TRABAJO DE FIN DE GRADO

«THE MENTAL LEXICON: A CONTRASTIVE ANALYSIS OF MOTION VERBS IN ENGLISH AND SPANISH»

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CONTENTS

1. INTRODUCTION 1

1.1. Definition and justification 1

1.2. Aim and hypotheses 1

1.3. Methodology 2

2. THEORETICAL FRAMEWORK: Brain and language, the mental lexicon and semantic networks. 3

2.1. THE NEUROPHYSIOLOGICAL BASIS OF LANGUAGE 3

2.1.1. Broca and Wernicke: The traditional model of language 4

2.1.2. Towards specific language areas 6

2.2. THE MENTAL ORGANIZATION OF LANGUAGE 10

2.2.1. The mental lexicon 10

2.2.2. Semantic memory and semantic networks 12

3. WORDNET: A TOOL OF ORGANIZATION FOR THE MENTAL LEXICON .. 17

4. TOWARDS A PRACTICAL APPROACH: Motion verbs 19

4.1. General linguistic background 19

4.1.1. Grammatical categories: Differences between nouns and verbs 19

4.1.2. Paradigmatic and syntagmatic relations 20

4.2. The case of motion verbs 21

5. CONTRASTIVE ANALYSIS: ENGLISH AND SPANISH MOTION VERBS 23

5.1. General aspects 24

5.2. Case study 26

6. CONCLUSIONS 32

REFERENCES 34

Annex I 38

Annex II 40

Annex III 40

Abstract: This paper presents a theoretical approximation to the mental organization of language and therefore, to the existence of a mental lexicon where the lexical items of a language are stored and organized into semantic networks. These will be illustrated using a sample selection of motion verbs and making a contrastive analysis comparing the way English and Spanish shape these associations in a different way.

Keywords: mental lexicon, psycholinguistics, motion verbs, semantic networks, contrastive analysis, WordNet

Resumen: El presente trabajo consiste en un acercamiento teórico a la organización mental del lenguaje y, como consecuencia, a la existencia de un lexicón mental donde almacenar los elementos del léxico de una lengua que a su vez se organizan en redes semánticas. Teniendo en cuenta un análisis contrastivo inglés/español de verbos de movimiento, veremos cómo estos funcionan como redes y cómo distintas lenguas establecen distintas asociaciones en el lexicón mental.

Palabras clave: lexicón mental, Psicolingüística, verbos de movimiento, redes semánticas, análisis contrastivo, WordNet

1. INTRODUCTION

1.1.Definition and justification

Currently, we know that most relatively educated adults know a number of between 75.000 words minimum up to a maximum of 150.000 (Oldfield (1963) Seashore & Eckerton, (1940), as cited in Garman, 1992). This makes one wonder how it is possible for humans to store that impressive amount of words in our brain, where these words are stored and the way we unconsciously create different types of relations among them to access and process them with such ease. All these questions lead to the existence of a speaker's mental dictionary or list of words which requires a previous psychological and neuroanatomical foundation.

After five years of university studies on Linguistics and English, the inspiration for the present piece of research surges due to the interdisciplinary character of Linguistics as a branch of knowledge. There is, without a doubt, a fascination for Linguistics as an interdisciplinary science and for Psycholinguistics as one of its many different applications; encouraged by the significance of the University of Cádiz's Instituto de Lingüística Aplicada (ILA) and its intervention in different fields of knowledge. Hopefully, this paper could serve as well to draw a path to future projects that allows us to go further in the present investigation.

1.2.Aim and hypotheses

Most theorists agree on the fact that humans have, not only a lexicon where vocabulary is stored, but also a grammar to combine and create utterances of multiple and infinite possibilities. Since different linguistic connections are made in different languages because each mental lexicon is different (Durán 2004: 259), the purpose of this paper is to take the mental lexicon as our object of study and draw the similarities and differences between English and Spanish regarding the way they organize the words in the mental lexicon.

The aims of this investigation are the following: (1) to review the appropriate literature on the neural and psychological basis of language, (2) to draw a theoretical framework around the idea of the mental lexicon and its functioning, (3) to understand WordNet as a tool of linguistic representation and as a lexical database, (4) to consider a theoretical approach to motion verbs and (5) to make a contrastive analysis between two different languages, English and Spanish, focusing on a specific case study of motion verbs.

Considering the two major topics we will be addressing, the contents will be divided in two main blocks: a theoretical framework focused on psycholinguistics and a more practical approach focused on motion verbs.

1.3.Methodology

The nature of this piece of research requires a descriptive theoretical framework based in the revision of the appropriate literature on psycholinguistic and neurolinguistics followed by a practical case study based on the analysis of a selection of verbs that requires as well the support of the relevant linguistic literature on the topic.

The theoretical framework follows then a qualitative methodology based on the selection of appropriate articles, studies and handbooks to reach the previously stated objectives. It consists on a revision of neuroanatomical models of language and models that consider more specifically those areas for lexical knowledge storage, which consider semantic memory as a starting point.

Princeton's University WordNet will be used as a tool for a possible illustration of how words are stored in the mental lexicon and how these relate to one another creating semantic networks. Towards a more practical approach, we will work on a specific case study by the selection of a series of verbs WordNet tagged under the category of motion verbs.

Our practical approach will follow a deductive methodology. We are going to consider general features regarding motions verbs so that we can clearly focus in more particular cases in the proposed case study. Several acclaimed linguists have been taken as reference for the theoretical backbone of the contrastive analysis we propose, including the pioneering Ferdinand de Saussure's *Course on General Linguistics* and Beth Levin's typology of English verbs as the primary sources for our analysis of the behaviour of verbs as semantic networks. Verbs have been considered over the rest of grammatical categories for this analysis due to their grammatical complexity, richness and their ability to not only form different semantic associations among them but also their combinatorial behaviour involved in the sentence frames they can appear in.

2. THEORETICAL FRAMEWORK: Brain and language, the mental lexicon and semantic networks.

In this theoretical framework we will revise the appropriate literature that explains the brain processes involved in language production and comprehension from a traditional and general approach to a more definite one that considers specific brain circuits for specific linguistic domains, especially lexical storage and organization.

On the previous basis one most recognize that there are two fields which concur when studying the relation of language and brain: Psycholinguistics and Neurolinguistics. Seeing that both share the same object of study, one must distinguish and establish the boundaries that differentiate them. According to Duarte and Varo's (2006) distinction, Psycholinguistics studies those linguistic tasks under the traditional, psychological interaction of body and brain. As for Neurolinguistics, it deals with the brain and its neuronal connections in a physiological way (Duarte and Varo 2006: 108). Both will be present during this theoretical framework. On the one hand, from a neurolinguistic lens, one will examine the neural bases of language supported by several neuroanatomical experiments and models; on the other hand, the revision of different models of lexical access —relevant to the study of the mental lexicon— will be supported by psycholinguistic theory.

2.1.THE NEUROPHYSIOLOGICAL BASIS OF LANGUAGE

Language is a complex phenomenon that has been an object of investigation by neurologists and linguistics for centuries, with aphasiology studies as its predecessors until our present time with the development of cognitive sciences and the intervention of Linguistics, giving birth to new fields of research such as Psycholinguistics and Neurolinguistics. It is imperative to become familiar with the cognitive aspects that interfere with language before progressing to study the mental lexicon in depth since Cognitive Linguistics cannot ignore this clear neurological part of language (García et al. 2011: 65). As Pulvermüller (1999) claims:

> In recent years, more and more neuropsychological studies have been devoted to the investigation of cortical mechanisms necessary for word processing, and psychophysiological studies have been investigating the brain areas that "light up" when words are being produced of comprehended (Pulvermüller 1999: 254).

Pullvermüller's words remind us that every piece of evidence we hold up to date about the functioning of the brain and the areas involved are thanks to aphasiologies and neurofunctional imaging studies. To understand then, the underpinning and neuroanatomical correlates of language one must review and discuss the appropriate literature on the human brain, subcortical structures, neocortex, hemispheres, lobes and memory systems; all of them involved somehow in linguistic-related processes. We have to consider the existence of two essential systems for language, listed as (1) an instrumental system, located in the dominant hemisphere and that would correlate to Broca and Wernicke's areas and (2) a semantic system, that holds great cortical extensions from both hemispheres and deals with concepts and meanings (Damasio (1992), as cited in Castaño 2003: 781).

2.1.1. Broca and Wernicke: The traditional model of language

Even though the biological foundation of language has been of interest for centuries, one must retrocede to the first and most significant aphasiologies. The traditional approach to a neurological model of language dates from the 19th century. Most authors agree then on two key neuroanatomical studies as a starting point to discuss the location of language-specific areas in the brain. As Damasio and Geschwind (1984) claim, "the oldest and admittedly the most fruitful of them was the neuropathological study of focal cerebral lesions in patients with aphasia" (Damasio and Geschwind 1984: 121). Based on a postmortem study on linguistic deficits, it is Paul Broca's (1861) report on one of his patient's aphasia which marked a before and after in the study of language. Similarly, a decade later, Carl Wernicke's (1874) findings contributed to extend this model as well. The relationship between language and brain is, therefore, supported by these two significant and pioneering neuroanatomical studies with the revealed what would be called Broca's area and Wernicke's area.

The discovery of said areas lead us to first consider the cerebrum (as illustrated below), which is the largest part of the brain. It is divided into two hemispheres, left and right and despite each one of them being more or less mirror images of each other (Ullman 2014: 251), some linguistic functions may differ from one hemisphere to another. Each hemisphere is divided as well into four lobes: the frontal lobe, the temporal lobe, the parietal lobe, the and occipital lobe.

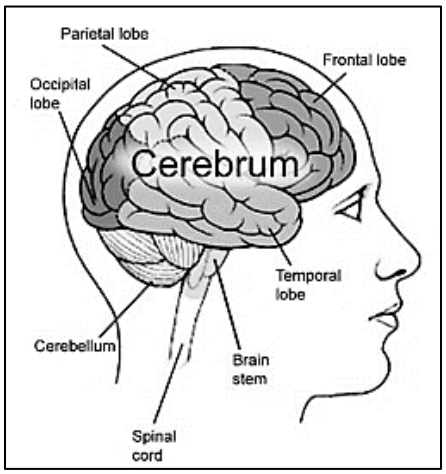

Figure 1. A first look into the cerebellum. Source: Ullman (2014: 251)

Broca's and Wernicke's areas essentially constitute which is conceived as the language center in the brain. Both areas are usually[1] situated in the left hemisphere of the human brain and both of them are considered essential to the human faculty of language. It is important to understand here lateralization as the phenomenon that allows language control and organization to be located in the left hemisphere of the brain.

Broca's area is destined for language production and articulation and it is agreed on residing in the frontal lobe of the human brain (Broca 1861). Nevertheless, some authors have decided to limit its extent within the left inferior frontal gyrus to Brodmann's area 44 and 45 (Galaburda (1980) and Amuntus et al. (1999) as cited in Papathanassiou et al. 1999: 347). It was the damaged part of the frontal lobe of the human brain which confirmed that this area was "associated with the motor images of speech" (Price 2000: 336) and where conceptual information is stored (Caplan 1994). More specifically, its frontal location has led to the suggestion that it holds the place to access verbs and functional words (Castaño 2003: 781).

Wernicke's area on the other hand, whose task is language comprehension, is believed to be positioned on the left posterior superior temporal gyrus and Brodmann 22. Its function is language decoding, and even though it does not interpret semantic contents, its damage might seem to affect the access to the semantic 'pool' (Castaño 2003: 781).

[1] Research has proven how left-handedness can increase language dominance in the right hemisphere (cf. Knecht, S., Dräger, B., Deppe, M., Bobe, L., Lohmann, H., Flöel, A., … Henningsen, H. (2000). Handedness and hemispheric language dominance in healthy humans. *Brain, 123*(12), 2512–2518).

Broca's and Wernicke's areas conform the classical model for language production and comprehension from a localizationist point of view. Inspired by a curiosity for linguistic deficits such as aphasias, both have been later on supported by specific neuroimaging techniques. However, as it is previously mentioned, the localization as well as the structure of said regions have been questioned and considered a matter of debate in psycholinguistic and neurological theory due to the recent advances in cognitive science and techniques. (Papathanassiou et al. 1999: 347). As discussed by Tremblay and Dick (2016):

> [A]pplied to contemporary research questions, with current knowledge of brain structure and function, the earliest Classic Model instantiations offer a spatial accuracy that is too limited to test modern hypothesis about brain/behavior relationships (Tremblay and Dick 2016: 62).

Considering the localizationist approach's limitations (Pullvermüller 1999: 254) recent functional neuroimaging techniques have led to a revision of the role of both Broca and Wernicke's area, as well as an observation of the implication of other areas related to language generation task, aiming to illustrate and uncover a network of areas that are implicated simultaneously in linguistic tasks. Several authors have pointed out at the recent evidence that leads both neurologists and linguists to consider a holistic approach to the way brain and language converge (Lamb 1999: 360).

2.1.2. Towards specific language areas

Broca and Wernicke's traditional model is one that may be exclusively focused on localization (del Río and López-Higes 2015: 127). However, recent research has uncovered the role of other areas that not only does specify the relation between brain and language but also makes it inevitably more complex. Wishing to accomplish a broader approach to the neural basis of language that go beyond the previously reviewed traditional model, some authors have focused their research on these specific areas involved in linguistic tasks.

The ones that are source of interesting for this paper are those regarding semantic processing (cf. Binder and Desai 2011), which conform a network of heteromodal associations (Binder et al. 2009: 2782; Binder and Desai 2011: 534). Most concretely, we will focus on those neural system specialized for the storage of semantic knowledge. Research based on neuroimaging techniques such as the one presented by Papathanassiou et al. (1999) aim to

detangle these essential neural areas involved in linguistic tasks and where the lexical and semantic knowledge appears to be stored. Their paper is a revision on the uncertainty and exclusivity that the model of Broca's and Wernicke's areas involves and suggests a more actualized and inclusive model supported based on PET activation studies on normal volunteers. Said study considers Broca and Wernicke as language epicentres[2] and shows there is a common language network for both language production and comprehension –when they are lesioned or electrically stimulated–, claiming there are specific areas related to semantic tasks. Binder (2009: 2784) classifies these areas spread across the cortex into three categories: the posterior heteromodal association cortex (highlighting the relevance of the angular gyrus); specific subregions of heteromodal cortex (with dorsal and ventral streams) and medial paralimbic regions (highlighting the role of the hippocampus).

Furthermore, Binder and Desai (2011), in their proposal for an anatomical-functional model for semantic memory, review several experiments that associate language and most specifically, semantic processing and retrieval, to concrete areas from the human brain. We know that the subcortical structures of the brain (illustrated below) must not be ignored, they are equally important since "no part of the brain acts on its own" (Ullman 2006: 241). The angular gyrus, situated in the parietal lobe and Brodmann 39, deals with the transferring of visual information from Broca's to Wernicke's area, in order to create meaning out of perceived words. Therefore, it is strongly linked to semantic memory and accordingly lexical retrieval (Binder et al. 2009: 2774-2775) and its damaging may lead to semantic aphasia. On the other hand, the inferior frontal gyrus is engaged when tasks require an effortful election of semantic information (Binder and Desai 2011: 532). As for other areas, they highlight the evidence on the so-called semantic dementia and the damage the subjects presented in the inferior and lateral temporal lobe to understand these areas of the brain as essential regarding semantic tasks. This syndrome is "characterized by progressive temporal lobe atrophy and multimodal loss of semantic memory" (Binder and Desai 2011: 532), meaning they cannot remember names of objects or categorize them.

[2] The authors chose to describe language epicentres as "transmodal regions that have an associative function linking the various representations of word conducting to its meaning" (Papathanassiou et al. 1999: 348)

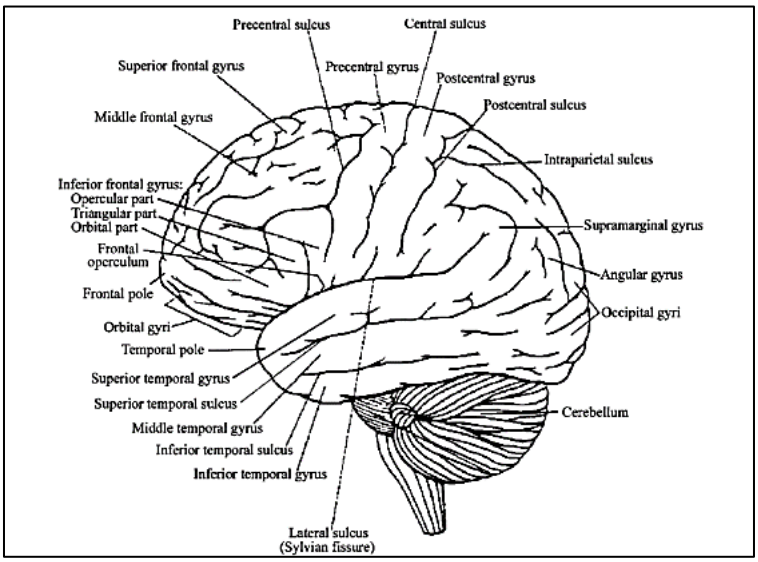

Figure 2. An overview to the anatomical structures in the left hemisphere of the cerebrum and cerebellum. Source: Ullman (2014: 237)

Recent research on the cortex of the human brain to identify language-specific cortical areas has led to new frameworks for a better understanding of the functional anatomy of language. One of the current models on the neuroanatomical organization of language is the one on dorsal and ventral streams. Hickok & Poeppel (2003) suggest a dual stream model to the neuroanatomical organization of language that provides more specific functions apart from the broadly defined speech production or speech comprehension (Hickok & Poeppel 2003: 94). This points to a neural language network that considers dorsal and ventral pathways, each of them serving a different and specific language function (Friederici and Gierhan 2013: 252).

This neuronal network should function as a circuit that supports language functions by connecting the language-relevant brain regions. Considering semantically related tasks, these authors premise how there must be a cortical network that maps conceptual-semantic representations in the brain; claiming there is a system that maps sound into meaning and vice versa. Out of these two routes they suggest, it is the ventral one (in purple below) to be intrinsically linked to semantic processing and semantic and conceptual representations of language, which would be a sound-meaning "interface" (Hickok & Poeppel 2003: 72) of lexical items with a computational system responsible for semantic operations as well. This sound-meaning interface is said to support access to the mental lexicon (Hickok & Poeppel 2003: 78). Studies on aphasiologies, neurophysiological studies and imaging studies have proposed a possible location for this system in the temporal-parietal-occipital junction. (Hickok & Poeppel 2000; Hickok & Poeppel 2003). This accessibility to the mental lexicon through the ventral

system has been supported by the identification of the middle portion of the middle temporal gyrus as something essential to "conceptually-driven lexical selection" (Indefrey & Levelt 2000: 77). Moreover, its location in the temporal love leads to the involvement of left posterior inferior temporal regions in aspects of language comprehension and production that go beyond phonemic aspects such as comprehension and naming tasks. This leads to the affirmation that the posterior inferior temporal lobe plays a crucial role in lexical-semantic processing. Accordingly, there are speculations on how grammatical processing would fit into this neural network. It seems to be represented by the collective activity of a large network that involves frontal, anterior temporal and posterior temporal systems (Caplan, Hildebrandt, and Makris (1996), as cited in Hickok & Poeppel 2003: 85).

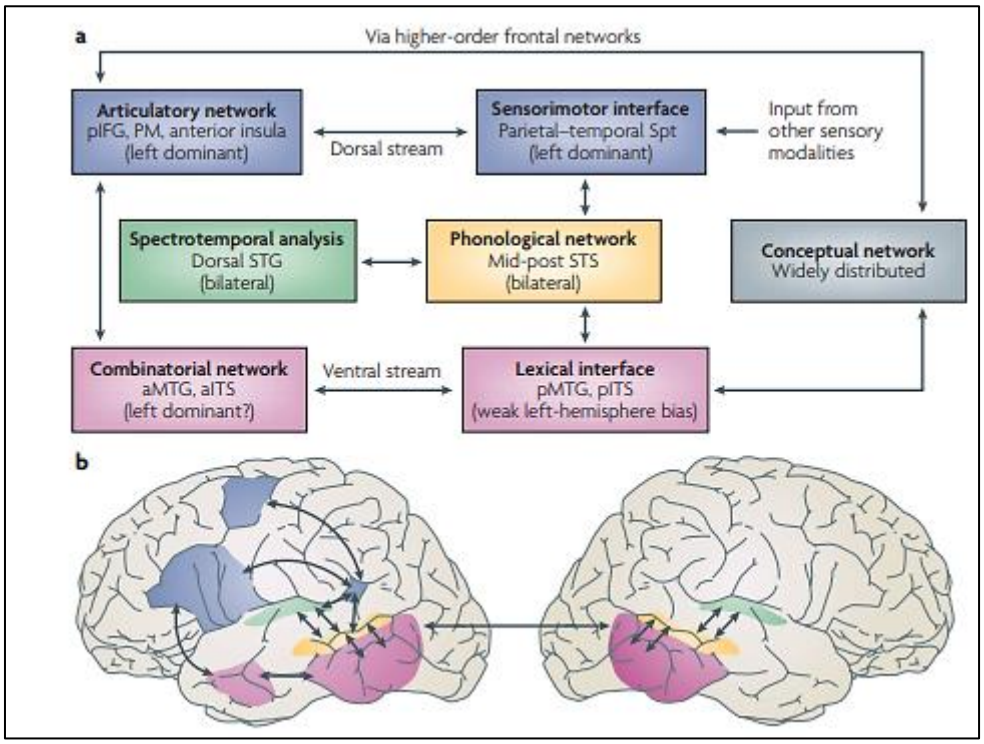

Figure 3. Hickok & Poeppel's ventral and dorsal pathways model. Source: Hickok & Poeppel (2007: 395)

There are has been further research on areas of the brain that deal with more specific semantic tasks. Binder et al. (2009: 2780) talk about semantic subsystems and one that arises particular interest is the fact that there is a distinction between perceptual and verbal representations in the brain, "exemplified by the contrast between concrete and abstract words" (Binder et al. 2009: 2780), being the latter more difficult for the speaker to process as evidenced by specific neuroimaging studies. Namely, regarding language processing, the psycholinguistic

and neurolinguistic research has insisted on the fact that there is evidence for semantic category-specificity in the human brain. Whereas nouns are typically linked to visual knowledge, most verbs are semantically linked to action knowledge instead. Evidence from neuroimaging studies claim that different areas of the brain activate depending on whether the input word is action- or visually- related; it is the case of the fronto-central cortex for action-related words and the occipital and inferior-temporal cortex for words not related to action (Pulvermüller 2011: 436; Binder et al. 2009: 2780). Some other subcortical structures deep inside the cerebrum such as the hippocampus, which are suggested to also be important for specific linguistic tasks (Ullman 2006: 241); it is situated within the lower temporal lobe, is strongly related to episodic memory and declarative memory in general and so it plays an essential role in linguistic-related activities (Lamb 1999: 298).

2.2.THE MENTAL ORGANIZATION OF LANGUAGE

2.2.1. The mental lexicon

Most of the evidence we have about the mental lexicon, its organization and its accessibility come from aphasiologies, experiments and neuroimaging studies. However, in this section we will be addressing the mental lexicon from a linguistic point of view. Our premise is the definition given by Cambridge's Dictionary, which claims the lexicon to be "(a list of) all the words used in a particular language or subject, or a dictionary" ("Lexicon", n.d.). While some definitions would agree on referring to it as a dictionary, it is not as simple. Despite the evident similarities, the mental lexicon must not be seen as a dictionary or a mere list of words, since it would be impractical and impossible to collect all possible linguistic information about a word in a printed dictionary (Aitchinson 1987: 12). As Collins and Quillian point out, definitions contained in dictionaries are not specifically orderly, and they "doubt that human memory, which is far richer, is even as orderly as a dictionary" (1969: 242). It was Oldfield, in his work *Things, Words and the Brai*n (1966) the first one to suggest the existence of a mental lexicon, and we know now that most models for language comprehension and production agree on the existence of a mental lexicon.

On the mental lexicon's configuration, which has been subject of controversial opinions, one must, as according to Varo (2010: 155), determine first the lexical entries within, its internal structure and the way these are organized. Accordingly, Murphy (2003: 15) presents two major problems with regards to the lexicon: there is no consensus on the type of

information that is stored in it nor the way it is structured. These questions will be the starting point for our approach to the lexicon.

Traditionally, the mental lexicon is understood as "the repository of all lexical knowledge possessed by an individual language user" (Stemmer & Whitaker 2008: 151), consisting on a wide system where words are, not only stored but also learnt, understood and retrieved (Ullman 2006: 256). Ullman's contributes to the definition of the mental lexicon claiming that it is "a repository of stored information, including all idiosyncratic, word-specific information, such as any arguments that must accompany a verb" (2001: 717). This means that, from both a linguistic and cognitive approach, the lexicon is extraordinarily complex since it also contains linguistic information that goes beyond a list of lexical items. Therefore, not only it does contain lexical, semantic and phonological information but it could work as an appendix of a language's grammar, "a list of basic irregularities" of a particular language (Bloomfield 1933: 274).

These lexical items, however, are not stored following alphabetical order, as a dictionary would do. Instead, there are multiple ways in which lexical items can be organized; there are several factors to consider in order to illustrate the structure and the means of organization of the mental lexicon as the ones proposed and listed by Reeves et al. (1999): (1) frequency, (2) concretion and abstraction, (3) semantics, (4) grammatical category, (5) phonology. If we consider first frequency, revised evidence suggests that it does holds an important place in lexical storage and access (Reeves et al. 1999: 181), but it seems to correlate to processes that happen after lexical access (Balota and Chumbley 1984). Moving on to (2) concretion and abstraction as a criterium for lexical organization, Ullman (2006: 258-259) claims that "words denoting items with strong visual attributes such as form or color involve a temporal-occipital ventral area just in front of visual cortex", whilst other lexical items such as actions described by verbs[3] activate the posterior lateral temporal regions. This leads one to believe that grammatical category does have a critical role in the organization of language in the brain. As Varo (2017: 314) claims, the differences between verbs and nouns, for instance, can imply the participation of different neuroanatomical structures. Nonetheless, even words from a different category can trigger the activation of different areas, which, considering

[3] Ullman specifically addresses the concept of "motion perception" (2006: 259), which will be revised afterwards in **4. TOWARDS A PRACTICAL APPROACH: Motion verbs**.

Ullman's (2006) example of *giraffe* and *screwdriver*, links with the factor of abstraction and concretion. Regarding a criterium based on phonology, despite not being as frequent, there is evidence that words that have a similar sound may be close in storage or at least access (Reeves et al. 1999: 184). These criteria, despite each one being equally important and independent, do not always work on isolation. They can cooperate and do not necessarily have to be "linearly separable" (Dell, Chang and Griffin 1999: 519).

It is, nonetheless, the third factor that we listed previously the one that serves of the most interest for us. Its richness and evidence relying on brain damage confirm that indeed, semantics and the different associations between words are one of the most reliable criteria regarding lexical organization in the brain. Ullman draws attention to the temporal lobe and its relation to the use of lexical knowledge, providing evidence from patients with semantic dementia (2006: 257). When we are discussing different associations about words, we are referring to semantic networks. Some evidence for the existence of such can be collected from patients with cerebral damage which leads one to believe that meaning and the different associations between words have a strong possibility to be involved in the way we access to lexical items. (Varo 2017: 1839 and that the brain holds in this wide inventory of knowledge that is the mental lexicon, where words are intertwined considering their semantic attributes (Gasparri 2016: 467).

2.2.2. Semantic memory and semantic networks

It is clear that most authors' interests reside on semantic memory. The fact that word storage in the brain is linked to human long-term memory is practically unanimous (Durán 2004; Price 2000, Varo 2017). The main types of memory involved in language are, as listed by Price (2000: 335), phonological, ortographic and semantic. It is the latter that is object of interest for this paper. Many authors highlight this unification by talking about semantic memory, understood as "an individual's store of knowledge about the world" (Binder and Desai 2011: 527) and regarded as something uniquely human due to its natural way or representing and associating concepts.

Seeing the consensual opinion that linguistic knowledge is stored in the brain thanks to long-term memory, the existence of as Durán claims, "un mundo fuertemente conectado y cohesionado cognitivamente, en el cual todo resulta familiar" (2004: 261) is undeniable. We

have to review the semantic memory system and find a way of representing and organizing said semantic knowledge in the human brain.

Many authors take memory as the starting point to discuss the mental organization of language, the existence of a lexicon and its properties, leading to theories that agree on the existence of a large lexical database (Durán 2004: 242) that owes its functioning to long-term semantic memory. Similarly, most models on the organization of language have likely been stimulated by the presence of brain areas that share linguistic "sustratos cerebrales compartidos por funciones lingüísticas y otras funciones cognitivas como la memoria" (Varo 2017: 314).

Prior to a discussion on semantic networks and the mental lexicon in depth, one must briefly review Ullman's model on declarative/procedural memory, since this model was meant to model the psychological and neural foundations of a mental lexicon and a mental grammar. Hence, there is an undeniable link between lexical and semantic memory and this brain memory system distinction for two essential reasons Ullman (2001) suggests: (1) the declarative memory underlies semantic knowledge, (2) neurophysiological evidence indicates how the temporal lobe system may be involved in subserving words. This model clearly deals with neural localization as well, which links the previously discussed neural correlates of specific language domains. Several studies on aphasiologies have shed some light on the neural correlates of such systems. The declarative memory system, as evidenced by several studies on aphasiologies, is claimed to be located in the medial temporal lobe (Ullman 2001: 718), whereas the procedural system is rooted in portions of the frontal cortex, the basal ganglia, the parietal cortex and the cerebellum. On the one hand, the declarative memory system deals with associative and structured representations in our brain. Thus, is the one linked to semantic and episodic knowledge, meaning that the learning and representations of facts and events is registered there, respectively. Therefore, this system consolidates new memories and storages and retrieves the already stored ones. The procedural memory system, on the other hand, deals with storage that is said to be implicit: habits as well as motor and cognitive skills such as "learning or processing skills that involve action sequences" (Willingham (1999), as cited in Ullman 2001: 718). Evidence from studies of the damage of these basal ganglia circuits that extend to the frontal cortex suggest an impairment of this areas with the expression of motor skills as well as grammar. This way, this system entails a set of grammatical rules that is clearly coordinated with lexical items in the case of verbs.

The fact that word storage in the brain is linked to human long-term memory is practically unanimous (Quillian 1966; Price 2000; Durán 2004). The main types of memory involved in language are, as listed by Price (2000: 335), phonological, orthographic and semantic. It is the latter that is object of interest for this paper, first introduced by Quillian (1966) in his doctoral dissertation. Many authors highlight this unification by talking about semantic memory, regarded as something uniquely human due to its natural way or representing and associating concepts.

Wishing to illustrate the way semantic information was stored in the brain, Quillian (1966) developed a hierarchical network model for semantic memory in the mid-sixties. His theory on semantic memory relies on the existence of memory nodes (representing concepts) and different levels of hierarchy. The design of such model consists of "a mass of nodes, interconnected by different kinds of associative links" that suggested that semantic memory was stored hierarchically. Said nodes can be related to one another either a) directly, by other nodes that represent the meaning of its name word, or b) indirectly, to a word concept, by having one special kind of associative link which points to that concept's type node (Quillian 1966: 13).

> [A] word's full concept is defined in the memory model to be all the nodes that can be reached by an exhaustive tracing process, originating at its initial, patriarchal type node, together with the total sum of relationships among these nodes specified by within-plane token-to-token links (Quillian 1966: 19).

Quillian suggests that what was a minimal approach to a lexicon which was reduced to a set of rules by generative grammar can be extended into adding semantic information (1966: 8). Semantics, then, would not be a secondary subordinate to a set of primary syntactic rules, but rather a primary factor that does not rely on a set of rules or divided up into small structures. Quillian distinguishes between such basis and a memory structure that would relate to a deep structure (according to transformational theory) in which language is stored as an "enormous, interlinked net" (Quillian 1966: 10-11).

This was later furtherly developed and can be exemplified if one considers Collins and Quillian's examples provided in "Retrieval Time from Semantic Memory" (1969). The kind of associations that can be made between nodes are those which represent category memberships and those which represents properties. The fact that 'canary' points to a superset or category

name of ‘bird’ and also holds the properties of being yellow and being able to sing suggests there are pointers that travel from one node to another, from ‘animal’ (a general or higher order category) to ‘bird’ and eventually to ‘canary’ (a specific or lower order category).

This model is important because it settles the bases for semantic networks. The afore mentioned suggests a clear relation between semantic networks and the neuropsychological organization, pointing to the interlinked net that Quillian (1966) discussed. This neuroanatomically based, functional network of semantic memory requires a place to store all the linguistic knowledge that is agreed by consensus to be the mental lexicon.

As previously mentioned, the fact that our brain contains a complex interface of neural networks suggests the existence of semantic networks as well. Since Collins and Quillian (1969) claimed that semantic memory works as a network underpinned by sets of intertwined nodes, one understands that the mental lexicon is also a structured network, similar to a neural network (García et al. 2011: 64). Technological advances regarding cognitive neuroscience have induced to a new perspective on said interface called the functional network.

> [U]n conjunto de neuronas fuertemente conectadas entre sí, distribuidas en un conjunto específico de áreas corticales, que trabajan juntas como una unidad funcional y cuyas partes, por tanto, son mutuamente dependientes (Varo 2017: 313).

This leads to the belief that connectivity is indispensable. The existence of semantic and syntactic networks as linguistic networks leads to the affirmation that a language’s mental lexicon is not based on random and unorganised entries. Instead, speakers of a language can easily get from one word —or sense— to another despite the amount of words stored in the brain (García et al. 2011: 67). These networks work in a way that allow the intercommunication of nodes via different ways, creating a complex network of different relations. (Durán 2003: 235). The interest for this “interconnected system” (Aitchison 1987: 72) has encouraged different theorization on the way in which words relate to each other.

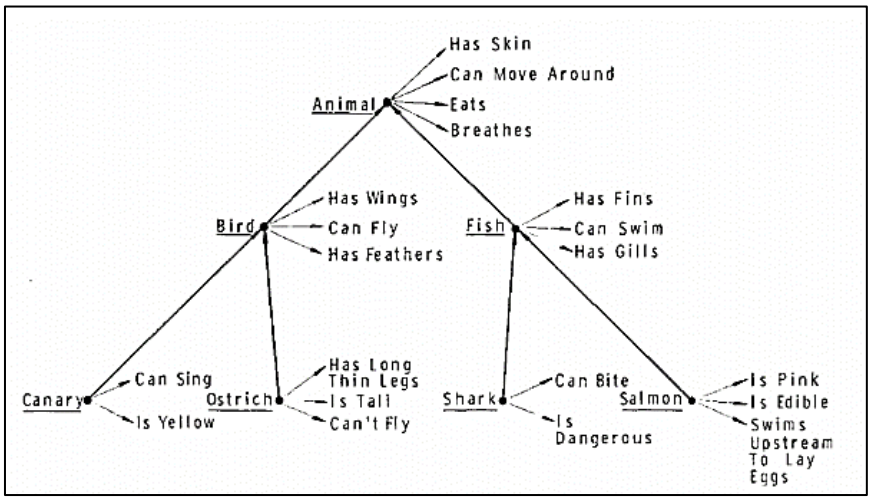

Figure 4. Source: An overview of a hierarchichal model of semantic memory. Collins and Quillian (1969: 241)

Aitchison discusses the existence of a word-web and presents four essential type of relations between words: 1) co-ordination, 2) collocation, 3) superordination and 4) synonymy. Co-ordination refers to a relation between words which "cluster together on the same level of detail[4]" (Aitchison 1987: 74). The author exemplifies this with the pair *salt/pepper* or a list of colours, *red/white/blue*. The second type of relation relates to the likeliness of the cooccurrence between words, such as *bright/red* or *salt/water*. Superordination was observed whenever the speaker answered with a word that included the stimulus word (e.g.: *insect/butterfly*). Synonymy is also a possible type of relation between word, when participants answered with a synonym to the original word, as in *starved/hungry.*

There are several theories for lexical organization but considering Collins and Quillian's (1969) proposal, the one that is of interest for a semantic network and therefore for this paper are formal relations and semantic relations, as both aspects are represented in the mental lexicon (Varo 2017: 305). However, and considering Aitchinson's (1987:75) line, we are going to mainly consider superordination (or IS-A relations, as in "a canary is a type of bird") and synonymy.

To summarize what has been discussed in this section, we can list the following properties as essential to the configuration of the mental lexicon: its interconnectivity, that allows the speaker to quickly 'travel' from one node to another and efficiently access lexical

[4] Opposites are included in this group. Consider, for instance, the relation between *hot/cold.*

items; its hierarchical structure or pyramidalization (Durán 2003) into semantic fields. After having reviewed semantic networks, it is necessary to consider a model or a proposal that takes all the previously discussed into account, meaning that it allows the representation of words into semantic networks and that, consequently, takes into account the psycholinguistic basis that it entails.

3. WORDNET: A TOOL OF ORGANIZATION FOR THE MENTAL LEXICON

It is 1986 when George Miller predicts how important research on lexical knowledge, its nature, properties and organization would be in the future we are now living in (Miller 1986: 305). Over three decades later, technological advances have allowed us to different ways of representing natural language as a contrast to the traditional ones (dictionaries, thesauri, etc.). Miller hinted at specific criteria that he considered critical for a natural language interface system: (1) they must allow the user to access to a large, general-purpose knowledge base; (2) be able to deal with an enormous vocabulary; and (3) be able to reason in ways that human users find familiar.

A project that seemingly matches the previous criteria is Princeton University's WordNet, an approximation to a computational lexicon created by George Miller himself and a group of psychologists and linguists in the mid-eighties. WordNet is an online lexical data base that offers a range of nearly 100,000 word forms (almost half of them being collocations) which are organized into approximately 70,000 word meanings or sets of synonyms called synsets (Millet et al. 1990: 2). This seems to surpass the first two criteria suggested by Miller. As for the third one, the fact that WordNet is able to reason in a familiar way to human users has to do with the fact that it based on psycholinguistic criteria. Moreover, according to one of his creators, it is "an electronic lexical reference system for English, designed in accordance with psycholinguistic theories of the organization of human lexical memory" (Miller 1995: 1). It is, then, a useful option for natural language representation and organization and relevant for this paper in particular due to its psychological foundation linked to memory models. Considering its latest advances in computing and technology, we can consider WordNet as a modern proposal "for a more effective combination of traditional lexicographic information and modern high-speed computation" (Miller 1995: 1).

WordNet consists in four different lexical databases, containing only functional words, meaning that prepositions and conjunctions, for instance, are not included and the system will

not give the user any result if searching for one of these. Then, English nouns, verbs, adjectives and adverbs are organized into synonym sets (henceforth, synsets), "each representing one underlying lexical concept" (Miller et al. 1993: 1). It is clear that the main difference whilst being compared to traditional dictionaries in terms of functioning is that WordNet does not work with word lists following alphabetical order. Instead, its developers chose to consider semantic relations between words and cluster them together in these synsets; linked through different relations: (1) synonymy, (2) hypernymy/hyponymy, (3) troponymy, etc. Moreover, WordNet also offers the user different possible sentence frames for each lexical item in the case of verbs:

> To cover at least the most important syntactic aspects of verbs, therefore, WordNet includes for each verb synset one or several sentence frames, which specify the subcategorization features of the verbs in the synset by indicating the kinds of sentences they can occur in. This information permits one quickly to search among the verbs for the kinds of semantic-syntactic regularities studied by Levin[5] and others. (Fellbaum 1990: 55)

It is the third one from the listed above the relation that is of interest for this paper. Troponymy is a term introduced by Miller and Fellbaum to explain a relation of superordination that can only be applied to verbs. Therefore, the lexical entry of a verb would reflect "the relatedness of words and concepts" (Fellbaum 1990: 23) and WordNet's verbs would then be organized into semantic networks based on this hierarchical relation. For instance, when searching for the verb *eat*, the user would find the word defined in terms of other words that relate to it with some specific differences added (e.g.: *slurp* is a way to eat noisily, *devour* is a way to eat greedily, etc.[6]). Troponymy is then a specific kind of entailment regarding verbs (Fellbaum 1990: 47), that involves a more general verb (e.g.: *eat*) which also entails the specific manner of a verb (e.g.: *slurp*, *devour*). The way troponymy follows the construction "x is a way of…" makes it work the way IS-A relations do or other semantic relations based on a hierarchical structure such as hypernym/hyponym.

The fact that WordNet brings all this information together into a lexical database leads to the existence of a more limited field called psycholexicology. Inspired and encouraged by

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[5] Check section **4.2. The case of motion verbs.**

[6] Examples taken from WordNet's data.

mid-century word association studies such as Quillian's hierarchical model on semantic memory, along with the technological advances that came along during the last decades, Psycholinguistics have discovered "many synchronic properties of the mental lexicon that can be exploited in lexicography" (Miller 1990: 2) and thus, this co-operation of lexicology and psycholinguistics allow to add more specific information about the lexicon and how the phonological, syntactic and lexical components are able to work together in everyday linguistic production and comprehension (Miller 1990: 2).

This accessible design that can work as a possible illustration of the English language's lexicon and its undeniable link to semantic memory is what makes WordNet perfectly plausible for this paper. The type of hierarchical relations between words WordNet can offer are the associative links that Quillian (1966) discussed in the late sixties.

4. TOWARDS A PRACTICAL APPROACH: Motion verbs

In recent years the lexicon has gained increasing attention from linguists. Verbs in particular have been the subject of much research in pursuit of a theory of lexical knowledge. (Fellbaum 1990: 50). Prior to the contrastive analysis, it is essential to revise a general linguistic framework that provides the foundations of our practical approach.

4.1.General linguistic background

4.1.1. Grammatical categories: Differences between nouns and verbs

The interest for the differences between these two grammatical categories has been object of study as recent research has proved by, for instance, the implication of different areas of the brain depending on the grammatical category. We have previously discussed grammatical categories in the brain from a psycholinguistic point of view; henceforth, in this section we will be analysing verbs as lexical items from a linguistic lens. Verbs are the choice for analysis considering their complexity over nouns, generally because they contribute to the major meaning of an utterance. As opposed to nouns, which usually represent concepts, verbs describe actions and also, some verbs select (or do not select) certain arguments. This predicate-argument structure, also called subcategorization frame, "specifies the possible syntactic structures of the sentences in which it can occur" (Fellbaum 1990: 40), which is something interesting to consider if we want to see the sentences frames in which they move in and if they are much different from one language to another. It is not only their syntactic information that

is relevant but also the semantic one if we analyse the different associations between verbs into semantic networks as well. Both generally and equally contribute to the verb's lexical entry in the speaker's mental lexicon (Fellbaum 1990: 40). These two types of information support the complexity of verbs as an object of analysis and are what lead us to the analysis of their paradigmatic and syntagmatic relations.

In computational models of linguistic representation, we find lexemes as lexical entries. It is essentially the use of WordNet which establishes the connecting link between psycholinguistics and the proposed case study of WordNet because a) WordNet organizes lexemes into semantic fields and hierarchichal relations based on a psycholinguistic foundation and b) these lexical entries offer the user information about the combinatorial behaviour of verbs as subcategorization frames.

4.1.2. Paradigmatic and syntagmatic relations

In his work *Course in General Linguistics*, Saussure claimed that "[i]n a language-state everything is based on relations" (Saussure 1916: 122). There, according to the saussurean *langue*, two types of relations essential to the linguistic sign: associative (henceforth paradigmatic, as a more prevailing definition) and syntagmatic relations[7]. Taking a deeper look into the semantic level, we know the lexeme is characterized by both paradigmatic and syntagmatic relations (Durán 2004: 225). This means that lexemes can be opposed to other similar in their semantic nature considering paradigmatic relations among words (Murphy 2003: 3) and can also be combined with other units in syntagmatic relations. These saussurean concepts are believed to be relevant to the structure, the conceptual information and the different associations between words in the mental lexicon (Murphy 2003: 3; Erdeljac and Sekulić 2008: 795), because they can shed some light on how one language conceptualizes and structures reality, which is strongly linked to the psycholinguistic bases we previously discussed.

Considering the linear nature of a language, there is a possibility to combine linguistic elements, one after the other, in a linguistic chain or syntactic structure (Saussure 1916: 123; Murphy 2003: 8). Said relations are called syntagmatic relations. These are relevant to our object of study if we consider how their combinatorial behaviour adds more information to be

[7] Also referred to as in presential and in absentia relations, respectively.

stored in the mental lexicon. The fact that verbs, as lexical items, are stored in the mental lexicon with add-on information about their combinatorial behaviour has led to the thought that they hold several yet restricted admissible possibilities to select as arguments.

Saussure then draws his attention to the nature of the lexicon as an "inner storehouse that makes up the language of each speaker" (Saussure 1916: 123). There is a type of relations located in the brain whose task is to join those words which share common features in our memory. Called associative relations by the author, one will refer to them as paradigmatic relations. They do not follow an order of succession like syntagmatic relations would. Instead, words rather associate in different ways:

> Mental association creates other groups besides those based on the comparing of terms that have something in common; through its grasp of the nature of the relations that bind the terms together, the mind creates as many associative series as there are diverse relations (Saussure 1916: 125).

The mental associative series applies to the previously introduced semantic relation of troponymy, as well as the other different relations that a speaker of a language can unconsciously create between words that contribute to a semantically organized vision of the mental lexicon.

4.2. The case of motion verbs

The reason behind choosing motion verbs over the wide variety of different types of verb mainly comes from their complexity. They are a type of verb that have received the most attention, typologically wise speaking. Moreover, motion verbs present interesting semantic and syntactic features and, consequently, exploitable cross-linguistic differences for our later analysis.

There have been different theoretical approaches to verbs of motion and verbs in general. WordNet for instance, considers first several semantic classes and then procedes to fit in all the data as lexical entries. The system lists a classification of verbs into 15 classes based on their semantic properties. Its data on verbs is based on "over 21,000 verb word forms (of which over 13,000 are unique strings) and approximately 8,400 word meanings (synsets)" (Fellbaum 1990: 41). These are organized into 15 files on the basis of semantic criteria and "all but one of these files correspond to what linguists have called semantic domains listed as: (1)

Verbs of Bodily Functions and Care, (2) Verbs of Change, (3) Verbs of Communication, (4) Competition Verbs, (5) Consumption Verbs, (6) Contact Verbs, (7) Cognition Verbs, (8) Creation Verbs, (9) Motion Verbs, (10) Emotion or Psych Verbs, (11) Stative Verbs, (12) Perception Verbs, (13) Verbs of Possession, (14) Verbs of Social Interaction and (15) Weather Verbs. (Fellbaum 1990: 57-61)

Levin's typology (1993), on the other hand, is more specific and also adds a subclassification inside motion verbs, which leads us to a better understanding to the not only semantic but also syntactic nature of this type of verbs. This semantic-syntactic correlation has been discussed by several authors considering how a particular verb's semantic content can determine its syntactic behaviour. In other words, a verb's meaning can determine whether it chooses (or not) an argument or another. Levin's typology in *English verb classes and alternations: A preliminary investigation* (1993) adds a distinction into seven different groups within motion verbs:

1. Verbs of Inherently Directed Motion: *advance, arrive, ascend, climb, come, cross, depart, descend, enter, escape, exit, fall, flee, go, leave, plunge, recede, return, ·rise, tumble.* Locative preposition drop alternation in some specific verbs (e.g.: escape the police/escape from the police)
2. *Leave* verbs: *abandon, desert, leave*. They do not specifically express a manner of motion, but rather indicate that motion away from some location is taking place.
3. Manner of motion verbs. These are verbs that describe motion without specifying the direction of the action. There are two types:
   3.1. *Roll* verbs. They are usually characteristic to "inanimate entities" (Levin 1993: 265), such as ball or cart. Generally speaking, we could refer to *bounce, drift* or *slide* as roll verbs, or more concrete ones that describe motion around an axis, like revolve, rotate or spin.
   3.2. *Run* verbs. These, on the other hand, relate to animate entities, although inanimate entities are not excluded from these either; they simply are less likely to relate to these verbs. It is the case of verbs like *gallop, hike, jog, leap,* to name a few out of an extensive list of examples.
4. Verbs of Motion Using a Vehicle.
   4.1. Verbs That Are Vehicle Names. If we consider a few of the examples provided: *bicycle, bike, boat, bus, cab, caravan*, we can observe how this type of verbs are

formed by using the original noun that represents the vehicle. No specific direction of the motion is expressed.

4.2. Verbs That Are Not Vehicle Names. It can also be the case that the motion of a vehicle is not specifically expressed by using the name of the vehicle in question. It is the case of verbs such as *cruise, drive, fly* or *sail.* However, they do describe the motion of a specific vehicle. As well as in 4.1., the direction of the motion is not expressed.

5. *Waltz* Verbs. Parallelistic to the immediately previous type, these verbs relate to names of dances (*waltz, boogie, polka, rumba, samba*). In principle, according to Levin (1993: 269), "any dance name should give rise to a zero-related verb of this type", meaning that we could create any verb out of any dance name. No specific direction of motion is implied.
6. *Chase* Verbs. These verbs imply a subject that is the chaser and an object that is the person being chased. The author lists *chase, follow, pursue, shadow, tail, track* and *trail* as examples.
7. *Accompany* Verbs. About this last type of verbs, Levin comments on "the nature of the relation between the two participants" (Levin 1993: 270) in which one person is taken from one place to another by another person. The examples provided are *accompany, conduct, escort, guide, lead and sheperd.*

Concerning motion verbs, WordNet's data is based on groups of over 500 synsets. They are furtherly divided into two top nodes: to move as in make a movement or to move as in travel. (Fellbaum 1990: 48). The first one would relate to what Levin would call *roll* verbs, whilst the second would relate to the first two types Levin suggests (inherently directed motion and *leave* verbs). More specific information about motion events that Levin described is encoded in WordNet as troponyms, such as the speed of motion, the medium of transportation. Therefore, this verb taxonomy would be organized into two levels in terms of hierarchy; consider *walk>march*; *jump>bounce,* and such. This hierarchical taxonomy contributes to the psycholinguistic basis of our proposal since it follows a similar scheme to semantic memory models and the organization and accessibility of words thanks to a set of intertwined semantic nodes.

5. CONTRASTIVE ANALYSIS: ENGLISH AND SPANISH MOTION VERBS

Not all languages express meaning in the same way. Considering the previous theoretical framework, we know that this relates to the way languages conceptualize reality and

therefore, structure and organize the mental lexicon (Naigles and Terrazas 1998: 363). These differences in lexical organization applies to verbs especially if we consider:

> [T]he range of meanings available to members of a particular verbs class in one language may not be available to the members of the corresponding class in another language, with systematic differences attested. (Slobin (1987, 1996), Talmy (1975, 1985, 1991) and Wienold (1995), as cited in Hovav and Levin 1997: 4)

This contrastive analysis is going to be divided in two sections. First of all, we will draw the theoretical and general similarities and/or discrepancies with regard to motion verbs in English and Spanish and then we will complete this theory with support from WordNet's data and an analysis of such based on saussurean syntagmatic and associative relations.

5.1.General aspects

As we mentioned in the previous section, Levin's typology (1993) might seem slightly restrictive considering its limitation to the English language. Years later, Levin revisits this typology, possibly influenced by advances in other typologies. There is a key dichotomic distinction within verbs of motion that is the one of manner/path suggested by Talmy (2000) in *Toward a Cognitive Semantics*. It is a more inclusive, extensive and concrete approach that explains how there are different dimensions to motion: path and manner. Although believing this typology to be applicable to all language would be pretentious, it is the closest we can get, considering how path and manner are, substantially, semantic components of the verb, inherent to its nature. Consequently, it seems like the closest approach to creating a typology that can explain verbal behaviour across languages.

According to this verb-framing typology on the semantics of motion verbs, the manner of motion events refer to a type of motion described by a particular verb; whilst the path of motion refers to the direction of the motion itself. Consider the contrast between English's *bounce, hop, roll,* etc. and *pass over, go around, arrive in.* Whereas the first group of verbs express a way of movement, the latter express the direction of motion, not on their own, but supported by what Talmy (2000) calls satellites. This is what Levin's typology (1993) referred to when claiming there was no specific expression of direction, for direction (Talmy's path) is expressed through satellites or prepositional phrases.

On this basis, several linguists agree on the fact that English has a tendency for manner verbs whilst Spanish prefers path verbs. (Naigles and Terrazas 1998: 363). The distinction between path and manner leads then to a tripartite typology that classifies languages into three groups with regard to the way they express motion: satellite-framed languages, verb-framed languages or the recently added equipollently-framed languages (henceforth, S-framed; V-framed and E-framed).

S-framed languages are those that has manner encoded in the verb, whilst path acts as a satellite to the verb. Since this type applies to all Germanic languages, English clearly belongs in this category. If one remembers Levin's typology of motion verbs, most verbs she mentioned had no specific direction implied. This means that the notion of path is added as a satellite to the verb or with an adjunct that implies direction (e.g.: *He jogged back to the house*).

V-framed languages work the other way around. This applies to all Romance languages; therefore, it is the case of Spanish. In this type of languages, path is encoded in the verb (*entrar, salir, llegar, subir)* whilst manner is encoded via a separate adjunct of a satellite.

E-framed languages (Slobin 2004, as cited in Beavers et al. 2009: 333) are those whose distinction between path and manner is not as delimited as it is with Germanic and Romance languages. It is essentially a type of language in which one verb may encode manner and another one may encode path.

This third-way verb-framing typology is supported by other theories such as Slobin's (1997) who suggested that languages seem to have two different levels within the lexicon of motion verbs. There would be a general level, which contains everyday verbs (*walk, run, jump,* etc.) and a more specific one which would hold different ways of walking (*stroll, wander, shuffle*) or running (*spring, jog*). (Slobin 1997: 459). This could lead to the statement that verbs are organized following semantic criteria, into semantic fields, with walk, for instance, as a superordinate term and many different options to choose as troponyms who add specific features to the general verb.

From a comparative lens, English appears to have a more extensive and complete second level, whereas Spanish's does not seem as rich (Cifuentes Pérez 2008: 3). Accordingly, V-framed languages, such as Spanish, "tend to have small inventories of manner-of-motion verbs" (Beavers et al. 2010: 343), since the priority of these languages appears to be focused

on path rather than motion. This approach of a two-tiered lexicon will be the premise to start our contrastive case study on motion verbs in both languages English and Spanish.

5.2.Case study

In order to analyse the internal structure of the semantic field of motion, we present the case study of three verbs of motion verbs *walk, run* and *jump* and its correlates in Spanish: *andar, correr* and *saltar*. Taking Quillian's (1969) "a canary is a type of bird", we can consider the proposed verb's troponyms and establish an analogy and claim, "walk is a way of moving" and more specifically, "sneak is a way of walking". This makes us see how verbs work like semantic fields inside a semantic network, based on hierarchical relations.

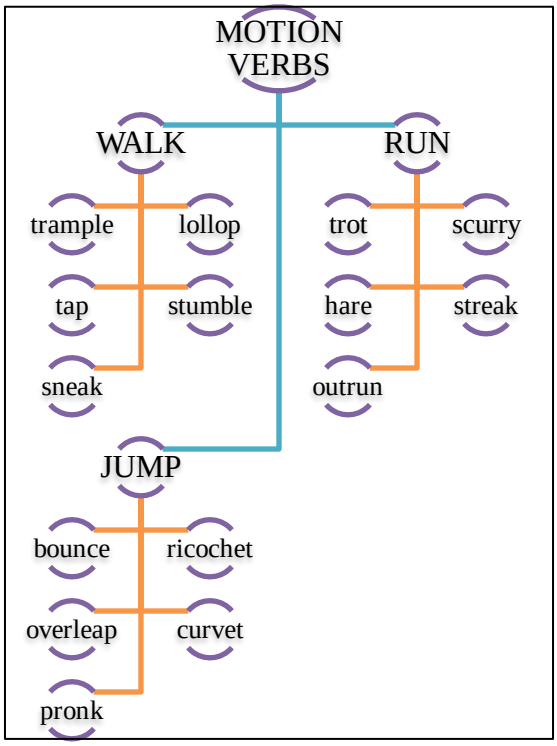

Figure 5: An overview to a hierarchical representation of selected motion verbs. Source: Self elaboration

The information has been taken from WordNet's data base and its complete table can be found in the annex of this paper. These verbs walk/run/jump and its Spanish correlates could correspond to a main lexicon and the more specific ones (collected in tables below) would belong to the second layer of this two-tiered lexicon.

It was mentioned previously how relevant the semantic-syntactic correlation is regarding verbs; the difference in meaning brings along differences in the syntactic behaviour of these verbs. Therefore, if meaning is variable in cross-linguistic terms, so is argument selection.

The data contained in the following tables has been gathered after selecting the searching criteria of "troponyms (particular ways to…)". Due to the limited extension of this paper, the following verbs have been reduced to one sense per each, only considering the first one in frequency. The troponyms (tagged as V2) although numerous, have been limited to five per superordinate (tagged as V1) and their translational correlates in Spanish have been taken from Cambridge's Online Dictionary, except for those followed by an asterisk; those are personal suggestions due to the lack of a lexicalized translation. The examples provided to furtherly explain the syntactic phenomena that revolves around these verbs in English have been taken from WordNet. On the Spanis part, the examples have been personally provided.

English superordinate (V1)	**English troponyms (V2)**	**Spanish superordinate (V1)**	**Spanish troponyms (V2)**
walk	(1) trample (2) lollop (3) tap (4) stumble (5) sneak	**andar**	(1) pisotear (2) andar con torpeza* (3) caminar ligeramente* (4) tropezarse (5) caminar a hurtadillas*

Table 1. English and Spanish V1 *walk/andar* and some of their troponyms. Source: Self elaboration.

a) Paradigmatic relations for *walk/andar*

In English, manner is encoded in the verb, inherent to its meaning. In other words, the specific information added to the superordinate is lexicalized in the verb itself. It is the case of "in a clumsy way" in (2) lollop; "swiftly or softly" in (3) tap and "furtively or stealthily" in (5) sneak (parallel to other similar verbs such as *tiptoe*).

Just two out of five of our selected verbs have a lexicalized version in Spanish. It is the case of (1) trample, whose correlate (1) pisotear adds the specificity of walking on something with your feet and (4) stumble, whose correlate (4) tropezarse implies there is something to stumble upon.

b) Syntagmatic relations for *walk/andar* and their troponyms

According to WordNet's data, (1) tramble requires something to trample ("trample the flowers"); it requires an object. This requirement stays the same in its Spanish counterpart pisotear ("pisotear las flores"), so there is no difference, syntactically speaking, regarding this pair of verbs.

Similarly, (4) stumble finds its counterpart in Spanish (4) tropezarse. Notice how in (i) the manner of motion is encoded in the verb, whilst path is added with 'about' as a satellite. On the other hand, the Spanish counterpant does not need any adittion but the pronoun 'se'.

(i) a. The drunk man stumbled about.
b. El borracho se tropezó.

As we have recently discussed, (2) lollop, (3) tap and (5) sneak do not find their counterparts in Spanish. The fact that English is a S-framed language and therefore, encodes manner in the verb, leaves no further semantic information to be added as a satellite or adjunct to the verb. On the contrary, we know that Spanish, as a language, works the other way around. This specific semantic information that cannot be encoded in the verb needs to be added as a satellite or an adjunct. In this case, we have suggested a prepositional phrase 'con torpeza' and 'a hurtadillas' and an adverbial phrase 'ligeramente' as possible suggestions to fill in these gaps.

(ii) a. The children lollop to the playground.
b. Los niños andan con torpeza hacia el patio.

(iii) a. The children tap to the playground.
b. Los niños andan ligeramente hacia el patio.

(iv) a. The children sneak to the playground
b. Los niños andan a hurtadillas hacia el patio.

Notice the similarity in the possible sentence frames for these verbs. All of them encode manner in the verb whilst path is added through a prepositional phrase that indicates direction, 'to the playground'.

English superordinate (V1)	**English troponyms (V2)**	**Spanish superordinate (V1)**	**Spanish troponyms (V2)**
run	(1) trot (2) scurry (3) hare (4) streak (5) outrun	**correr**	(1) trotar (2) escabullirse (3) correr rápidamente, correr como una liebre * (4) correr desnudo * (5) correr más que *

Table 2. English and Spanish V1 *run/correr* and some of their troponyms. Source: Self elaboration.

a) Paradigmatic relations

We face again the same limitations than we did when contrasting *walk/andar*. (1) trot seems to adjust to its Spanish counterpart as illustrated in the table above; trot is a way to run 'at a moderately swift pace', which correlates to Spanish trotar.

The rest of the verbs proposed, however, do not seem to find a correlate in Spanish due to this language's verbal behaviour as a V-framed language. English lexicalizes the specific way of running as encoded in the verb: scurry is a way to run 'hurriedly'; streak is a way to run 'naked in a public space'; outrun is a way 'to run faster than another'. As for its possible Spanish correlates, we have suggested the use of the superordinate followed by certain additions that add the semantic gaps to the verb: 'correr desnudo, correr más que'. This change in the verb's meaning implies an alteration of the verb's sentence frames which we will see immediately below. Note as well how (3) hare here is an interesting choice considering how sometimes can have a metaphorical sense of running 'like a hare'. The lack of a correlate in Spanish leads again to the use of a superordinate and the addition.

a) Syntagmatic relations

Whilst the pairs (1) trot/trotar and (2) scurry/escabullirse do clearly follow similar syntagmatic patterns in both languages, the second adds the alteration in the sentence frame of an enclicit pronoun ‘se’ to the verb.

(v) a. The horses trot across the field.
b. Los caballos trotan por el campo.

(vi) a. They scurried to higher ground.
b. Se escabulleron a tierras altas.

As for (3) hare, it has a metaphorical sense so one possible translational counterpart would be adding a comparative clause in Spanish ‘como un conejo’ or either simplify and ignore the metaphorical sense implied in English and choose an adverbial phrase ‘rápidamente’ instead. Again, we face the need for a prepositional phrase ‘down the hill’ that indicates direction and therefore expresses the path we do not find encoded in the verb.

(vii) a. He hared down the hill.
b. Corrió colina abajo rápidamente/como un conejo.

Regarding (4) streak, the lack of a correlate has led to the use of the superordinate followed by a predicative complement in Spanish ‘desnudos’ that identifies this semantic component of nudity that in English is encoded in the verb.

(viii) a. Sam and Sue streak.
b. Sam y Sue corren desnudos.

The last troponym (5) outrun is an interesting choice. In Spanish there is no counterpart for such verb and the closest one can get is ‘correr más que’, which would imply adding a subordinate comparative clause to the verb.

(ix) a. I managed to outrun everybody else.
b. Conseguí correr más que el resto.

English superordinate (V1)	**English troponyms (V2)**	**Spanish superordinate (V1)**	**Spanish troponyms (V2)**

jump	(1) bounce (2) ricochet (3) overleap (4) curvet (5) pronk	**saltar**	(1) botar (2) rebotar (3) saltar (un obstáculo) * (4) saltar * (5) saltar *

Table 3. English and Spanish V1 *jump/saltar* and some of their troponyms. Source: Self elaboration.

a) Paradigmatic relations

Perhaps *jump* is the most complex to consider out of the three selected for this paper due to its restricted meaning in Spanish, *saltar*. The first two of the proposed, (1) bounce and (2) ricochet easily find their correlates in Spanish as a jaw to jump and "leap suddenly" and jump "away from an impact", respectively.

(3) overleap, according to WordNet's definition, means "to jump across (an obstacle)". The lack of counterpart in Spanish leads to the use of the superordinate, *saltar*, followed by the addition of an object "un obstáculo" to complete the intended sense of overleap. As for (4) curvet and (5) pronk, they are verbs that express specific motion events performed by or related to animals. Curvet, as according to WordNet's definition, means "to perform a leap where both hind legs come off the ground, of a horse" whilst pronk means to "jump straight up" and adds the example of kangaroos. This applies to other verbs that do not specifically appear as troponyms for *jump* but express motion performed by animals, such as *waddle*, for instance.

b) Syntagmatic relations

The first pair (1) bounce/botar share almost parallel sentence frames. Whilst English's *bounce* does not select an object, its Spanish counterpart has the optionality whether to select and object or not. Not selecting an object would involve an alteration of the agent role (e.g.: La pelota de goma botó) for a patient one in the subject (e.g.: Alguien botó la pelota de goma).

(x) a. The rubber ball bounced.
b. La pelota de goma botó.

Similarly, (2) ricochet/rebotar follows a similar scheme.

(xi) a. Some bullets ricochet*.[8]

b. Algunas balas rebotan.

The case of (3) overleap implies jumping over an obstacle. This way, the use of this sense in Spanish requires an object. Thus, the sentence frame remains the same in English and Spanish because of the necessity of an object to complete the meaning.

(xii) a. He overleapt the fence*.

b. Saltó la valla.

As for the verbs (4) curvet and (5) pronk, we know those are reserved for motion expressed by animals, more specifically by horses and kangaroos, respectively. Therefore, and considering the lack of a Spanish counterpart for either of them, the use of the superordinate must be combined with an animate non-human subject (e.g.: su caballo, los canguros).

(xiii) a. Her horse was curveting across the field*.

b. Su caballo estaba saltando por el campo.

(xiv) a. Kangaroos pronk.

b. Los canguros saltan.

After this case study, we reach the following conclusions: (1) it is common to find lexical gaps from one language to another; notice for instance how certain verbs that would appear in a two-tiered Spanish motion lexicon (e.g.: entrar, salir) do not find their counterparts in English without a satellite (e.g.: walk in, walk out); (2) English has a more detailed and rich second level of the mental lexicon for motion verbs; (3) Spanish tends to the generalized use of the superordinate followed by specific expressions of manner by adding adjuncts to the verb.

6. CONCLUSIONS

The present dissertation aimed to fulfil several purposes established on the introduction, and we can say we have fulfilled such purposes. First of all, to establish a theoretical framework after having revised the appropriate literature. This has led to the neural correlates of specific linguistic tasks related to semantics and lexical storage and how the neurophysiological bases

[8] Henceforth, the asterisk-marked examples are self-provided considering WordNet's lack of examples for some verbs.

of language can illustrate how linguistic information is stored and organized in the brain. This finds its location in the mental lexicon, whose structure, functioning and properties evidently have a psycholinguistic foundation based on semantic memory and hierarchical relations between words.

These hierarchical relations between words, having a cognitive constituent that resides in semantics, are distinct and variable from one language to another, which confirms our hypothesis that different languages organize the mental lexicon in different ways. Given the theory of lexical items stored into semantic networks, the suggestion of WordNet as a linguistic tool for lexical storage representation has been useful, yet we have faced a number of limitations such as lack of examples for certain verbs or repetitive examples in countered occasions.

These differences can be appreciated, for instance, in the way different languages encode motion events and therefore, has been exemplified with a first theoretical approximation to motion verbs followed by a specific case study from a cross-linguistic perspective, contrasting these in English and Spanish and organizing them into a semantic network based on relationships of troponymy. We have used English as the main language for our case study and Spanish as rather a complementary language to search for and establish features to contrast with regard to English in order to illustrate this concrete approach to the different perceptions of motion verbs in such languages. Our analysis and the evidence of lexical gaps from one language to another has proven how motion is encoded differently in different languages, which adds on to the idea of how languages organize conceptual materials in different ways.

It is necessary to highlight again the importance of the interdisciplinary nature of Linguistics as a science, establishing bonds with other fields of knowledge. It is certainly this interdisciplinarity which has allowed this paper to have two main axes, a psycholinguistic one and another one that is close to a computational approach, both linked together thanks to semantic memory theories.

Lastly, since this paper has faced a number of limitations, especially regarding WordNet's display, it would be interesting to focus further research on this topic on the design of a Spanish lexical-database interface similar to Wordnet that takes into account the psycholinguistic criteria highlighted in this paper, which would be relevant for certain applications such as dictionary elaboration and cross-linguistic studies.

REFERENCES

Aitchinson, J. (1987). *Words on the Mind: an Introduction to the Mental Lexicon.*

Bally, C., and Sechehaye, A. (Eds.). (1966). *Course in general linguistics Ferdinand de Saussure*. McGraw-Hill Book Company.

Balota, D. A., and Chumbley, J. I. (1984). Are lexical decisions a good measure of lexical access? The role of word frequency in the neglected decision stage. *Journal of Experimental Psychology: Human perception and performance*, *10*(3), 340.

Binder, J. R., and Desai, R. H. (2011). The neurobiology of semantic memory. *Trends in cognitive sciences*, *15*(11), 527-536.

Binder, J. R., Desai, R. H., Graves, W. W., & Conant, L. L. (2009). Where is the semantic system? A critical review and meta-analysis of 120 functional neuroimaging studies. *Cerebral cortex*, *19*(12), 2767-2796.

Bloomfield, L. (1993). *Language*. Univ. of Chicago Pr.

Broca, P. (1861). Remarques sur le siège de la faculté du langage articulé, suivies d'une observation d'aphémie (perte de la parole). *Bulletin et Memoires de la Societe anatomique de Paris*, *6*, 330-357.

Caplan, D. (1994). Language and the brain. In M. A. Gernsbacher (Ed.), *Handbook of psycholinguistics*. Academic Press, 1023-1053.

Castaño, J. (2003). Bases neurobiológicas del lenguaje y sus alteraciones. *Rev Neurol*, *36*(8), 781-785.

Collins, A. M., & Quillian, M. R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behaviour*, 8(2), 240.247.

Damasio, A. R., and Geschwind, N. (1984). The neural basis of language. *Annual review of neuroscience*, *7*(1), 127-147.

Del Río, D., & López-Higes, R. (2015). Redes funcionales que sustentan los procesos lingüísticos. In *Conectividad funcional y anatómica en el cerebro humano: análisis de señales y aplicaciones en ciencias de la salud*, 127-140.

Dell, G. S., Chang, F., & Griffin, Z. M. (1999). Connectionist models of language production: Lexical access and grammatical encoding. *Cognitive Science*, *23*(4), 517-542.

Duarte, M. J. P., and Varo, C. V. (2006). Lenguaje y cerebro: conexiones entre neurolingüística y psicolingüística. In *Actas Del Primer Congreso Nacional De Lingüística Clínica*, Vol. 1, 107-119.

Durán, J. D. D. L. (2004). El conjunto léxico articulado: el lexicón mental. *Estudios de lingüística del español*, [online], 2004, Vol. 21, 223-264.

Erdeljac, V., & Sekulić, M. (2008). Syntactic-semantic relationships in the mental lexicon of aphasic patients. *Clinical linguistics & phonetics*, *22*(10-11), 795-803.

Fellbaum, C. (1990). English verbs as a semantic net. *International Journal of Lexicography*, *3*(4), 40-61.

Friederici, A. D., and Gierhan, S. M. (2013). The language network. *Current opinion in neurobiology*, 23(2), 250-254.

García, Á. L., Montaner, A., Morant, R., and Pruñonosa, M. (2011). Redes léxicas como redes neuronales. *Revista de Investigación Lingüística*, *14*, 61-86.

Garman, M. (1992). Psycholinguistics. *Child Language Teaching and Therapy*, *8*(1), 102-104.

Gasparri, L. (2016). Mental files and the lexicon. *Review of Philosophy and Psychology*, *7*(2), 463-472.

Gow Jr, D. W. (2012). The cortical organization of lexical knowledge: a dual lexicon model of spoken language processing. *Brain and language*, *121*(3), 273-288.

Hickok, G., & Poeppel, D. (2000). Towards a functional neuroanatomy of speech perception. *Trends in cognitive sciences*, *4*(4), 131-138.

Hickok, G., & Poeppel, D. (2003). Dorsal and ventral streams: a framework for understanding aspects of the functional anatomy of language. *Cognition*, *92*(1-2), 67-99.

Hickok, G., & Poeppel, D. (2007). The cortical organization of speech processing. *Nature reviews neuroscience*, *8*(5), 393-402.

Lamb, S. M. (1999). *Pathways of the brain: The neurocognitive basis of language* (Vol. 170). John Benjamins Publishing.

Levelt, W. J., & Indefrey, P. (2000). The speaking mind/brain: Where do spoken words come from. *Image, language, brain*, 77-93.

Levin, B. (1993). *English verb classes and alternations: A preliminary investigation*. University of Chicago press.

Lexicon. (n.d.). In *Cambridge's Dictionary* (Cambridge University Press 2020). Retrieved from https://dictionary.cambridge.org/

Miller, G. A. (1986). Dictionaries in the Mind. *Language and cognitive processes*, *1*(3), 305-314.

Miller, G. A., Beckwith, R., Fellbaum, C., Gross, D., & Miller, K. J. (1990). Introduction to WordNet: An on-line lexical database. *International journal of lexicography*, *3*(4), 235-244.

Murphy, M. L. (2003). *Semantic relations and the lexicon: Antonymy, synonymy and other paradigms*. Cambridge University Press.

Naigles, L. R., and Terrazas, P. (1998). Motion-verb generalizations in English and Spanish: Influences of language and syntax. *Psychological Science*, *9*(5), 363-369.

Oldfield, R. C. (1966). Things, words and the brain. *Quarterly journal of experimental psychology*, *18*(4), 340-353.

Papathanassiou, D., Etard, O., Mellet, E., Zago, L., Mazoyer, B., and Tzourio-Mazoyer, N. (1999). A common language network for comprehension and production: a contribution to the definition of language epicenters with PET. *Neuroimage*, *11*(4), 347-357.

Price, C. J. (2000). The anatomy of language: contributions from functional neuroimaging. *The Journal of Anatomy*, *197*(3), 335-359.

Pulvermüller, F. (1999). Words in the brain's language. *Behavioral and brain sciences*, *22*(2), 253-279.

Pulvermüller, F., Lutzenberger, W., & Preissl, H. (1999). Nouns and verbs in the intact brain: Evidence from event-related potentials and high-frequency cortical responses. *Cerebral cortex*, *9*(5), 497-506.

Reeves, L. M., Hirsh-Pasek, K., and Golinkoff, R. (1998). Words and meaning: From primitives to complex organization. *Psycholinguistics*, *2*, 157-226.

Slobin, D. I. (1997). Mind, code, and text. *Essays on language function and language type: Dedicated to T. Givón*, 437-467.

Stemmer, B., & Whitaker, H. A. (Eds.). (2008). *Handbook of the Neuroscience of Language*. Academic Press.

Tremblay, P., and Dick, A. S. (2016). Broca and Wernicke are dead, or moving past the classic model of language neurobiology. *Brain and language*, *162*, 60-71.

Ullman, M. T. (2001). A neurocognitive perspective on language: The declarative/procedural model. *Nature reviews neuroscience*, *2*(10), 717-726.

Ullman, M. T. (2006). *Language and the brain*.

Ullman, M. T. (2014). Language and the brain. In *An introduction to language and linguistics*. Cambridge university Press. (Eds.) Fasold, R. W., & Connor-Linton, J., 249-286.

Varo, C. V. (2017). Léxico y lexicón mental: problemas y alternativas. In *Investigaciones actuales en Lingüística [Recurso electrónico]: Vol. II: Semántica, Lexicología y Morfología*, 305-321. Universidad de Alcalá.

Varo C. V. (2017). Nuevos retos en la investigación del contenido léxico: elementos para una neurosemántica. *Rilce. Revista De Filología Hispánica*, *33*(3), 1032-1059.

Annex I

walk -- (use one's feet to advance; advance by steps; "Walk, don't run!"; "We walked instead of driving"; "She walks with a slight limp"; "The patient cannot walk yet"; "Walk over to the cabinet")

=> tramp down, trample, tread down -- (walk on and flatten; "tramp down the grass"; "trample the flowers")

=> lollop -- (walk clumsily and with a bounce)

=> tap -- (walk with a tapping sound)

=> stumble, falter, bumble -- (walk unsteadily; "The drunk man stumbled about")

=> spacewalk -- (move in space outside a space craft)

=> foot, leg it, hoof, hoof it -- (walk; "let's hoof it to the disco")

=> toe -- (walk so that the toes assume an indicated position or direction; "She toes inwards")

=> traipse, shlep -- (walk or tramp about)

=> perambulate, walk about, walk around -- (walk with no particular goal; "we were walking around in the garden"; "after breakfast, she walked about in the park")

=> ambulate -- (walk about; not be bedridden or incapable of walking)

=> sneak, mouse, creep, pussyfoot -- (to go stealthily or furtively; "..stead of sneaking around spying on the neighbor's house")

=> wade -- (walk (through relatively shallow water); "Can we wade across the river to the other side?"; "Wade the pond")

=> tittup, swagger, ruffle, prance, strut, sashay, cock -- (to walk with a lofty proud gait, often in an attempt to impress others; "He struts around like a rooster in a hen house")

=> sleepwalk, somnambulate -- (walk in one's sleep)

=> slink -- (walk stealthily; "I saw a cougar slinking toward its prey")

=> limp, gimp, hobble, hitch -- (walk impeded by some physical limitation or injury; "The old woman hobbles down to the store every day")

=> shuffle, scuffle, shamble -- (walk by dragging one's feet; "he shuffled out of the room"; "We heard his feet shuffling down the hall")

=> stroll, saunter -- (walk leisurely and with no apparent aim)

=> amble, mosey -- (walk leisurely)

=> prowl -- (move about in or as if in a predatory manner; "The suspicious stranger prowls the streets of the town")

=> skulk -- (move stealthily; "The lonely man skulks down the main street all day")

=> toddle, coggle, totter, dodder, paddle, waddle -- (walk unsteadily; "small children toddle")

=> promenade -- (take a leisurely walk; "The ladies promenaded along the beach")

=> march -- (walk fast, with regular or measured steps; walk with a stride; "He marched into the classroom and announced the exam"; "The soldiers marched across the border")

=> stride -- (walk with long steps; "He strode confidently across the hall")

=> hike -- (walk a long way, as for pleasure or physical exercise; "We were hiking in Colorado"; "hike the Rockies")

=> slog, footslog, plod, trudge, pad, tramp -- (walk heavily and firmly, as when weary, or through mud; "Mules plodded in a circle around a grindstone")

=> tiptoe, tip, tippytoe -- (walk on one's toes)

=> stalk -- (walk stiffly)

=> flounce -- (walk emphatically)

=> stagger, reel, keel, lurch, swag, careen -- (walk as if unable to control one's movements; "The drunken man staggered into the room")

=> stagger, flounder -- (walk with great difficulty; "He staggered along in the heavy snow")

=> stomp, stamp, stump -- (walk heavily; "The men stomped through the snow in their heavy boots")

=> lumber, pound -- (move heavily or clumsily; "The heavy man lumbered across the room")

=> pace -- (walk with slow or fast paces; "He paced up and down the hall")

=> tread, trample -- (tread or stomp heavily or roughly; "The soldiers trampled across the fields")

=> slouch -- (walk slovenly)

=> mince -- (walk daintily; "She minced down the street")

=> clump, clomp -- (walk clumsily)

=> march, process -- (march in a procession; "They processed into the dining room")

=> step -- (walk a short distance to a specified place or in a specified manner; "step over to the blackboard")

Annex II

run -- (move fast by using one's feet, with one foot off the ground at any given time; "Don't run--you'll be out of breath"; "The children ran to the store")

=> trot, jog, clip -- (run at a moderately swift pace)

=> scurry, scamper, skitter, scuttle -- (to move about or proceed hurriedly; "so terrified by the extraordinary ebbing of the sea that they scurried to higher ground")

=> romp -- (run easily and fairly fast)

=> run bases -- (run around the bases, in baseball)

=> streak -- (run naked in a public place)

=> run -- (run with the ball; in such sports as football)

=> outrun -- (run faster than; "in this race, I managed to outran everybody else")

=> jog -- (run for exercise; "jog along the canal")

=> sprint -- (run very fast, usually for a short distance)

=> lope -- (run easily)

=> rush -- (run with the ball, in football)

=> hare -- (run quickly, like a hare; "He hared down the hill")

Annex III

jump, leap, bound, spring -- (move forward by leaps and bounds; "The horse bounded across the meadow"; "The child leapt across the puddle"; "Can you jump over the fence?")

=> pronk -- (jump straight up; "kangaroos pronk")

=> bounce, resile, take a hop, spring, bound, rebound, recoil, reverberate, ricochet -- (spring back; spring away from an impact; "The rubber ball bounced"; "These particles do not resile but they unite after they collide")

=> burst -- (move suddenly, energetically, or violently; "He burst out of the house into the cool night")

=> bounce -- (leap suddenly; "He bounced to his feet")

=> capriole -- (perform a capriole, of horses in dressage)

=> galumph -- (move around heavily and clumsily; "the giant tortoises galumphed around in their pen")

=> ski jump -- (jump on skis)

=> saltate -- (leap or skip, often in dancing; "These fish swim with a saltating motion")

=> vault -- (bound vigorously)

=> leapfrog -- (jump across; "He leapfrogged his classmates")

=> vault, overleap -- (jump across or leap over (an obstacle))

=> curvet -- (perform a leap where both hind legs come off the ground, of a horse)

=> hop, skip, hop-skip -- (jump lightly)

=> caper -- (jump about playfully)

=> hop -- (make a jump forward or upward)