be presented (i.e., <*o ladrão é roubado pelo dinheiro*> / <the thief is stolen by the money>). Syntactic Judgment II contemplates sentences with verb inflection errors and incorrect pronouns (i.e., <*isto não é de ti, é de nós*> / <this is not from you, this is from we> or, <*a Teresa canta uma música ontem*> / <Teresa sings a song yesterday>). About this task, first names were adapted to Portuguese frequent first names. In addition, the same number of incorrect and correct sentences was used, 13 and 12 (respectively), as well as the number of active and passive voice sentences, 8 and 17 (respectively). Sentence type was maintained, 16 subject-verb-object (SVO) and 9 subject-object-verb (SOV). Focusing on the second task, Syntactic Judgment II, an integral literal translation was suitable except for the presence of first names. All the sentences are in the active voice, 15 are in simple present form, 7 in past perfect simple, 1 past simple and 1 in the future form. Regarding sentence structure, 19 follow the SVO structure. For the assessment of both these tasks, the application instructions are, to give an answer within a reasonable time, which will be scored as 0 – incorrect or 1 – correct. The assessor is advised to previously practice the aloud reading of these sentences in order to avoid hesitation. Some research questions arose related to these tasks, particularly, the Syntactic Judgment I, in which active and passive voice sentences are contemplated. Participants performance for difference sentence types was thus analysed. It was also hypothesised that the education level had an influence in the performance on Syntactic Judgment I task, in other words, persons with lower levels of education (less years of study) have a lower performance in this task when compared with higher educated persons based on previous studies by Dąbrowska and Street, (2006). These authors postulate that since passive voice sentences are mostly used in written material, more educated persons might be expected to perform better considering their exposure to this sentences type.

In the apropos Verb Generation task, singular nouns are presented so that the participant can relate them to a verb, evoking it. It is a task composed of 50 items in which a 4 s time frame per item is given to obtain an answer. A break is allowed at the end of the 25th item. Only the word <*voorschot*> (<deposit>) was considered difficult to translate, without compromising the understanding and connection of this noun to a verb. Thus, this word was changed to the word <*dente*> (<tooth>).

Finally, the Syntactic Fluency task goal is the production of the maximum quantity of verbs possible within a minute. These tasks will be schematically described in table 2 (Results section).

As previously mentioned, in some specific tasks incorporated in the Linguistic areas considered in DuLIP-EP, patients must generate a response within 4 seconds, which is the time frame that DES actuates per stimulation (Witte et al., 2015).

2.2 Application

The experimental version of DuLIP-EP was tested on 144 volunteers, recruited following the same inclusion criteria as the original study in order to collect normative data for the Portuguese population: European Portuguese as native language; no history of cardiovascular, neurological, psychiatric or speech and language disorders; no substance abuse; normal vision; normal hearing; no use of sleep induction medication, psychopharmaceutic or neuroleptic drugs; a score above 24/30 on the Mini Mental State Examination (MMSE). All the participants were over 18 years of age and no upper age limit was applied. All the Ethical procedures were assured by the previous request and approval from the Coimbra's Nursing School Ethical Committee (Appendix G).

The application of DuLIP-EP begins by reading and clarifying the contents of the informed consent (Appendix A), filling in the anamnesis form (Appendix B) in which personal, educational and clinical information is collected, followed by the completion of Addenbrooke's Cognitive Examination III (ACE-III). The score obtained in ACE-III was then converted to a Mini Mental State Examination (MMSE) score (Matías-Guiu et al., 2018) to compare with the original selection criteria.

To statistically analyse the collected data and verify the hypothesis of this study, the software IBM SPSS Statistics 24 was used. In line with the methodology of the original study and considering the data non-normality distributed, non-parametric tests were applied to perform the statistical analysis. Therefore, the Mann-Whitney U test was used to analyse differences between the various variables tested. Simple descriptive statistics were produced in order to characterise the sample, regarding mean, percentiles, standard deviation and minimum and maximum values from the obtained scores and demographic information.

As described before, a total of 144 participants were recruited, 82 females and 62 males and are described below according to their age and years of education:

		N	*Mean*	*Std. Deviation*	*Maximum*	*Minimum*
Age	*Total*	144	36.81	14.859	89	18
	≤ 54y	121				
	> 54y	23				
Years of Education	*Total*	144	15.36	4.144	4	24
	≤ 12	32				
	> 12	112				

Table 1 - Sociodemographic data analysis – mean and dispersion measures regarding age and years of study.

The Eurostat data (available at https://ec.europa.eu/eurostat/web/health/overview), shows that life expectancy in Portugal (81.6y) and Netherlands (81.8y) is considerably close. For this reason, the age value cutline was maintained as in the original study allowing direct comparison between these values. Since the obligatory education in Portugal, nowadays, relies in completing the secondary school (12 years of education) this cutline was also maintained. The considered data is geographically distributed in four main areas of Portugal relying on the National Statistics Institute (Instituto Nacional de Estatística – INE) division: 35 participants from the North; 94 participants from the Centre; 13 participants from the Lisbon Metropolitan area and 2 participants from the Autonomous Region of Madeira (a Portuguese archipelago). Three of them were left-handed, 140 right-handed and 1 ambidextrous.

3. RESULTS

3.1 Protocol adaptation in the DuLIP-EP version

Considering the first stage of this study and following the methodology previously described, the 6 experts involved in this study achieved consensus on a version ready to be applied. The scheme below (Table 2) describes the final tasks considered and summarises the adaptations made prior to the application of DuLIP-EP to the Portuguese normal population.

Linguistic Area	*Tasks*	*Assessment Goal*	*Adaptation changes*	*Observations*
Semantics				
Naming	- Object naming	Name 100 objects (black and white drawings)	44/100 images	Within 4s
Syntax	- Judgment I (word order incorrections) - Judgment II (lack of verbs and prepositions & nouns and verbs conjugation errors)	Discriminate between correct and incorrect sentences, syntactically speaking	First names	
	- Verb generation	Relate a verb to a singular noun, evoking it		Within 4s
	- Fluency	Produce the maximum quantity of verbs possible		Within 60s
Phonology				
Articulation				

Table 2 - Tasks description and adaptation changes

3.2 Application of the DuLIP-EP to the population sample

The results presented in this section are a parcel of a global analysis of DuLIP-EP. The mean age of the female group was 38.16 years old (std. deviation 13.41) and of the male group, 35.05 years old (std. deviation 15.82). As in the original study, no difference in mean age was found between female and male participants (p-value=0.269). Concerning years of study (education level), the female group mean was 15.67 years (std. deviation 4.22) and the male group mean was 14.95 years (std. deviation 4.03). Again, as in the original study, no differences were found (p-value=0.293). We used the Mann-Whitney U test, since the data was not normally distributed.

As previously mentioned, participants were grouped by age, years of study and gender. As shown in Table 3, four different groups were created, crossing two of these variables (age and years of education).

Age	*Gender*	*Years of education*	***Groups***
Younger (18-54y)	Male	Low (0-12y)	**Younger/Low education**
Older (+54y)	Female	High (+12y)	**Older/Low Education**
			Younger/High Education
			Older/High education

Table 3 - Group variables – standard variables - age, gender and years of education (education level) and grouped

Regarding the created groups, only the Younger/High education group was studied in detail due to its considerable sample size (n=102). The other groups were small invalidating the performance of any inferential statistical analysis (Appendix D).

Since the distribution of the studied data (mentioned on Table 3) was found not to be normal, the non-parametric Mann-Whitney U test was used to measure the effects of these variables on each task. Similarly, to the original study, the common p-value used (p-value=0.05) was considered and the Sidak (1967) correction (p-value= 0.0034, Appendix E) was applied in every statistical test performed. The Sidak (1967) correction was based on the number of tasks analysed on this study (5). Percentiles 2 and 7 were calculated since, as in the original study, these were the cut-off scores considered to be clinical markers of a pathological impairment and clinical impairment, respectively.

3.2.1 Naming

Considering that an 80% accuracy rate of correct naming of an object represented in two specific images was not achieved for two items, these were excluded: <doll> /<*boneca*> (67.36%), which was frequently named as <girl> / <*menina*>, and <roller skate> / <*patim*> (77.08%), confounded with various objects. As a result, the naming task is composed of 98 objects to name within a time frame of 4s. In Table 4 the general statistics results based on the number of correct items named, are shown.

Naming	Mean	95.43
	Std. deviation	3.124
	Maximum	98
	Minimum	81

Table 4 - Naming task basic statistics: The number of correctly named images are presented.

Significant differences were found in naming for both age (p-value= 0.00343) and years of study (p-value= 0.000025), whereas, no significant difference was found regarding gender (p-value= 0.259). After applying the Sidak's (1967) correction, no differences were found. Details are presented in Appendix C. Appendix D, reproduces the results regarding the relation between the performance on this task for the four groups.

The synonym analysis revealed that the word <*polegar*> / <thumb>, maintaining the literal translation of the original study, was systematically named as <*dedo*> /<finger>, by more than 80% of the participants. Therefore, these words were switched in the score form (<*dedo*>, as the main target word to name, and <*polegar*> as a possible synonym).

3.2.2 Syntax

In the Syntactic Judgment I task, one item had to be excluded (item 13), since a 90 percent accuracy rate was not achieved (85.42%), whereas in the Syntactic Judgment II task, no change had to be made. For the same reason, six words (nouns) had to be excluded by the Verb generation task, specifically, items 1, 5, 19, 25, 42 and 47. An example is <*mente*> /<mind> that was frequently related to its homonym that is connected to a different verb (<to lie>). Accuracy rates, in this case, were between 80.56% and 89.59%. As a result, verb generation tasks were composed of 44 items and Syntactic Judgment I & II by 24 and 25 items, respectively. Basic statistics are presented in Table 5:

Verb Generation		
	Mean	42.29
	Std. deviation	3.219
	Maximum	44
	Minimum	27

Syntactic Fluency		
	Mean	22.44
	Std. deviation	7.495
	Maximum	40
	Minimum	5

Syntactic Judgment I		
	Mean	23.72
	Std. deviation	0.633
	Maximum	24
	Minimum	21

Syntactic Judgment II		
	Mean	24.51
	Std. deviation	0.811
	Maximum	25
	Minimum	22

Table 5 - Basic statistics of the Syntax analysis; A) Verb Generation; B) Syntactic Fluency; C) Syntactic Judgment I; D) Syntactic Judgment II.

Using the standard p-value (0.05), significant differences were found relating the verb generation task to gender (p-value= 0.006), age (p-value= 0.023) and years of study (p-value=0.00000019). Regarding the syntactic fluency task, significant differences were found as well (p-values= 0.021; 0.004; 0.000013), respectively. On the Syntactic

Judgment II task, significant differences related to the years of education (p-value= 0.017), were found (details in Appendix C). Using the corrected p-value (Sidak, 1967), significant differences were still found on verb generation and syntactic fluency considering, only, years of study.

On table 6, the percentage of correct items answered within the variables can be observed, in the naming and syntax tasks. Syntactic Fluency task is presented by words per minute (w/m) since the aim of this task is to elicit the maximum number of verbs within a minute and there was no expected number of words to be achieved. The groups with the highest scores are highlighted in bold.

	Gender		*Age*		*Years of Study*	
	Male	*Female*	*≤54y*	*>54y*	*≤12y*	*>12y*
Naming	*97.04*	***97.63%***	***94.90%***	*94.77%*	*94.73%*	***95.15 %***
Verb Generation	*94.39%*	***97.72%***	***96.83%***	*93.48%*	*90.41%*	***97.96%***
Syntactic Fluency	*20.58 w/m*	***23.84 w/m***	***23.22 w/m***	*18.30 w/m*	*17.44 w/m*	***23.87 w/m***
Syntactic Judgment I	***98.88%***	*98.79%*	*98.79%*	***98.92%***	*98.17%*	***99%***
Syntactic Judgment II	*97.68%*	***98.76%***	***98.12%***	*97.72%*	*96.64%*	***98.48%***

Table 6 - Percentage of correct items per task (in exception of Syntactic Fluency task) within variable groups. Gender, age and years of study. Syntactic Fluency task unit is words within a minute (w/m) and there was no maximum score expected.

Details about the relation between the performance on these tasks regarding the four groups (combining age and years of study) can be consulted in Appendix D.

To answer the question if there is a significant difference between sentence type and error rate in the Syntactic Judgment I task, a Mann-Whitney U test was applied but no relation was found (p-value=0.571), as shown in Appendix F.

4. DISCUSSION

This study reports the performance of Portuguese normal population when their language skills are assessed with DuLIP-EP. The adaptation of DuLIP resulted in a very similar tool to the original, maintaining the same assessment goals and a large number of the original stimuli, as requested by the original authors. As a result of the exclusion of some items for not achieving the specified and needed accuracy rate to validate the stimuli, some tasks of DuLIP-EP have fewer items. Consequently, no statistical comparisons were possible for those tasks. Nevertheless, similar conclusions to the original study were drawn regarding age and education level (years of education) . These variables have an influence on the naming and some of the syntax tasks performances, such as Verb Generation and Syntactic Fluency. In these three tasks, the younger population (≤54 years old) scored better than the sample above 54 years of age. Also, more educated individuals (>12 years of study) performed better than less educated individual (≤12 years of study). In the Syntactic Judgment II task, a statistical influence was found only when considering the education level (high performance among the more educated sample, i.e., with more than12 years of study). A gender influence was found as well, with the female group scoring higher in every task, except on Syntactic Judgment I. No significant differences were found for none of the analysed variables on Syntactic Judgment I task. This task is the one related to the presence of passive and active voice sentences, where we found no significant differences combining error rate and sentence type as well so, no relation was found between education level and the capacity of processing these different sentences types as previously shown by Dabrowska and Street, (2006).

The mean results from the Naming and Verb Generation tasks are distant from the maximum score possible to perform in these tasks, with a std. deviation higher than 3 (items), in other hand, the Syntactic Judgment tasks mean close to the maximum score possible value to perform this task (std. deviation inferior to 1). This means that the first two tasks were the ones that elicited more errors. Equally, the DuLIP authors concluded the same for Naming.

The use of synonyms on the Naming task was frequent and mostly related to the participants origin (region of Portugal, mostly in the North region). Yet, only one item had to be changed in the task score form.

5. CONCLUSIONS AND FUTURE WORK

A better knowledge about the history of low-grade gliomas, its behaviour and clinical outcomes, as well as the techniques available to map and resect this particular brain tumour, contributes to understand how to control this disease aiming for improving quality of life in these patients. There is a need to understand what has to be evaluated and what to expect from a patient submitted to an awake brain surgery in three different moments: pre-, intra- and post-surgery. For this reason, a validated assessment test battery is a helpful tool to detailly mapping the language functions in the brain, in other to preserve them in post-operatory time. Developing DuLIP-EP was a first step forward in Portugal, since there were no validated instruments to perform this kind of assessments specifically regarding pre-, intra- and post low grade-gliomas resection. The DuLIP original version has been used in some case studies with positive outcomes. We aim to validate DuLIP-EP in the surgical field with real patients and study its pertinence and sensitivity within pathological population sample.

It would be important to achieve the same number of participants as the original study, as well as the exact same number of items per task, in order to perform a statistical comparison between the Portuguese version and the original one. A more balanced sample within the groups created would contribute to a better statistical outputs and would allow to consider data that was not suitable to be statistically analysed in the study. The population sample studied was not very well distributed within Portugal. In fact, there were Portuguese regions that were not taken into account as a consequence of the lack of participants, especially from the South region of Portugal, and only an archipelago was considered (Madeira island). It would have been beneficial to this study all Portuguese regions.

5.1 Scientific outputs developed under the scope of this dissertation

While developing this work, it was possible to attend the ExLing 2019 – 10th International Conference of Experimental Linguistics in Lisbon, Portugal (25-27 September 2019), to present and to discuss the study with a highly qualified audience in the field. This opportunity was supported by the attribution of a participation grant from meeting's organisation committee.

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APPENDICES

Appendix A

Participant's informed consent:

Consentimento Informado, Livre e Esclarecido para Participação em Investigação de acordo com a Declaração de Helsínquia

(Helsínquia 1964; Tóquio 1975; Veneza 1983; Hong Kong 1989; Somerset West 1996; Edimburgo 2000; Washington 2002; Tóquio 2004; Seoul 2008)

Título do estudo: Tradução, Adaptação e Validação para Portugal do *Dutch Linguistic Intraoperative Brain Protocol (DuLIP).*

Enquadramento: Este estudo enquadra-se no Mestrado em Terapia da Fala, da Escola Superior de Saúde da Universidade de Aveiro orientado pelo Professor Doutor Luís Jesus e visa traduzir e adaptar um instrumento de avaliação da linguagem em contexto cirúrgico e pós-cirúrgico, mais especificamente das áreas semântica, fonológica e morfossintática. Avalia ainda a articulação verbal. A sua colaboração contribuirá para a adaptação de um teste inovador para o português europeu e, posteriormente, para a melhor compreensão do mapeamento cerebral no que concerne às áreas da linguagem e fala.

Explicação do estudo: Este é um estudo científico que envolve entrevistas e aplicação de testes em local e horário que lhe sejam convenientes. Será solicitada a resposta a determinadas questões demográficas e clínicas. Além disso, será pedida a resposta a determinados itens específicos que o teste a validar contempla.

O Dutch Linguistic Intraoperative Protocol (DuLIL) é um instrumento de origem Holandesa, criado e validado para a avaliação de competências de linguagem em contexto pré, intra e pós cirúrgico em pacientes diagnosticados com lesões tumorais a nível cerebral e submetidos a estimulação elétrica direta (DES) – uma técnica utilizada em neurocirurgia com o paciente acordado, que permite o mapeamento das regiões cerebrais corticais e subcorticais. Embora esta técnica seja cada vez mais utilizada e já considerada um procedimento *gold standard* em neurocirurgia, ainda carece de instrumentos validados para a avaliação das competências a testar no aparato cirúrgico.

No que refere às lesões tumorais que afetam as áreas da linguagem, sabe-se que existem benefícios na utilização desta técnica relativamente ao *outcome* linguístico pós-operatório. Não obstante, a existência de métodos de identificação das áreas associadas a estas competências, validados para os contextos anteriormente referidos são escassos e, no caso do Português Europeu, de acordo com a pesquisa bibliográfica realizada, inexistentes. Assim, este estudo poderá contribuir para a prática clínica das áreas de Neurocirurgia, Neurologia, Terapia da Fala, Neurolinguística e Neuropsicologia, maximizando os resultados e possível potencial de reabilitação dos utentes. Permitirá ainda contribuir para o melhor mapeamento de regiões e trajetórias cerebrais, corticais e subcorticais, relacionadas com a linguagem, nomeadamente nas áreas da fonologia, semântica e sintaxe. As capacidades articulatórias também são contempladas no instrumento.

Condições de financiamento: A participação no estudo não é remunerada. A decisão de participar no mesmo é inteiramente sua. Caso aceite participar, poderá desistir a qualquer momento, bem como recusar qualquer procedimento, sem ser penalizado por isso.

Possíveis riscos ou desconforto: As tarefas não apresentam quaisquer riscos ou desconforto para os participantes.

Confidencialidade e anonimato: A confidencialidade dos dados e dos envolvidos no estudo está salvaguardada. A identificação pessoal ou dados alusivos à mesma não serão disponibilizados a outro grupo ou instituição.

Gratas pela disponibilidade demonstrada, encontramo-nos disponíveis para esclarecer qualquer questão relativa ao estudo.

Contacto para possível esclarecimento de dúvidas:

Joana Alves	Mafalda Cardoso	Mariana Morgado
914500949	915708546	961908302
joanapalves@ua.pt	mafaldacardoso@ua.pt	mariana.morgado@ua.pt

documento é composto de 2 páginas e feito em duplicado: uma via para o/a investigador/a e outra para a pessoa que consente

DECLARAÇÃO DE CONSENTIMENTO

de acordo com a Declaração de Helsínquia

(Helsínquia 1964; Tóquio 1975; Veneza 1983; Hong Kong 1989; Somerset West 1996; Edimburgo 2000; Washington 2002; Tóquio 2004; Seoul 2008)

Título do estudo: Tradução, Adaptação e Validação para Portugal do *Dutch Linguistic Intraoperative Brain Protocol* (DuLIP).

Eu, ____, abaixo-assinado, declaro ter lido e compreendido este documento, bem como as informações orais que me foram fornecidas pela(s) pessoa(s) que assinaram abaixo.

Foi-me dada a oportunidade de fazer as perguntas que julguei necessárias, e a todas obtive resposta satisfatória.

Tomei conhecimento de que, de acordo com as recomendações da Declaração de Helsínquia, a informação ou explicação que me foi prestada versou os objetivos, os métodos, os benefícios previstos, os riscos potenciais e o eventual desconforto. Além disso, foi-me garantida a possibilidade de, a qualquer momento, recusar participar no estudo sem qualquer tipo de comprometimento.

Eu compreendo que os resultados do estudo podem ser publicados em revistas científicas, apresentados em conferências e usados noutras investigações, sem que haja qualquer quebra de confidencialidade. Portanto, dou autorização para a utilização dos dados para esses fins. Assim, aceito participar neste estudo e permito que a utilização dos dados que de forma voluntária forneço, confiando que são utilizados confinadamente para o que me foi descrito e me é garantida, pelos investigadores, a confidencialidade e anonimato dos mesmos.

P'los investigadores, O participante,

___________________________________ _________________________________

_________, ___ de __________________ de 2019

Este documento é composto de 2 páginas e feito em duplicado: uma via para o/a investigador/a e outra para a pessoa que consente

Appendix B

Anamnesis:

universidade de aveiro

Erasmus MC
University Medical Center Rotterdam

CÓDIGO___________

PROTOCOLO PARA RECOLHA DE DADOS

Data da realização do teste: ___/___/_____

Dados recolhidos por: ________________

IDENTIFICAÇÃO PESSOAL

Região de residência: ____

Sexo: Masculino (__) Feminino (__)

Data de nascimento: ___/___/_____ Idade ____ anos

FORMULÁRIO DE INFORMAÇÃO PESSOAL

Lateralidade: Destro (__) Esquerdino (__)

Grau de escolaridade: Não sabe ler nem escrever (__) Sabe ler e escrever (__)
Ensino primário (__) 2º ciclo (__) 3º ciclo (__) Ensino secundário (__)
Pós-graduação (__) Licenciatura (__) Mestrado (__) Doutoramento (__)

Indicar o número de anos de estudos: ____

Situação de empregabilidade atual: Estudante (__) Empregado (__) Desempregado (__) Reformado (__)
Profissão ou antiga profissão: ____

Informação linguística

Língua materna: Português (__) Outro (__)

Qual a língua que fala em casa? Português (__) Outro (__) Especifique: ___________________________

Qual a língua na qual recebeu educação? Português (__) Outro (__) Especifique: ___________________

É fluente noutras línguas? Português (__) Inglês (__) Francês (__) Espanhol (__) Especifique: __________

História clínica

Antecedentes neurológicos (e.g. epilepsia)? Sim (__) Não (__) Especifique: ___________________________

Antecedentes psiquiátricos? Sim (__) Não (__) Especifique: ____

Alterações de aprendizagem ou comportamentais? Sim (__) Não (__) Especifique: ____________________

Alterações de fala e/ou linguagem? Sim (__) Não (__) Especifique: _________________________________

Alterações relacionadas com visão/perceção de cores? Sim (__) Não (__) Corrigida (___)

Especifique: ____

Alterações relacionadas com audição? Sim (__) Não (__) Corrigida (__) Especifique: ___________________

Dependente de substâncias tóxicas álcool ou drogas? Sim (__) Não (__) Especifique: __________________

Medicação que possa influenciar os resultados (e.g. medicação indutora de sono; psicofármacos; medicação neuroléptica)? Sim (__) Não (__) Especifique: ____

Antecedentes cardiovasculares: Sim (__) Não (__)

Observações (e.g. observação comportamental durante o teste):

____

____

____

Appendix C

Mann-Whitney U Test results – task per variable (gender, age, years of study):

	Gender			*Age*			*Years of study*		
	U	**Z**	**p-value**	**U**	**Z**	**p-value**	**U**	**Z**	**p-value**
Naming	2267.500	-1.129	0.259	865.000	-2.926	0.00343	932.000	-4.212	0.000025
Verb generation	1903.000	-2.769	0.006	1002.000	-2.281	0.023	783.500	-5.205	0.000000194
Syntactic Judgement I	2519.000	-0.150	0.881	1353.000	-0.300	0.746	1656.000	-0.935	0.350
Syntactic Judgement II	2265.000	-1.351	0.177	1333.500	-0.382	0.702	1381.500	-2.384	0.017
Syntactic Fluency	1969.500	-2.312	0.021	863.000	-2.885	0.004	884.000	-4.368	0.000013

Significant differences found with p-value=0.05

Significant differences found with p-value=0.00341 (Sidak's correction)

Appendix D

Grouped variable crossing age groups with level of education (years of study) mean and dispersion measures:

Statistics (SPSS output)

Groups			VerbGeneration	SyntaxAnalysisI	SyntaxAnalysisII	SyntacticFluency	Naming
YoungerLowEd	N	Valid	19	19	19	19	19
		Missing	0	0	0	0	0
	Mean		41,68	23,47	24,21	18,42	94,63
OlderLowEd	N	Valid	13	13	13	13	13
		Missing	0	0	0	0	0
	Mean		41,46	23,69	24,08	16,00	90,23
YoungerHighEd	**N**	**Valid**	102	102	102	102	102
		Missing	0	0	0	0	0
	Mean		45,07	23,75	24,59	24,12	96,16
	Median		46,00	24,00	25,00	24,00	97,00
	Std. Deviation		1,941	,553	,722	6,973	2,038
	Percentiles	**2**	35,30	22,00	22,00	8,06	91,00
		7	43,00	23,00	23,00	14,00	93,00
OlderHighEd	N	Valid	10	10	10	10	10
		Missing	0	0	0	0	0
	Mean		45,00	23,80	24,90	21,30	96,30

Appendix E

Sidak's correction:

$\alpha_{SID}=1-(1-\alpha)^{1/m}$, m being the total number of tested variables. For this study:

$$\alpha_{SID}=1-(1-0.05)^{1/5} = 0.0034$$

Appendix F

Mann-Whitney U test results – number of errors per sentence type

	SentenceType	N
Errors	PassiveVoice	7
	ActiveVoice	18
	Total	25

Test Statistics[a]

	Errors
Mann-Whitney U	54,000
Wilcoxon W	82,000
Z	-,567
Asymp. Sig. (2-tailed)	,571

Appendix G

Ethics approval

COMISSAO DE ETICA

da **Unidade Investigação em Ciências da Saúde: Enfermagem** (UICISA: E)

da **Escola Superior de Enfermagem de Coimbra** (ESEnfC)

Parecer Nº 545/ 01-2019

Título do Projecto: Tradução, Adaptação e Validação para Portugal do Dutch Linguistic Intraoperative Brain Protocol (DuLIP)

Identificação das Proponentes

Nome(s): Joana Patrícia Gomes Alves, Mafalda Inês Martins Cardoso e Mariana Morgado Oliveira Martins

Filiação Institucional: Escola Superior de Saúde da Universidade de Aveiro (alunas de mestrado em terapia da fala)

Investigador Responsável/Orientador: Prof. Luís Miguel Teixeira de Jesus

Relator: Sofia Raquel Teixeira Nunes

Parecer

Considerando a avaliação das competências linguísticas pré, intra e pós-operatórias em doentes com lesões tumorais a nível cerebral e submetidos a estimulação elétrica cerebral, este estudo tem como objetivo traduzir e adaptar ao português europeu o instrumento DuLIP e validar o referido à população portuguesa normal. Segundo os investigadores, será um estudo do tipo metodológico com fase qualitativa e quantitativa (a primeira respeita a tradução e adaptação do instrumento e a segunda respeita à aplicação do mesmo).

A data de início de colheita de dados encontra-se prevista para 1 de fevereiro de 2019 e o término a 1 de março de 2022, pelo que à data atual terão os investigadores de adaptar as mesmas.

A amostra agregará no mínimo 140 pessoas da população portuguesa, com critérios de inclusão bem definidos. Será realizada uma amostragem por conveniência em diversas regiões de Portugal.

Os investigadores irão utilizar para além dos instrumentos de colheita de dados, instrumentos que permitam aferir da compatibilidade com os critérios de inclusão dos participantes.

Referiram os investigadores que toda a informação recolhida será tratada de forma confidencial, onde são garantidas a voluntariedade e a autonomia dos participantes. Os dados serão utilizados mas os nomes dos participantes serão substituídos por códigos e só os investigadores terão acesso aos dados. Contudo, é referido que irão recolher o nome dos participantes mas que estarão em destacáveis que serão retirados. Foram verificadas algumas situações na identificação dos utentes e no folha informativa que prontamente foram corrigidas pelos investigadores.

Sendo assim, somos do parecer que o projeto pode ser aprovado sem restrições de natureza ética.

O relator:

Data: 12/03/2019 O Presidente da Comissão de Ética: ____________

UNIDADE DE INVESTIGAÇÃO EM CIÊNCIAS DA SAÚDE

Escola Superior de Enfermagem de Coimbra

FCT Fundação para a Ciência e a Tecnologia