Incidental Learning of Novel Words in Adult Spanish Speaking Learners of English as a Second Language: Measures of Lexical Configuration and Lexical Engagement and the Effects of Learners' Individual Differences

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“Learning and using one language is an impressive achievement; learning and managing several is incredible.”

(Harley, 2014, p.162)

ABSTRACT

Studies on second language (L2) incidental vocabulary learning through reading have mainly focused on learning and testing factual static knowledge of recently learned words, that is, their form and meaning, often in isolation. Thus, little research has explored how through incidental reading newly learned words lexically *engage* (or interact) with other lexical levels (e.g. semantic and syntactic) and items in the bilingual mental lexicon. Moreover, the effects of learners' individual differences in incidental vocabulary learning and lexical engagement remain unexplored. The present work, therefore, aimed to contribute to the existing literature by examining the extent of L2 incidental vocabulary learning, not only through measures of lexical configuration (e.g. recognition and recall) but also via measures of lexical engagement (e.g. predicting upcoming linguistic material, making lexical decisions following semantic priming, and parsing temporarily ambiguous (garden-path) sentences) in adult Spanish speaking learners of English in comparison to a monolingual English speaking control group. The effects of phonological working memory (PWM), language aptitude, vocabulary size, and verbal fluency on lexical configuration and lexical engagement of recently learned pseudowords were also explored.

Two offline studies on lexical configuration knowledge (e.g. recognition and recall vocabulary post-tests), and three online studies on lexical engagement of spoken form (e.g. visual-world eye-tracking paradigm), meaning (e.g. lexical decision task with priming), and grammatical use (e.g. eye-tracking study with text) of recently learned pseudowords were designed. A training/learning phase preceded the studies where participants read meaningful English sentences containing the target items.

The results confirmed that L2 incidental vocabulary learning from reading reaches lexical engagement of form, meaning, and use in recently learned pseudowords. In addition, it corroborated that learners' individual differences have an effect on lexical configuration and lexical engagement of novel words. The findings contribute to existing theories on L2 vocabulary learning by demonstrating that incidental learning from reading can lead to lexical engagement, and thus to deeper understanding of word knowledge beyond factual memory.

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AUTHOR'S DECLARATION

I hereby declare that this thesis and the work presented in it are my own and have been generated by me as the result of my own original research since the official commencement of this degree program. I confirm that where I have consulted the published work of others, it is always clearly attributed. The first study of this work was partially published in:

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This work has never been submitted for award at this, or any other, university.

CHAPTER 1 INTRODUCTION

1.1 Research Context

It is uncontroversial to state that word learning is essential to become a skilled language user, providing the grounds for how well one develops speaking, listening, reading, and writing skills (Gathercole & Baddeley, 1995; Mirjalili, Jabbari, & Javad, 2012). When it comes to learning new words, adults have demonstrated normal acquisition of novel information (Batterink & Neville, 2011) as they continue to learn new vocabulary throughout their lifespan in their first (Gaskell & Ellis, 2009) and/or second language (Bordag, Kirschenbaum, Tschirner & Opitz, 2014). Yet, research on adult word learning is not as vast as that of vocabulary[1] learning in childhood, and not as widely explored when it comes to L2 adult vocabulary learning.

L2 adult word learning differs from L1 vocabulary learning, as L2 adults already possess a fully developed processing system and vocabulary knowledge from their native language by the time they start learning a new language. To illustrate, an average adult would know approximately 60000 words by the end of high school (Bloom, 2000) with a boost on their vocabulary level depending on their literacy skills[2]. Thus, L2 learners already have a vocabulary base line when they start learning a second language. In addition, L1 vocabulary learning is less likely to be affected by the interference of other words than L2 vocabulary learning (Boers, 2015). To illustrate, L2 adult learners have L1 labels (lexical entries) for a great variety of objects, which may hinder acquisition of new L2 labels for the same objects (Ellis, 2008). In addition, L2 learners carry out parallel lexical processes and operations of two different languages at the same time (Dijkstra & Van Heuven, 2002; de Groot, 2011) and this makes their vocabulary learning differ from that of L1 speakers. To illustrate, concepts that are linked to L1 and L2 words may present bidirectional transfer while reading (Wolter & Helms-Park, 2016). Other factors such as individual differences and the type of input L2 learners receive during learning can affect their vocabulary development (Boers, 2015).

A vast body of empirical research has shown that L2 adult vocabulary learning occurs through incidental reading (Waring & Takaki, 2003: Webb, 2007; 2008; Pellicer-

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[1] Vocabulary defined as "the set of words that are available to the speakers of a language" (Geeraerts,
[2] Given that it is beyond the scope of this work to discuss literary skills, they will not be examined. For a discussion on how L1 literacy skills may influence L2 skills and reading processes see Wolter and Helms-Park (2016).

Sánchez & Schmitt, 2010; Bisson, van Heuven, Conklin & Tunney, 2014; Pellicer-Sánchez, 2015); however, little is known about how that learning develops beyond factual knowledge and whether it interacts with other lexical items and levels in the mental lexicon. In addition, how learners' individual differences affect L2 incidental adult word learning remains unexplored.

The current work, therefore, examines word learning from incidental reading[3] (through its comparison with explicit learning, and a combination of incidental and explicit learning) in adult learners of English as a second language (L2). It aims to provide a deeper account of L2 word learning in adulthood by testing not only learners' acquisition of word meaning and form via recognition and recall (i.e. lexical configuration (Leach & Samuel, 2007)), but also via online methods, specifically, prediction of upcoming linguistic material, making lexical decisions with priming, and the processing of temporarily ambiguous sentences (i.e. lexical engagement). The online methods seek to determine the extent to which a word has been learned such that its semantic and phonological properties can be used in real-time processing by predicting upcoming linguistic material during aural processing, recognising whether a word is semantically related or unrelated to it, and whether during real-time reading the semantic properties of the word have been integrated deeply enough in the mental lexicon to detect online plausible and implausible direct objects when encountering subject-object ambiguities in sentence processing. This research also aims to determine if the cognitive individual differences of phonological working memory, vocabulary size, and verbal fluency have an effect on L2 word learning, as measured in the offline and online tasks.

1.2 Theoretical Considerations

The current work is based on incidental word learning. Incidental learning refers to learning without any conscious intention to learn (Ellis, 2008), and it is the result of using language without intending to learn any linguistic feature (Schmitt, 2010). The term incidental learning has been used in different ways in the second language literature, meaning it may overlap with research on *implicit* learning, which is learning that occurs in the absence of conscious awareness of what has been learned (DeKeysser, 2003; Eysenck & Keane, 2015). In implicit learning, the learner's attention is on the stimulus and not on other conscious operations (Nation, 2001). A detailed definition of

[3] It is outside the bounds of this work to examine L2 reading processes; hence, for an in-depth discussion on L2 reading refer to Chen et al., (2016).

implicit learning is that of Cleeremans and Jimenez (2002, p. 20, as cited in Eysenck and Keane, 2015):

> "Implicit learning is the process through which we become sensitive to certain regularities in the environment (1) in the absence of attention to learn about these regularities, (2) in the absence of awareness that one is learning, and (3) in such a way that the resulting knowledge is difficult to express." (p. 235)

One of the main differences between incidental learning and implicit learning is that the latter focuses on the amount of learning that occurs instead of the participants' level of awareness (Bisson et al., 2014). Therefore, it can be said that incidental learning happens through mere exposure to language that was not explicitly highlighted (Bisson et al., 2014).

In the literature, incidental learning has also been intertwined with intentional learning, which refers to the learning of a specific feature that takes place when the learner consciously tries to learn it (Ellis, 2008). The main difference between incidental learning and intentional learning is that in the former attention is placed on meaning, and in the latter attention is deliberately placed on a linguistic feature (Ellis, 2008). It can be said then that incidental learning requires the learner to pay attention to meaning while learning other features (e.g. form) without conscious intention to learn them. This work will focus on L2 incidental vocabulary learning as a by-product of sentence reading.

When referring to incidental vocabulary learning, L2 studies have shown that it is the learning of vocabulary as a by-product of reading or listening that does not explicitly focus on vocabulary acquisition (Laufer, 2001; Brown, Waring, & Donkaewbua, 2008; Bordag et al., 2015; Pellicer-Sánchez, 2015). In incidental vocabulary learning, there is no explicit learning intention since the learners' primary task is that of text comprehension, rather than vocabulary acquisition (Rieder, 2003). For instance, incidental vocabulary learning from reading usually results from an aim to understand a story or to read for pleasure (Bisson et al., 2014), and it may provide fewer learning gains than intentional learning (Bordag, Kirschenbaum, Rogahn, Opitz & Tschirner, 2017). In addition, when learning new words the number and quality (see Perfetti & Hart, 2002 and Perfetti, 2007 for lexical quality in reading) of encounters plays a transcendental role given that they leave memory traces. To illustrate, every encounter with a target word leaves a code (e.g. a memory trace) that is reinforced every time the learner encounters it (Salasoo, Shiffrin & Feustel, 1985). Thus, the number of repetitions of the target item in the learning input contributes to incidental vocabulary learning. Materials used for L2 incidental word learning should enrich those memory traces, for this reason, in this research the quality and quantity of encounters of the novel words will be taken into account.

Given that this work uses explicit learning, to determine the extent of incidental learning, it is relevant to briefly describe it. In general terms, explicit learning is input processing with the conscious intention to learn from it (Hulstijn, 2005). It takes place when a learner makes a conscious effort to understand language material (Dörnyei, 2009), and it is related to the type of knowledge to be acquired, which in this case is explicit knowledge.

Roehr-Brackin (2015) has provided one of the most accurate definitions of what explicit knowledge refers to in language learning: it is "knowledge that is represented declaratively, can be brought into awareness and can be verbalised" (p. 118). This type of knowledge is accessed during controlled processing (Roehr-Brackin, 2014) (e.g. when the learner is consciously aware of the learning intention), and it speeds language acquisition (Ellis, 2015). Thus, it may be faster to learn language features through explicit learning than through incidental learning (for reviews on the interaction between incidental and explicit knowledge in language learning see Ellis et al., 2009 and Rebuschat, 2015). Given that explicit knowledge is related to explicit memory (e.g. knowledge accessed through conscious awareness (Batterink & Neville, 2011)), one can assume that explicit vocabulary knowledge occurs when learners can consciously access the meaning, form, and use of a given word from their mental lexicon.

This study also adopts Leach and Samuel's (2007) theory on how words are learned in adulthood. Their theory establishes that knowledge of new lexical representations can be classified into *lexical configuration* and *lexical engagement*, which have not been previously accounted for in L2 incidental word learning. Lexical configuration refers to the factual knowledge of the word, such as how the word sounds, what it looks like, what it means, and how it fits into sentences (Leach & Samuel, 2007), and it is rather static and taps into memorization of factual knowledge. Lexical engagement is a more dynamic lexical development beyond factual knowledge. It refers to how a word interacts with other lexical levels (e.g. semantic and phonological), sub-lexical levels (e.g. units smaller than the word such as letters and visual features (de Groot, 2011), and lexical items; thus, it is based on how lexical representations interact with each other in the mental lexicon.

1.3 Research Questions

This thesis aims to contribute to the existing literature on L2 incidental vocabulary learning by addressing two main general interrelated research questions:

1) Are adult Spanish speaking learners of English able to lexically engage the meaning, form, and use of novel words with other lexical levels and items through incidental vocabulary learning from reading?

2) Do individual differences in language aptitude, phonological working memory, vocabulary size, and verbal fluency have an effect on lexical configuration and lexical engagement of L2 novel words recently learned from incidental reading?

Within each research question, a set of specific research questions and hypotheses arise which are addressed throughout the different studies of this thesis.

1.4 Research Methodology

This study comprises a set of experiments. In a series of five different experimental studies this work employed offline and online tests aiming to provide a comprehensive analysis of L2 novel word learning of form, meaning, and use through measures of lexical configuration and lexical engagement. Within each study different learning conditions (incidental, explicit, and a combination of incidental and explicit exposures) are compared to determine the extent of L2 incidental vocabulary learning from sentence reading, and the individual differences mentioned above are taken into account to examine whether they have an effect on L2 incidental word learning.

The offline tests were vocabulary post-tests that tapped into word recognition and recall processes of meaning and form (studies 1 and 2). Vocabulary post-tests have been successfully used in L2 vocabulary research (Waring & Takaki, 2003; Webb, 2007, 2008; Pellicer-Sánchez and Schmitt, 2010); hence, they can be effective for the purposes of this work. A visual-world eye-tracking study tests lexical engagement of spoken form through prediction of upcoming linguistic material (study 3); an online lexical decision task examines lexical engagement of meaning (study 4); and an eye-tracking study with text investigates lexical engagement of use through parsing subject-object ambiguities in garden path-sentences (study 5). Participants were the same across the three studies on lexical engagement, and the experimental tasks were completed as follows: first participants carried out the visual-world eye-tracking experiment, then the eye-tracking study with text, and lastly the lexical decision task.

Each study has its own methodology, research questions, discussion and conclusions in order to deeply understand and analyse L2 word learning in adulthood[4]. However, the target pseudowords employed were the same for most of the studies, except for study 1 which has a different set of target pseudowords. In addition, the majority of the studies are conducted with L1 adult learners to control data for comparison (Pellicer-Sánchez, 2015); hence, most of the analyses are performed on L1 and L2 learners separately, given that the main focus of this work is L2 incidental word learning. L1 results are discussed; however, this work does not attempt to provide further theoretical discussions of L1 incidental word learning and processing.

Given that eye-tracking research can highly contribute to one's understanding of word processing (Harley, 2014) and processing efforts while performing a task (Conklin, Pellicer-Sánchez & Carrol, 2018) it was employed in this work. This reflects a more natural reading process, in experimental conditions, than other techniques, such as self-paced reading, because participants are not required to perform other actions such as button-pressing. It accounts for an unobtrusive and detailed online record of attention-related processes (Eysenck & Kane, 2015). In addition, eye-tracking data is gathered in uninterrupted real-time input processing, which provides information regarding comprehension and online reading processes (Roberts & Siyanova-Chanturia, 2013).

One of the main advantages of using eye-tracking in L2 reading research is that it can reveal what happens when a word is encountered. For example, it can reveal if the word is skipped or for how long it is fixated upon, or even if the reader goes back to re-read a word (Conklin et al., 2018). Therefore, eye movements during reading in L2 research bring an extraordinary opportunity for the study of how words are learned and processed.

This thesis employed semantic priming to test lexical engagement of meaning given that if novel items have been integrated in established lexical-semantic networks, they would act as effective primes (Tamminen & Gaskell, 2013). Therefore, it can shed light on lexical engagement of meaning. One of the benefits of using semantic priming is that it facilitates processing of semantically related words (McDonough & Trofimovich, 2009), and that it is one of the most established examples of lexical engagement (Leach & Samuel, 2007). Specifically, this thesis used semantic priming through a lexical decision task with priming to find out whether the recently learned pseudowords acting

[4] This thesis does not include a methodological chapter given that each study comprises different methodology and research questions. Thus, methodological aspects are discussed within each study.

as primes would activate lexical related items (Rodd, Cutrin, Kirsch, Millar & Davis, 2013). Relevance of this work

By applying Leach and Samuel's (2007) lexical configuration and lexical engagement knowledge of new lexical entries into L2 incidental word learning, this study makes a theoretical contribution to the L2 vocabulary learning field. To illustrate, most studies in the field of L2 incidental word learning have only focused on factual knowledge of form, meaning, and use of recently learned words (Webb, 2007, 2008; Pellicer-Sánchez & Schmitt, 2010) and they have not tapped into more dynamic lexical developments beyond factual knowledge. Even though recent L2 studies (see Bordag et al., 2015; Elgort, Brysbaert, Stevens, & Van Assche, 2018) have discussed L2 lexical engagement, their main focus has been on knowledge of familiar words and not on recently learned words (see Bordag, Kirschenbaum, Rogahn, Opitz & Tschirner, 2017 for the only study, to the researcher's knowledge, of lexical engagement of recently learned words). Thus, this work will contribute to the L2 incidental vocabulary learning field by expanding the scope of what it is to know a novel word from factual knowledge to unconscious lexical engagement in the mental lexicon. In sum, L2 lexical engagement of recently learned words is still an emerging field (Bordag et al., 2017); therefore, more research is needed and highly encouraged.

In addition, by taking into account learners' individual differences this thesis seeks to bring a more comprehensive understanding of L2 incidental word learning. Even though previous studies (Webb, 2008; Pellicer-Sánchez & Schmitt, 2010; Pellicer-Sánchez, 2015; Bordag et al., 2017; Elgort et al., 2018) have made essential contributions to our understanding of L2 incidental vocabulary learning, there is not enough research on how L2 learners' individual differences may have an effect in incidental word learning. This thesis aims to fill that gap by researching whether phonological working memory, vocabulary size, and verbal fluency have an effect on L2 incidental word learning from reading.

The findings of this study can also potentially inform English language teachers of the potential of novel vocabulary learning. For instance, it may provide them with the knowledge that through sentence reading of meaningful contexts, L2 learners may learn the form, meaning, and use of novel words beyond factual knowledge. Thus, teachers can promote different types of reading inside and outside of classroom conditions to boost their students' vocabulary learning.

1.5 Thesis Outline

This thesis is divided into 10 chapters. Following this introductory chapter, **Chapter 2** discusses how words are related in the mental lexicon and gives an overview of the bilingual mental lexicon. It then examines how new words are established in light of Salasoo et al.'s (1985) codification theory of how new lexical entries form and develop in the mental lexicon. The chapter introduces Leach and Samuel's (2007) lexical configuration and lexical engagement of word knowledge in adulthood as an alternative approach to understanding L2 word learning. It explains how Leach and Samuel's (2007) theoretical accounts can be adapted and combined into Nation's (2001) models of word knowledge.

One of the foci of the current work is on the use of novel words during processing. Thus, **Chapter 3** reviews L1 word learning processes with emphasis on word recognition, recall, prediction of upcoming linguistic material, and syntactic and semantic ambiguities. It describes the garden path model in ambiguous sentences, and it also reviews relevant studies on the L1 processes just mentioned.

Similarly, **Chapter 4** discusses the L2 word learning processes of word recognition, recall, prediction of upcoming linguistic material, and lexical ambiguities. It introduces Chlasen and Felser's (2006) shallow structural hypothesis, and it reviewsrelevant studies on the L2 processes mentioned above.

The empirical studies are presented in chapters **5 – 8.** They describe the methodology, research questions, results, and conclusions of each study. **Chapter 5** presents two offline studies testing recognition and recall of L2 novel words based on Webb (2007). It employs the LLAMA tests to research if language aptitude has an effect on recognition and recall of novel words. **Chapter 6** discusses a visual-world eye-tracking study modelled on Altman and Kamide (1999) tapping into lexical engagement of form. **Chapter 7** introduces a study using a semantic priming lexical decision task based on Batterink and Neville (2011) to research lexical engagement of meaning. **Chapter 8** describes a study employing an eye-tracking with text modelled on Roberts and Felser (2011) to research lexical engagement of use. **Chapter 9** discusses the main findings of every study and the limitations of this work. Finally, **Chapter 10** provides a general discussion and conclusion of this work and recommendations for future directions.

CHAPTER 2 WORD LEARNING AND ITS RELATED FACTORS

2.1 Theoretical Aspects of the Mental Lexicon

The focus of this thesis is on L2 acquisition of novel words. Words, and one's knowledge of them, are stored in a mental lexicon. The idea of the mental lexicon was first introduced by Treisman (1961) in her doctoral thesis (as cited in Coltheart et al., 2001) and it has been developed to such an extent that today it is known that the mental lexicon carries out multiple simultaneous processes. For instance, it stores precise information about words (Eysenck & Keane, 2015), it is a long-term memory component that holds word knowledge information (de Groot, 2013), and it can aid the emergence of new lexical entries (Levelt, 1993). It is deeply and well organized (Aitchison, 2012). Every item in the mental lexicon is argued to have at least four features: those related to meaning, syntactic properties, morphological, and phonological information (Levelt, 1993). How words are specifically stored and connected in the mental lexicon is still in constant theoretical development and it is beyond the scope of this thesis to discuss theories on how the mental lexicon is structured and organised (for a review see Jackendoff, 2002; Aitchison, 2012).

Lexical categories are one of the aspects that has to be taken into account when considering the organisation of the mental lexicon. The fact that, in language, there are more nouns than verbs (Webb, 2008; Aitchison, 2012), and that nouns may be easier to learn than verbs (Bornstein, Cote, Maital, Painter, Park, Pascual & Vyt, 2004; Bornstein, 2005; McDonough, Song, Hirsh-Pasek, Golinkoff & Lannon, 2011) suggests that the mental lexicon may have more lexical entries related to nouns than to verbs. The "layered structure" of nouns like partonomy (e.g. a wrist is part of a hand, which in turn is part of a forearm, and the forearm is part of an arm) and verbs like superordination (e.g. to jog is to run at a gentle pace, but it is superordinated to the verb "run" (Aitchison, 2012)) differs, and this is likely to create a different lexical organization for nouns and verbs in the mental lexicon.

Another significant aspect of the mental lexicon is how it interacts with more than one language at a time. The bilingual mental lexicon differs from the monolingual because it processes and stores lexical entries and nodes of two language systems. Thus, the bilingual mental lexicon carries out parallel lexical processes and operations of two different languages at the same time (de Groot, 2011) and this may slow down L2 and L1 language tasks for bilinguals. For instance, L2 speakers may simultaneously activate the meaning and form of L1 and L2 words in reading processes as they depend on the language of the text they are reading (Dijkstra, 2005). This lexical competition is likely to cause L2 comprehension to be less accurate, more effortful, and time and resource-consuming (Dijkgraaf, Hartsuiker & Duyck, 2017). It may also cause L2 readers to be slower than L1 readers (Duncan, Segalowitz & Phillips, 2014) and slower when responding to stimuli either in their L1 or L2 (Green, 1986; Proverbio, Cok & Zani, 2002). This suggests that in experimental studies testing L1 and L2 learners, the latter may behave differently than the former which has been a theoretical debate in sentence parsing (Roberts & Felser, 2011) and predictive processing (Kaan, 2014).

How bilinguals store and access their lexical information from both languages has also been of interest. There is debate as to whether the L1 and L2 lexicons are interlinked or if bilinguals retain lexical knowledge of each language in different stores. According to separate-store models, each language has a separate lexicon but they are semantically connected (Kirsner, Smith, Lockhart, King & Jain, 1984). Common-store models suggest that languages are connected and stored in one lexicon and in one semantic memory system (Paivio, Clark & Lambert, 1989; Dong, Gui & Macwhinney, 2005). Taylor and Taylor (1990) have suggested that bilinguals can employ a combination of common and separate stores, while others have proposed that the organization of the bilingual mental lexicon is through language-specific networks according to proficiency level (Fortescue, 2014). It is relevant to highlight that in L2 language processing, the language users not only deal with high-order communicative processes (e.g. monitoring and/or reinterpretation) but also with ongoing lower-level processing such as recognition, morphological and syntactic parsing (Dronjic & Bitan, 2016). For L1 speakers, lower-level processing is in most cases automatic and completely unconscious whereas for L2 language users some of those processes may not be automatic[5]. Hence, L2 learners may show more processing cost during language processing. Those processing costs may be in evidence by slower reading and reaction times, and less automatic processing than observed in L1 learners. Thus, L1 and L2 language processing varies significantly.

[5] Automatic defined as the learner's ability to perform very quickly and with little or no effort (Segalowitz, 2010, p.53)

2.2 New Lexical Entries

One of the first theories on how words arise in the mental lexicon is that of Salasoo et al. (1985)[6]. They carried out a study to test words and pseudowords' memory traces and their retention. Salasoo et al. (1985) used the term 'codification' to explain how new lexical entries develop. It refers to a memory trace that responds, as a single unit, to a specific set of features that "serves to label, code, name or identify those features" (p. 51). The aim of their study was to find if repetition would enhance codification and if it differed between words and pseudowords. They used two threshold identification tasks to test words and pseudowords' codification:

a) A discrete identification task (DTI): a brief exposure to a group of letters, followed by a visual mask (e.g. eight characters made of random horizontal dots), then participants tried to identify the letters. The mask was employed to determine whether or not target identification was affected by it.

b) A continuous identification task (CTI): participants presented a group of letters rapidly and continuously, followed each time by a mask. Every exposure was incrementally longer than the mask and at the end of the trial participants tried to identify the group of letters.

Thirty-eight English monolinguals participated in Salasoo et al.'s (1985) study. Their results showed that pseudowords can create codification, and thus a lexical representation in the mental lexicon. However, the success of pseudoword codification depends on the number of repetitions given. To illustrate, they found that for pseudowords to be identified five encounters were needed, whereas words were identified before five repetitions. Therefore, the authors hypothesised that codification of entirely new lexical items may start developing after five encounters, and they will eventually show similar identification effects to those of words already established in the mental lexicon. Participants were tested after a year to assess delayed memory traces' retention. Results highlighted that participants were still able to identify both the pseudowords and the words to a very similar extent. Salasoo et al. (1985) concluded that new lexical entries in the mental lexicon emerge through a codification process and that repetition is essential for their emergence and development in the mental lexicon. Even though Salasoo et al. (1985) only tested the emergence of L1 lexical

[6] Only new lexical entries through written input will be discussed.

representations, their codification theory highly contributes to the understanding of how new lexical entries form and develop in the mental lexicon.

In terms of the development of L2 lexical items, studies on frequency of exposure have shown that new lexical entries in the L2 mental lexicon clearly need repetition in order to establish themselves (Waring & Takaki, 2003; Webb, 2008; Bisson et al., 2013). Repetitions, through auditory or visual input, can consolidate semantic, phonological, syntactic, and orthographic knowledge of the word. For instance, when exposed to new words in reading L2 language users develop and establish orthographic, phonological, and semantic representations (Elgort et al., 2018) that can be used when recognizing and trying to retrieve the word. However, how to measure learners' lexical knowledge of new L2 words, and what knowing the words entails, has been, and still is, widely researched and under continuing debate. Most L2 studies and L2 theoretical approaches have focused on knowing factual information about the meaning and form of the word (configurational knowledge); therefore, much less is known about how the word engages and interacts with other lexical representations in the mental lexicon. Hence, to expand on the extent of word knowledge, it is paramount to know how, or if, recently learned words interact with other lexical representations and with other lexical levels in the adult mental lexicon, and if this influences word learning.

One of the most recent experimental approaches on how new words are added in the mental lexicon in adulthood, and their interaction, is that of Leach and Samuel (2007). They carried out five experiments testing knowledge of the spoken form (e.g. how does the word sound and how is it pronounced) and claim that knowledge of new lexical representations can be classified into "lexical configuration" and "lexical engagement."

Lexical configuration refers to the factual knowledge of the word, such as how the word sounds, what it looks like, what it means, and how it fits into sentences (Leach & Samuel, 2007). It is rather static and taps into memorization of factual knowledge. For instance, lexical configuration knowledge is shown either by recognition of the phonological form, the orthographical form, the meaning, or the syntactic properties of a word (Bordag et al., 2015); or by the ability to use a word in spoken or written sentences through knowledge of its grammatical features. Hence, the ability to recognise a word, in orthographic input or even in a picture, or the ability to retrieve information about that word, related to its form, meaning or use, would show lexical configuration knowledge. Thus, the term "lexical configuration" refers to the facts a learner knows about a word and how they associate with their recognition and retrieval processes. Lexical configuration does not aim to establish and understand dynamic relations of the word, but instead its factual static characteristics. To gain lexical configuration knowledge participants may require fewer encounters with the target word.

Lexical engagement, on the other hand, is a more dynamic lexical development that goes beyond factual knowledge. It refers to how a word interacts with other lexical entries and sub-lexical representations (i.e. units smaller than the word such as letters and visual features, de Groot, 2011); thus, it is based on how lexical representations unconsciously interact with each other in the mental lexicon. If a word is part of one's lexicon it should influence the lexical units it is linked to (Tamminen & Gaskell, 2013), and this type of influence is what lexical engagement aims to find and demonstrate. For example, if a word (e.g. bread) has the ability to affect and/or influence the activation of other lexical items (e.g. butter) and sub-lexical representations (e.g. breath) then this would show lexical engagement. Given that competition is an example of lexical engagement (Leach & Samuel, 2007), if a new word is inhibited or facilitated by semantic or phonological competition, then this would show lexical engagement. To illustrate, if a recently learned word (e.g. mouse) semantically or phonologically competes with already established lexical entries (e.g. cat or house respectively) and/or if the new word is inhibited or facilitated through semantic or phonological competition, this demonstrates lexical engagement. Lexical engagement would indicate if a new word has been comprehended and integrated in the mental lexicon to such an extent as to influence and engage with other lexical representations and levels in the mental lexicon. Given that co-activating lexical neighbours speeds lexical integration with other items (James, Gaskell, Weighall & Henderson, 2017), lexical engagement may enhance word learning processes in general.

Leach and Samuel's (2007) concepts of lexical configuration and lexical engagement contribute to the understanding of how deeply, and to a what extent, a new word has been learned and engaged within the mental lexicon. They shed light on the robustness of the information acquired about the word beyond factual knowledge, and on whether it has been lexically engaged and integrated into the mental lexicon. Even though their theoretical distinction helps to understand word learning and processing in adulthood, it was developed in terms of L1 word learning, and, undoubtedly, L1 and L2 word learning processes differ, as previously discussed. Nevertheless, Leach and Samuel's (2007) theoretical distinction can provide a useful theoretical backdrop to the study of

L2 word learning. Thus, below I discuss L2 word learning theoretical constructs in light of Leach and Samuel's (2007) distinctions, in order to provide a richer theoretical background to the current study of L2 word learning and engagement in adults.

2.2.1 Lexical Configuration and Lexical Engagement in L2 Word Learning

L2 vocabulary acquisition scholars have extensively researched and made great efforts to understand and further our knowledge of L2 word acquisition (Nation; 2001; Waring & Takaki, 2003; Webb, 2007; Pellicer-Sánchez & Smith, 2010). However, much of the research up to now has addressed the factual knowledge of the word, not how it interacts and engages with other lexical items and lexical levels in the mental lexicon. For instance, the extent and depth of the form, meaning, and use of recently learned words have usually been related to their receptive and productive factual knowledge (Webb, 2007; 2008) and not to their lexical engagement. While Schmitt (2008) has used the term "engagement" to refer to factors that promote vocabulary learning and involvement, those factors only emphasise factual knowledge of the lexical items. In contrast to factual information about a novel word, there is much less information about its lexical engagement. Accounting only for factual information does not provide a deeper understanding of how, or if, L2 novel items interact and engage with other words and lexical levels in the L2 mental lexicon.

Schmitt (2010) has mentioned that L2 vocabulary researchers have only recently considered the depth of word knowledge in terms of lexical processing and automaticity. He emphasises that L2 vocabulary studies usually discuss the target items as being "learned;" hence, they are not discussed as "being processed," and it is that lexical processing that can shed light on lexical engagement. These "learned" items are tested to reconstruct factual knowledge of form, meaning, and use, but not if they interact and engage with other words and lexical levels in the L2 mental lexicon. Recent L2 studies (Bordag et al., 2015, 2017) have begun to discuss L2 lexical engagement; however, they have not addressed lexical knowledge of novel items within the same learning conditions, and they have not taken into account learners' individual differences in L2 lexical engagement. For instance, Bordag et al. (2015) carried out an incidental learning study with low frequency words as targets (thus, they did not use novel items), and Bordag et al. (2017) tested intentional (not incidental) learning of recently learned pseudowords. The key problem with this is that one cannot know the full extent of lexical engagement of novel words in L2 incidental word learning and if learners' individual differences have an effect on it. One issue that needs to be addressed then is if L2 novel words engage in the mental lexicon through incidental learning, and if learners' individual differences have an effect on it.

L2 lexical engagement of novel words would demonstrate if they have been comprehended and integrated into the mental lexicon, and if they have formed links with other lexical and sublexical units. Lexical engagement could also potentially show the interaction of recently learned words with lexical processes and stages that have yet to reach the level of consciousness (Bordag et al., 2015). For instance, if the L2 lexical representations of the form, meaning, and use of a word, and their links, unconsciously and automatically engage with the phonology, the semantic and/or the syntactic levels of other L2 lexical items and their sublexical representations. L2 lexical engagement would undoubtedly contribute to our understanding of the extent of L2 word learning; thus, it is paramount to further our knowledge on the depth and strength of L2 word knowledge by applying Leach and Samuel's (2007) concepts of lexical configuration and lexical engagement. However, to do so, one has to understand first what factual knowledge of the form, meaning, and use of L2 words entails to be able to account for lexical engagement in light of Leach and Samuel's (2007) lexical engagement concepts.

One of the most comprehensive and well developed theoretical accounts of L2 factual word knowledge is that of Paul Nation (2001). He developed a model of what L2 word knowledge involves, and how the factual knowledge of a word can be accounted for. He highlights that knowledge of a recently learned word falls into three categories, form, meaning, and use, and he makes a distinction between two levels of knowledge, specifically receptive and productive, that cover all aspects of word knowledge. For instance, receptive knowledge of a word entails knowing it well enough to extract communicative value from speech or writing, and productive knowledge refers to the knowledge needed to encode communicative content for speech or writing (Schmitt, 2010, p. 87). Similar to Leach and Samuel's (2007) lexical configuration knowledge, Nation (2001) affirms that recognition and recall of meaning and form provide factual information on words.

In Nation's (2001) model, knowing the form of a word involves spoken and written forms, as well as the parts comprising the word (e.g. prefixes or suffixes). Knowledge of meaning entails knowing the form and meaning, its concepts and referents, and its associations. In terms of knowing the use of the word, it involves knowledge of its grammatical functions, collocations, and constraints on use (Table 1). This model of L2 word knowledge does not emphasise the lexical relations between the words (Nation, 2001); hence, it provides factual information of word knowledge but not of lexical engagement; hence, it provides factual information of word knowledge but not of lexical engagement. Nevertheless, it is one of the most well developed models of L2 word knowledge and, similarly to Leach and Samuel's (2007) lexical configuration' constructs, it includes the ability to recognise and recall the meaning and form of the words.

An L2 lexical engagement approach based on Nation (2001) and Leach and Samuel (2007) could bring a deeper understanding of L2 word knowledge. Its purpose would be to provide a comprehensive, and perhaps systematic, explanation of L2 lexical engagement based on Nation's (2001) categories of what it is to know a word and to expand it. Hence, this work is a first attempt to explicitly discuss an L2 lexical engagement approach of new lexical items.

Nation's (2001) concepts of what it is to know a word will be taken as a referent to conceptualise lexical engagement knowledge of new words. In addition, in order to exemplify L2 lexical engagement, L2 studies on word processing and learning will be described; however, not all of them explicitly focus on L2 lexical engagement as a theoretical concept distinguishable from lexical configurational. Most of the studies do not characterize their research in terms of lexical engagement; however, they tap into it and bring valuable insights on L2 lexical engagement. Once more studies on L2 lexical engagement of recently learned words shed light on how to further it theoretically and experimentally, a complete new model of L2 lexical knowledge in word learning should be developed.

As can be seen from Table 1, Nation (2001) emphasises the lexical configurational knowledge of words but it does not take into account how knowledge of a word can be perceived and known from a lexical engagement perspective. Nevertheless, his model can undoubtedly shed light on lexical engagement given that it provides a vast and complete overview of lexical configuration. However, it would be necessary to adapt his categories in order to account for lexical engagement knowledge based on Leach and Samuel's (2007) constructs.

Table 1. *Nation's (2001) model of word knowledge*

Form	Spoken	R	What does the word sound like?
		P	How is the word pronounced?
	Written	R	What does the word look like?
		P	How is the word written and spelled?
	Word Parts	R	What parts are recognisable in this word?
		P	What word parts are needed to express the meaning?
Meaning	Form	R	What meaning does this word form signal?
	& Meaning	P	What word form can be used to express this meaning?
	Concepts	R	What is included in the concept?
	& Referents	P	What items can the concept refer to?
	Associations	R	What other words does this make us think of?
		P	What other words could we use instead of this one?
Use	Grammatical Functions	R	In what patterns does the word occur?
		P	In what patters must we use this word?
	Collocations	R	What words or types of words occur with this one?
		P	What words or types of words must we use with this one?
	Constrains on use	R	Where, when, and how often would we expect to meet this word?
	(register, frequency…)	P	Where, when, and how often would we use this word?

Note: R= receptive vocabulary, P= productive vocabulary, taken from Nation (2001, p.49).

2.2.1.1 L2 Lexical Engagement of Form

Table 2 describes L2 lexical engagement of form based on Nation (2001) and Leach and Samuel (2007).

Table 2. *L2 lexical Engagement of Form based on Nation (2001) and Leach and Samuel (2007)*

Lexical Engagement of Form
Spoken ● R Phonological activation and competition of similar phonemes to the spoken form. ● R Phonological and semantic activation of upcoming linguistic material based on auditory stimuli. ● P Resolution of phonological competition of similar phonemes to the spoken form. ● P Resolution of upcoming linguistic material and their lexical levels based on auditory stimuli.
Written ● R Activation and competition of other written forms similar to those of the target. ● P Resolution of orthographic competition of other written forms to those of the target.
Word Parts ● R Activation and competition of other word parts similar to those of the target. ● P Competition and resolution of other words parts similar to those of the target.

As can be seen from Table 2, L2 lexical engagement of form could be associated with the activation of other sublexical categories (e.g. phonemes) related to the form of the target word. Cook and Gor (2015) tapped into lexical engagement of spoken form through phonological activation and resolution of phonological competition. In their study, they tested L2 lexical activation of the phonological features of high and medium frequency words in L2 Russian, and L2 resolution of phonolexical competition through an auditory lexical decision task (LDT) with priming (e.g. whether a phonological stimulus influences a lexical decision). The LDT consisted of L2 target items that were either phonologically related (e.g. /stantsɨja/ – /starɨj/ (station – old), unrelated (/stantsɨja/ – /valna/ (station – wave)) or identical to the prime (/stantsɨja/ – /stantsɨja/, (station – station)). Their participants were 23 adult advanced American L2 learners of Russian. They first completed the LDT followed by a translation task of the primes to account for proficiency and knowledge of the words used in the LDT. They also included a familiarity scale, for the primes, from 1 to 5 where 1 referred to "I've never seen this word before" up to 5 which was "I know this word very well." Their results indicate that in targets that were "well known" phonologically related primes delayed recognition of the target, which shows lexical engagement of the phonological form of the prime and that of the target. However, when learners were less familiar with the targets, phonologically related primes sped up reaction times whereas those preceded by unrelated primes elicited longer reaction times. The authors suggest that lexical quality plays a role in lexical access and that well known words may reflect lexical competition as L1 targets do. Even though this study does not use the term lexical engagement, it highlighted that L2 speakers engaged the spoken form of the target with other lexical items (prime). Cook and Gor's (2015) results exemplify how lexical engagement of the spoken form of words can be tested and accounted for.

In a visual world (VW) eye-tracking study modelled on Altman and Kamide's (1999) work, Dijkgraaf et al. (2017) tested predictive eye-movements based on semantic information through auditory stimuli (spoken form) towards target objects in visual displays. They wanted to find if predictive processing differed between bilinguals and monolinguals. Their participants were 30 adult native speakers of Dutch who had English as a second language and thirty English monolinguals as a control group. Bilinguals were tested both in their first and second languages to compare their linguistic predictive processing, and they expected bilinguals with higher proficiency levels to generate more predictive looks towards the target object while listening to auditory input. Hence, they compared predictive processing in bilinguals (L1 vs. L2) and L2 predictive processing (L2 speakers vs. L1 control group). They created eighteen sets of stimuli where each set consisted of a four picture display with two sentences in Dutch and two translation equivalents in English. Participants listened to sentences such as "Mary knits a scarf" or "Mary loses a scarf" while viewing the display. Hence, their participants were expected to generate predictive looks, based on the semantic information of the verb (e.g. knits) before listening to the target object (e.g. scarf). In general, they expected a higher proportion of looks to the target object in the constraining condition (e.g. only one of the objects in the visual display could be "knitted") than in the neutral condition (e.g. condition where all the visual images could be "lost"). Specifically, they expected, 1) bilinguals to generate slower predictive looks towards the target when predicting in their L2, and faster looks when predicting in their L1; and 2) that bilinguals would show different predictive processing when predicting in their L1 in comparison to monolinguals predicting in their L1.

Dijkgraaf et al.’s (2017) results revealed that the fixation proportion of looks was higher in the constraining condition than in the neutral condition for both language groups. This suggests that bilinguals are able to simultaneously engage the semantic and phonological lexical information of the verb with the linguistic material yet to come. The analysis per time window showed that bilingual speakers, when listening to either their L1 or their L2, make slower predictions of upcoming linguistic material than monolinguals. However, this also reveals that L2 speakers are capable of predicting upcoming linguistic materials and that their predictive processing engages the meaning of the verb with other semantic items and lexical levels. Their results also confirm that L2 speakers can engage two lexical levels of upcoming material, semantic and phonological, to generate anticipatory looks. This study clearly demonstrates that when predicting upcoming material, based on the lexical knowledge of verbs, L2 speakers have to process and engage with multiple lexical items and lexical levels. Therefore, if those verbs were recently learned words, L2 learners would be able to make predictions if their lexical knowledge of the verbs was robust enough to engage with other lexical items and levels. Hence, this study exemplifies that lexical engagement of the spoken form of a verb could be accounted for in predictive processing and through the VW paradigm. Nevertheless, the study could have been more comprehensive if it took into account learners’ individual differences and their possible effects in predictive processing.

In terms of lexical engagement of the parts of the word, the VW eye-tracking paradigm has shown that in predicting upcoming linguistic material, L2 learners are able to activate and predict upcoming linguistic information based on their lexical configuration and lexical engagement knowledge of the parts of the words. For instance, lexical knowledge of agreement and gender in nouns shows that language users need to know the parts of the words, to establish which parts are needed to convey the correct meaning, and their semantic properties. Hopp (2013) investigated the relationship between L2 morphosyntactic gender agreement in lexical configuration and engagement processes. In his study, he conducted an offline production and an online comprehension task to find out whether L1 morphosyntax or L2 gender variability affect the online processing of L2 syntactic gender agreement. He tested twenty adult L2 high proficiency learners of German and twenty native speakers as a control. His stimuli consisted of trials with ambiguous gender (difference trials) cues such as 1 below and trials with gender cues matching the noun (same trials):

1) "Wo ist der/die/das gelbe (gendered noun)? / Where is the (masculine, feminine or neutral) yellow (gendered noun)?

The picture display for the "difference trials" consisted of a target object matching the colour of the noun, two objects matching the colour but with inaccurate gender, and a distractor of a different colour from that of the target. The "same trials" displayed consisted of three objects matching the gender and colour of the noun and a distractor with a different colour and gender. In the offline task, participants were shown the visual display and asked to name the objects and their colours, and in the online task participants were shown the same visual stimuli with a corresponding auditory input. The results demonstrated that both types of learners are able to assign accurate lexical gender and semantic categories to displayed objects; however, the L1 speakers outperformed L2 learners in the task. Hence, L2 learners showed lexical configuration knowledge of the L2 nouns and their corresponding gender. Hopp's (2013) results demonstrate that L2 learners are able to predict upcoming linguistic material based on gender; however those learners who present less sensitivity towards grammatical gender may not reflect anticipatory effects. Even though participants were not presented with novel items, and thus there are no learning effects, this study shows that L2 lexical engagement of form can be tested and accounted for. Hopp (2015) notes that his findings on anticipatory looks based on gender cues may be due to the combination of lexical and morphosyntactic properties, which in turn suggests that there is lexical engagement of the parts of the word in gender-based predictive processing.

Another study on lexical engagement of the parts of the words is that of Grüter, Lew-Williams and Fernald (2012). In an experimental study, they tested the extent of L2 grammatical gender comprehension and retrieval in online and offline tasks. Their participants were nineteen L2 adult learners of Spanish with a high proficiency level and nineteen Spanish native speakers as a control group. The study was comprised of three different experiments where the offline tasks tested lexical configuration and the online task accounted for lexical engagement. Their offline tasks included:

1) A sentence-picture matching: Participants were presented with sentences, such as A below, where the subject of the sentence is omitted, given that Spanish allows overt subject sentences. Participants had to choose the picture that grammatically, based on the gender of the modifier "otra" (feminine and singular), matched the sentence.

A) "Tenemos que buscar otra" / We must find another (one).

Pictures for the example just mentioned consisted of three objects that matched the modifier’s number but only one of them matched its gender.

2) An elicited production task: Participants had to create spoken sentences containing adjectives that had to match the noun in gender and number. Elicitation pictures such as a red butterfly and a yellow butterfly were presented and participants had to respond to cues such as B below, that would elicit gender and number agreement with the subject of the picture displayed.

B) “¿Cuál mariposa prefieres?” / Which butterfly do you prefer?

Their third experiment was an online VW eye-tracking task to find if gender marking, of a determiner, would elicit processing of the upcoming noun. The audio stimuli started with cues such as C below:

C) “¿Dónde está…?” / Where is or “Encuentra?…/ Find…

The visual display consisted of two pictures and two different conditions: two images with same gendered objects, and two images including the target and a distractor (different gender to the target). Faster looks towards the target were expected in the different gender trials. Their results suggested that both types of learners were sensitive and comprehended gender marking in all the offline/lexical configuration tasks. The online tasks suggested that both types of learners look at the target object before the audio input unfolds, which suggests that they used gender cues, and the parts of the words, to predict upcoming linguistic material. However, the study also revealed that the online predictive mechanisms in L2 grammatical gender diverge between native and non-native speakers. L1 speakers were faster when identifying and looking at the target picture than L2 speakers. This study showed that lexical configuration and lexical engagement, taking into account the parts of the words and grammatical processing, could be accounted for in L2 learners. Nevertheless, the study does not take into account whether learners’ individual differences have an effect on L2 grammatical gender comprehension and retrieval.

Even though the studies discussed above do not explicitly discuss and characterise their research on lexical engagement, they show that lexical engagement of form (spoken, and word parts) takes place in L2 word learning, and that it activates other lexical levels such as morphosyntactic, semantic and syntactic. The empirical studies also demonstrate that the use of the VW eye-tracking paradigm and LDTs could be sensitive techniques to account for L2 lexical engagement of form. Given that in the mental lexicon linguistic gender information is linked to the noun lemma (e.g. abstract conceptual form of the noun) or as a node (Carrol, 1989; Schriefers & Jescheniak, 1999, as cited in Hopp, 2013), gender learning and processing must engage other lexical levels and items. Hence, L2 lexical engagement of form requires the activation and engagement of other lexical items and sublexical levels. These empirical studies also demonstrated that much of the research on this area has not taken into account learners' individual differences, which is a topic that remains unexplored.

2.2.1.2 L2 Lexical Engagement of Meaning

Table 3 shows an adaptation of Nation's (2001) categories of lexical engagement of meaning.

Potential characteristics involved in the lexical engagement of the meaning of the words have been observed in different experimental studies. For instance, Elgort et al. (2018) in a study testing the process of L2 contextual word learning showed the extent of lexical configuration and engagement in L2 semantic learning Even though this study does not explicitly research lexical engagement of meaning, it taps into it through engagement of meaning and form with other lexical items.Their participants were forty L2 Dutch-speaking learners of English with a high L2 proficiency level; they read an English expository text in order to reflect naturalistic L2 contextual word learning. Their materials comprised a section of a nonfiction book in English that provided a long continuous reading text for participants. Fourteen low-frequency words (twelve nouns and two gerunds) and nine high-frequency words were used as targets. One of their aims was to find the extent of online L2 word form-meaning from reading long continuous texts.

They used eye-tracking with text to measure the lexical engagement of the L2 words and to determine the number of encounters needed for an unknown word to develop a familiarization process. They included an online reading post-test and a meaning generation task immediately after the eye-tracking reading task. The purpose of the generation task was to determine the capacity to recall word meanings explicitly in writing; participants were asked to explain each word either in their L1 or L2 or to provide a translation in their L1. Participants also completed a vocabulary size test and comprehension questions about the reading text. In the meaning generation task, target words showed accuracy scores of 34%, and the eye-tracking data revealed that after eight encounters of the target words, their online processing looks similar to that of when processing known words (99% accuracy in the meaning generation tasks). Hence, once the lexical configuration knowledge of the L2 target words increases, their online processing might resemble that when processing words already established in the mental lexicon. The authors state that first fixation durations revealed that only after five encounters with the target words, L2 learners may be able to establish and process their orthographic information and this can cause misreading of the target for an orthographic neighbour. This suggests that when learning the meaning-form of a new lexical item, even after only five exposures, L2 learners may already create lexical connections and engagement of meaning-form with other lexical items that share similarities with the target. Hence, they start lexically engaging meaning-form of the targets with already established lexical items in their mental lexicon. This study reveals that L2 lexical learning and engagement of meaning and form can activate and create competition of similar semantic and orthographic forms. In addition, the study also demonstrated that L2 lexical engagement of meaning-form can be addressed and tested in L2 word learning.

Table 3. *L2 lexical Engagement of Meaning based on Nation (2001) and Leach and Samuel (2007)*

Form & Meaning	
	● R Competition and activation of similar semantic forms. ● P Resolution of semantic competition and activation of similar semantic and orthographic forms.
Concepts & Referents	
	● R What other concepts and referents are activated and compete with the target? ● P Resolution of semantic competition of concepts and referents similar to the target.
Associations	
	● R What other words are activated, semantically related, and compete with the target? ● P Resolution of semantic competition of semantically related words.

Bordag et al. (2017) explicitly tested semantic lexical engagement of L2 new lexical items by conducting a priming semantic study. Their participants were seventy-six advanced L2 learners of German with various L1 backgrounds (e.g. Slavic or Romance). They selected twenty low-frequency German nouns (e.g. voliere, malmesser) and paired them with twenty phonotactically valid German pseudowords (e.g. schiemolk). The pseudowords were used as the target items; hence, they carried the semantic meanings of the low-frequency words. In the priming task, each pseudoword acted as the prime once in a semantically related condition, and paired with one word, and once in a semantic nonrelated condition also paired with one word. They also included a "repetition group" in which the target words were used as both primes and targets, and 160 filler items. A vocabulary knowledge scale was administered after the priming task in order to assess participants' knowledge of the target words. The scale ranged from one to five, 1 being the lowest range (e.g. not recognizing the word at all) and 5 the highest (e.g. correctly recalling its meaning and grammatical properties). Their results were based only on those items that were both recognised in the vocabulary scale and scored correctly in the LDT responses. LDT results of the related condition showed that in words where only the form was recognised, participants' responses were slower, but if form was both recognised and recalled, reaction times were faster. This suggests a relationship between knowledge of meaning and form, and that less established semantic representations may not engage with other lexical items as robustly as the more established ones. However, semantic lexical engagement might still be seen even when the words have not been fully integrated in other semantic networks. The authors note that their results highlight semantic associations and interactions between the recently learned words and other lexical items already established in the mental lexicon. They also claim that semantic facilitation effects can be seen in those lexical items that can be explicitly recalled after training and that recently learned words could be integrated into already existing semantic networks. This study shows a first conscious attempt to research semantic lexical engagement of meaning, form, and associations, in recently learned words. The results pointed out that L2 learners are able to engage the meaning of the words with other lexical items but that the strength of that engagement may depend on their ability in the recognition and recall processes. This study not only opens up the possibility to further knowledge on L2 semantic lexical engagement but also demonstrated that 1) lexical engagement of meaning occurs in L2 vocabulary learning and that 2) semantic LDTs can be a useful technique to account for it. However, this study fails to consider possible effects of different types of exposure.

In another study, Bordag et al. (2015) tested the incidental learning of recently learned L2 words in seventy-six advanced adult L2 learners of German with various L1 backgrounds. To the researcher's knowledge, this is the first L2 study of its kind that explicitly aimed at testing L2 lexical engagement of recently learned words, in light of

Leach and Samuel's (2007) lexical engagement constructs. The study employed a combination of offline and online methods such as a vocabulary scale, offline statements, self-paced reading, lexical decision, and semantic priming. One of their aims was to determine how syntactic complexity, in the texts where the target words appear, influenced incidental learning of new words. The study comprised two types of syntactic texts: complex and simple. The complex texts had longer sentences with more clauses per sentences, use of the passive voice, deverbal nominalizations, and infinitive constructions. The simple texts were adapted from graded reader texts. Twenty low-frequency German nouns served as the target items and they were paired with German-like pseudowords. Each target pseudoword appeared only three times in the texts. The input consisted of twenty short texts, each having a simple version and a complex version, and six filler texts with different levels of syntactic complexity. Their self-paced reading task aimed to test how text complexity might affect syntactic levels in L2 semantic incidental learning. Participants read plausible and implausible sentences based on the semantic meaning of the pseudowords. The plausible sentences contained plausible adjectives based on the meaning of the pseudowords and the implausible condition had adjectives semantically implausible with the target items. The semantic priming task targeted the L2 semantic integration and interaction with other semantically related lexical items in the mental lexicon. It consisted of semantically related and unrelated items in two conditions: the experimental, in which the target items were used as primes, and the control, where familiar German words were used as primes. The semantic primes, in the experimental condition, were matched with semantically related items previously seen in the learning phase and with lexical items that had not previously appeared in the experiment. This task also contained 160 fillers. Offline statements referring to the meaning of the target texts were administered as post-tests to ensure participants understood them. Their results showed that L2 learners read the syntactically complex texts slower than the simple texts (M=45.9s vs M=42.7s) but that they inferred the meaning of the target words in both the plausible and implausible sentences. The semantic LDT showed an inhibitory effect given that participant's RTs in the semantically related condition were approximately 8ms slower than in the unrelated condition. The authors mentioned that this effect indicates that the pseudowords' semantic representations engaged with semantically related representations in the mental lexicon. They also highlighted that emerging lexical items can be integrated into existing semantic networks. These results clearly demonstrate that the newly learned items semantically engaged with already established lexical items. The authors suggest that the results show evidence of semantic engagement and interaction, of the recently learned words, with the meaning of other lexical items in the mental lexicon given that semantic priming is an example of lexical engagement. The results also confirmed that given that semantic primes influence the processing of other lexical items, if recently learned words have been integrated in existing semantic networks, the prime would influence the processing of the newly learned words. This study clearly demonstrated that L2 incidental word learning can show lexical engagement with other lexical items and lexical levels, and that experimental tasks, such as self-paced reading and semantic LDT can potentially account for it. However, the study would have been more comprehensive if it had included learners' individual differences.

The studies mentioned above clearly show that L2 lexical engagement of meaning (meaning and form) occurs in L2 word learning and processing, and that diverse experimental tasks can be used to account for it. The studies also highlighted that there is an inconsistency on the number of exposures with the target to reach lexical engagement gains. For instance, Bordag et al. (2015, 2017) found gains only after three exposures with the target while Elgort et al. (2018) after five exposures. Given that Leach and Samuel (2007) suggest at least 24 repetitions with the target to see evidence of lexical engagement, it becomes relevant to research if their suggestion also applies to L2 lexical engagement. The studies reviewed also demonstrate lack of consistency in learning conditions. To illustrate, Bordag et al. 2015 investigated L2 lexical engagement through incidental learning while Bordag et al. 2017 via intentional learning. Thus, more research is needed to determine the extent of L2 lexical engagement in incidental learning. Given that semantic priming (see Neely, 1991 for a review) can be a measure of lexical engagement (Bordag et al., 2015) it will be used in this thesis to test L2 lexical engagement of recently learned words. However, none of the aforementioned studies took into account learners' individual differences in lexical engagement. This indicates a need to understand how or if learners' individual differences have an effect on L2 word lexical engagement of the form, meaning, and use of novel items, which is one of the aims of the current study.

2.2.1.3 L2 Lexical Engagement of Use

Table 4 presents an adaptation of Nation's (2001) theoretical constructs of knowledge of use into lexical engagement.

The use of the word is intertwined with its form, and, undoubtedly, with its meaning; thus, lexical engagement of the form of a word can potentially shed light on its use. In terms of the use of the grammatical functions of the word, studies testing the resolution of L2 semantic and syntactic ambiguities have shown their lexical engagement.[7] Given that learners use their knowledge of a verb's meaning, its syntactic structure, and its argument structure to process sentences (Juffs & Rodríguez, 2015), and that the meaning of a verb can determine the syntactic structure in which it may occur (Wasow, 1985, as cited in Juffs & Rodríguez, 2015), those lexical levels should engage when encountering and resolving semantic and syntactic ambiguities.

For instance, in sentences containing subject-object ambiguities, such as 1 below, parsers make use of the verb's semantic and syntactic structure to determine if a noun phrase (e.g. the wine in 1 below is the object of the preceding verb (e.g. drank) or the subject of the following noun phrase (e.g. the wine fell on the floor.

(1) While the woman drank the wine fell on the floor.

If a recently learned word is encountered in sentences containing subject-object ambiguities, such as garden-path sentences (e.g. 1 above) where the parser's initial semantic and syntactic analysis may be mislead after encountering an ambiguity, it has to establish links with the grammatical, semantic, and syntactic uses of other lexical items in order to resolve the ambiguity. If the word has not developed those semantic and syntactic links, it will not resolve the ambiguity or even notice it, which shows a lack of lexical engagement. A study showing lexical engagement of grammatical functions is that of Roberts and Felser (2011) who examined real-time processing of temporary subject-object ambiguities in a self-paced reading study. They created "weak" and "strong" garden-path (GP) sentences containing an ambiguous noun phrase (NP), which was either semantically plausible or implausible as the direct object (DO) of the immediate preceding verb. "Weak" sentences had plausible and implausible initial semantic and syntactic analyses in complement clauses (like 1 below) and "strong" sentences contained plausible and implausible initial analyses in adjunct clauses (like 2 below):

(1) The inspector (NP) warned the boss/crimes (DO) would destroy very many lives.

(2) While the band (NP) played the song/beer (DO) pleased all the customers.

[7] It is relevant to emphasise that such studies have not discuss lexical engagement of the grammatical form of novel items; however, they shed light on it.

Table 4. *L2 lexical Engagement of Use based on Nation (2001), Leach and Samuel (2007)*

Grammatical Functions	
	• R Interaction and competition with other semantic and syntactic patterns. • P Resolution of lexical competition with other semantic and syntactic patterns.
Collocations	
	• R Activation and competition with other semantic and syntactic patterns • P Resolution of lexical competition with other semantically related lexical representations.
Constrains on use (register, frequency…)	
	• R Activation and competition of other word uses and frequencies. • P Resolution of lexical competition of other word uses and frequencies.

Note: R=receptive, P=productive

Their participants were twenty-five L2 Greek learners of English and twenty-four English native speakers as a control. They read twenty experimental sentences, in addition to forty-two fillers with different structures than the experimental sentences. They answered comprehension questions after the experimental items. The reading times were recorded through the non-cumulative moving-window self-paced procedure. The results of the comprehension questions test indicated that L2 learners correctly answered 93% of the questions, in contrast to 89% for the L1 speakers. Analysis of the reading times showed that L2 learners read the "weak" GP sentences slower than the control group, and that they read plausible items faster than the implausible. In turn this suggests that L2 learners were "garden-pathed" given that when encountering the semantic implausibility their processing times increased. These plausibility effects reveal semantic and syntactic understanding and engagement of the verb's structure as L2 learners slowed down when reading implausible analyses. Thus, they showed lexical engagement of the grammatical function of the verb with other lexical items and lexical levels. In terms of the "strong" GP sentences (syntactically more complex than the "weak" senteces), L2 learners with lower processing speeds presented more difficulty while reading the implausible condition in comparison to the plausible. The authors concluded that L2 learners are sensitive to plausibility in GP sentences and that they processed the input incrementally. In terms of plausibility, measured through subject-object ambiguity, Roberts and Felser (2011) highlighted that L2 learners showed higher reading times because they go through a recovery process from the plausibility and ambiguity effects.

Roberts and Felser's (2011) study indicated that L2 learners comprehended the semantic and syntactic features of the subject-object ambiguity in the sentences as they showed initial misanalysis and higher reading times. This study clearly suggests than when processing subject-object ambiguities in semantically plausible and implausible sentences, L2 speakers engage their semantic and syntactic knowledge to parse them as potential direct objects of the preceding verb or as NPs during real-time reading. Thus, their lexical knowledge of such preceding verb has to be robust enough in order to notice and show sensitivity towards the subject-object ambiguity. Even though in this study participants read already known L2 words, it sheds light on how L2 lexical engagement of use of recently learned words can be examined. One of the limitations of the study is that it does not address how different types of input may affect grammatical processing and if learners' individual differences have an effect on it; however, that was not its main focus.

A study taking into account learners' individual variations in grammatical processing and engagement is that of Hopp (2013). In a garden-path eye-tracking study, on subject-object ambiguities, Hopp tested how individual differences affect processing of L2 ambiguities. He showed that L2 learners lexically engaged their knowledge of L2 words with other semantic and syntactic lexical items and levels when parsing and solving the ambiguities. His stimuli consisted of plausible and implausible sentences like (3) and controls like (4) below, and seventy-eight fillers.

(3) When the girl was playing the boy/piano made some funny noises.

(4) When the girl was praying, the boy made some funny noises.

The noun phrase "the boy" would be an implausible DO for the verb "playing" due to the context given. Participants would have to detect the subject-object ambiguity when parsing the sentence and, in order to do so, they may need their semantic and syntactic knowledge of the lexical items in the sentence. In addition, when processing the verb of the main clause, L2 speakers will need to engage its meaning with other lexical levels to be able to resolve the ambiguity. His participants were seventy-eight advanced German learners of English and eighteen English native speakers as controls. They were presented with thirty experimental items that were followed by comprehension questions. Participants also undertook a battery of individual differences tests: a working memory test, a lexical decision task, and a word-monitoring task. Hopp (2013) expected shorter reading times in the plausible condition than in the implausible, given that a plausible NP may be more easily integrated as an object. Shorter reading times in the implausible condition, in reanalysis, were expected given that once the parser identifies the ambiguity, recovering from the implausible condition may be easier than in the plausible condition. Second pass reading times, total-reading times, and the number of regressions to the verb in the main clause revealed that both L1 and L2 speakers read the plausible NP slower than the implausible NP. This suggests that L2 speakers need to engage the semantic and syntactic knowledge (engagement of other sub-lexical levels) of the verb in order to resolve the ambiguity, and thus understand and process the rest of the sentence. Generally, in terms of the effects of the individual differences, results show that neither working memory nor L2 proficiency elicited any interactions with plausibility and reading times. One can argue that effects of working memory were not found because the test used (reading span task) does not provide a detailed account of either phonological working memory or executive working memory (EWM). Given that EWM might have an effect in L2 attention-oriented processes in online processing comprehension (Zhisheng, 2015), a working memory test testing it could have been worth including. The LDT, which tapped into automaticity in linguistic processing, revealed effects in early fixation measures but not in later measures revealing reanalysis, which reveals that automaticity could contribute the L2 parsing of subject-object ambiguities. The word-monitoring task made clear that higher abilities in syntactic integration greatly contribute to the processing of plausibility information in sentences containing subject-object ambiguities. This suggests that L2 speakers engage the syntactic structure of sentences and their lexical items when parsing the semantic and syntactic plausible conditions. This study not only demonstrates that L2 learners show sensitivity to plausibility in subject-object temporal ambiguities, but also that they make use of syntactic and semantic lexical levels to process and resolve such ambiguities. Thus, undoubtedly, there is L2 lexical engagement of different lexical levels and items when parsing subjects and objects, and their ambiguities, in plausible and implausible sentences. It also exemplifies that the use of eye-tracking with text and garden-path sentences can potentially contribute to examine L2 lexical engagement during real-time sentence comprehension. Nevertheless, the study could have been more influential if it had taken into account how different types of exposure may affect subject-object ambiguities' processing and resolution.

The studies described in the preceding paragraphs demonstrated that L2 lexical engagement of use can be investigated, and that sentence ambiguities such as subject-object can shed light on lexical engagement of use with other lexical items and levels and they can be researched through the use of eye-tracking with text.

In general terms, activation, interaction, automatization, and competition processes of other lexical forms, meanings, and use, can shed light on the integration and engagement of recently learned words and to investigate the extent to which they have created traces in the mental lexicon. How L2 learners parse and resolve temporal semantic and syntactic subject-object ambiguities, their reaction times in lexical decision tasks, their anticipatory looks in predicting upcoming linguistic material, and their responses to language stimuli, can undoubtedly show L2 lexical engagement of meaning, form, and use. The methods used in the studies mentioned above have successfully tapped into L2 lexical engagement and they have served a methodological purpose.

The theoretical constructs discussed above and the studies reviewed have shown that L2 lexical engagement is an emerging field that needs development. However, the above results demonstrated that:

a) L2 lexical engagement of spoken form can be tested through LDTs and VW-eye tracking methodologies.

b) L2 lexical engagement of meaning can be addressed through LDTs and tasks tapping into predictive processing. Prediction of upcoming linguistic material is potentially "a powerful mechanism for learning" (Borovsky et al., 2012, p. 418) and prediction pre-activates semantic, morpho-syntactic, and lexical aspects of the words yet to appear (Federmeier, 2007). Therefore, it will be used in this research to examine for L2 lexical engagement of spoken form and meaning. In addition, the VW eye-tracking paradigm has been demonstrated to be a successful tool to test prediction of upcoming linguistic material in sentence contexts in bothL1 and L2 (Dijkgraaf et al., 2017; Almann & Kamide, 1999, 2007). Therefore, the VW paradigm will be used for the purposes of this research to test prediction of upcoming linguistic material based on semantic information embedded in sentential contexts.

c) L2 lexical engagement of use during real-time comprehension can be investigated via reading subject-object ambiguities. Recording eye movements, while reading, generates real-time information that can demonstrate word learning that resembles L2 vocabulary learning from reading (Elgort et al., 2018). Furthermore, since semantic and syntactic ambiguities may shed light on L2 lexical engagement of use, eye-tracking while reading such temporarily ambiguous (garden-path) sentences containing subject-object ambiguities will be used to test L2 lexical engagement of use.

2.3 Factors Affecting Word Learning

This section will present how frequency of repetitions influence L2 word learning, and it will discuss the cognitive factors of phonological working memory (PWM), vocabulary size, language aptitude, and verbal fluency, and their relation to word learning.

2.3.1 Frequency of Exposures in L2 Word Learning

The frequency of exposure is intrinsically related to word learning given that every encounter with a word strengthens permanent or emerging semantic memory codes (Salasoo et al., 1985) and traces; therefore, they contribute to the lexical establishment of novel words. Scholars have highlighted the importance of controlling the number of occurrences of a new word in order to determine how many encounters are needed to learn a word during fluent reading. One of the first studies to do so is that of Waring and Takaki (2003). They tested incidental word learning from reading a graded reader (e.g. language-simplified versions of existing books). Their participants were 15 lower-intermediate Japanese students studying at a university in Japan. The graded reader contained 25 target items (substitute words for existing English words functioning as nouns and adjectives) and participants were asked to read it for pleasure. The number of repetitions of the targets was controlled as follows: 1 repetition, 4 to 5 times, 8 to 10 repetitions, 13 to 14, and 15 to 18 times. Offline recognition and recall vocabulary post-tests were administered immediately after the reading session, a week later and also three months later. Their results demonstrated that words encountered more than eight times were highly recognised and recalled in the immediate post-tests; however, learning gains dropped in each delayed post-test. The authors concluded that at least eight encounters with the target item are needed to retain word knowledge over time (3 months). This first study on the relevance of frequency of exposures in L2 vocabulary learning led to more studies examining how many encounters are needed to obtain vocabulary learning gains from reading. For instance, in an incidental extensive reading study Pellicer-Sánchez and Schmitt (2010) tested if unknown words from an authentic text would be learned after different exposures and in diverse word knowledge aspects. The participants in the study were twenty advanced Spanish learners of English, and they read a novel for pleasure over a month. The novel contained unknown words of an African dialect that participants had no previous knowledge of. After participants completed reading the novel, they were tested on the target African words. The findings suggest that words with ten or more exposures were better learned than words with less than ten exposures.

A more recent study (Bisson et al., 2013) researched whether repeated exposures contributed to word learning gains in incidental and explicit vocabulary acquisition. In a multimodal stimuli experiment (written, visual, and auditory input) seventy-eight participants were exposed to eighty Welsh concrete nouns (participants did not have previous knowledge of Welsh) at different rates of exposure (two, four, six, and eight encounters) and in two different stages: incidental learning and explicit learning. The former consisted of a letter-search task in which participants were presented first with a letter (500ms) followed by a written word. They had to decide, by button-pressing, whether the letter appeared in the written word. Each written word was accompanied by its auditory form and a picture associated with it. In the latter participants had to complete a translation recognition task in which they listened to a Welsh word while viewing a possible translation (e.g. English written word). The participants had to answer, by button-pressing, whether the translation corresponded to the word. Feedback after each trial was given in order to promote learning. Their results indicate that for multimodal stimuli, learning gains can be obtained after eight exposures in an incidental learning situation. The studies mentioned above have used unimodal and multimodal stimuli to test incidental vocabulary learning at different exposures, and they have shown mixed results. However, in unimodal written stimuli (Webb, 2007, 2008; Pellicer-Sánchez & Schmitt, 2010) more than ten encounters seem to be needed in order to see learning gains in incidental vocabulary acquisition.

Other studies have found that with regards to the quality of encounters, involvement load (e.g. deeper levels of processing) and task type have an effect on vocabulary learning (Laufer & Hulstijn, 2001), and that frequency of encounters contributes more to vocabulary learning than contextual richness (Joe, 2010). Regarding multiple encounters of novel words, Ma et al. (2015) have mentioned the need for future research where novel words are presented multiple times in order to account for the effects of repetition in word learning.

It is relevant to highlight that the studies discussed above have tested lexical configuration knowledge of recently learned words but not their lexical engagement; hence, frequency of exposure may vary to see lexical engagement. To illustrate, studies on L1 lexical engagement of novel items have demonstrated that after 24 (Leach & Samuel, 2007) and 30 (Gaskell & Dumay, 2003) repetitions with the target novel words lexical engagement was evidenced; however as the number of repetitions increased (more than 24 exposures) lexical engagement was more clearly seen (Leach & Samuel, 2007). However, Bordag et al. (2017) found lexical engagement gains in L2 novel items only after three repetitions with the target. Given that L2 lexical engagement is an emerging field, it still remains unexplored how many repetitions are needed to see evidence of lexical engagement of novel items. Nevertheless, Leach and Samuel (2007) assertion that longer learning periods (more than 30 exposures) than those for lexical configuration may be needed to see evidence of lexical engagement.

2.3.2 Working Memory[8]

Working memory is one of the most relevant and researched traits of human cognition (Bunting & Eagle, 2015) and perhaps that is why it has been widely analysed and included in language learning studies. Working memory is a multi-component temporary memory system that processes and stores information (Gathercole & Baddeley, 1995), and it is a critical component of linguistic achievement and language comprehension (Baddeley, 2015; Bunting & Eagle, 2015; Gathercole & Baddeley, 1995).

Scholars researching the effects of working memory in L1 and L2 language learning and processing have frequently used Baddeley and Hitch's (1974) working memory model as a reference (Juffs & Harrington, 2011), including their subsequent updated versions. The 1974 model consists of a series of components that help temporary processing of information, information storage, and passing the information to the long-term memory system. The model has a central executive that regulates and controls the information within the working memory system. It can also retrieve information from long-term memory. This component has two "slave systems": the phonological loop and the visuo-spatial sketchpad (Gathercole & Baddeley, 1995). The visuo-spatial

[8] Only a brief review of the working memory system will be discussed given that this work only emphasises one of its components.

sketchpad is in charge of processing visual and spatial information whereas the phonological loop deals with phonological and verbal information (Juffs & Harrinton, 2011) (Figure 2). The central executive, hence, executes and controls the information in the visuo-spatial sketchpad and in the phonological loop and it decides whether or not it should pass it to the long-term memory system.

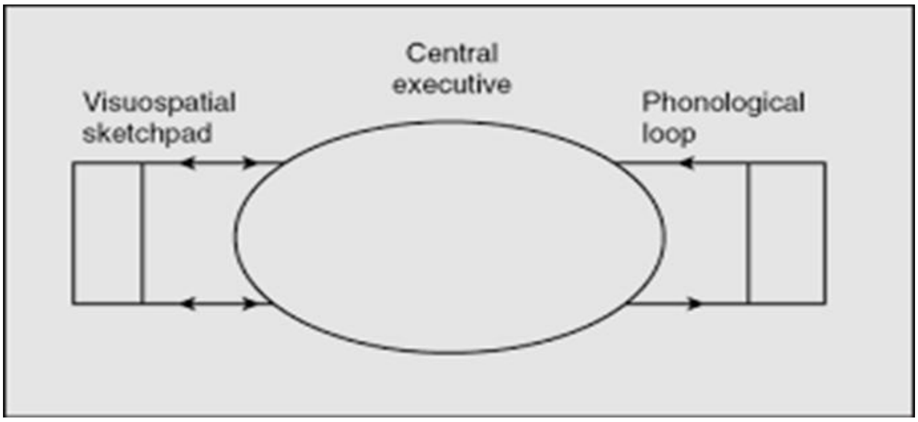

Figure 1 Original Baddeley and Hitch (1974) WM model. Source: Baddeley (2015).

The most recently added component is the episodic buffer (Baddeley, 2000). It is a multidimensional storage system that combines and links information from the visuo-spatial sketchpad and the phonological loop to information from long-term memory (Baddeley, 2015) (Figure 3).

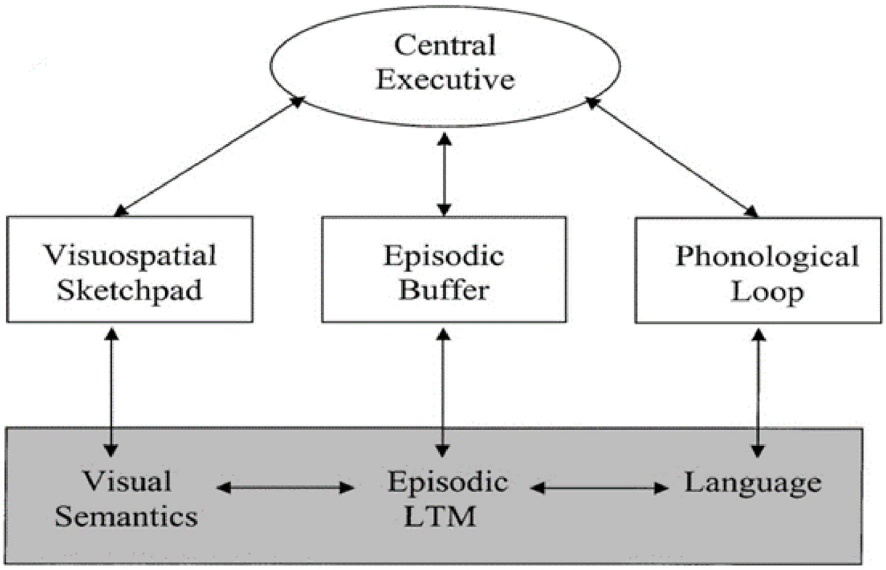

Figure 2 Updated version of the original Working Memory Model. Source: Baddeley (2000)

All of the components of the WM model, in one way or another, contribute to the processing and learning of languages. However, given that the role of the phonological loop is the most established in language and vocabulary learning (Baddeley, 2015), it will be the only one emphasised in this thesis.

2.3.2.1 The Phonological Loop and Phonological Working Memory

The phonological loop processes and stores speed-based information and is the component where subvocal articulation occurs (Eysenck & Keane, 2015). It is comprised of a passive phonological store that interacts directly with speech perception, and an articulatory process linked to speech production, which gives access to the phonological store (Eysenck & Keane, 2015). The phonological loop has two functions: to remember familiar words, and to learn L1 words (Baddeley et al., 1998; Eysenck & Keane, 2015) and L2 words (Baddeley, 2012); however, it may also facilitate grammar acquisition (Baddeley, Eysenck & Anderson, 2015). It taps into phonological working memory (PWM) as it stores speech and auditory information (Baddeley et al., 2015). PWM is a crucial language learning device that assists the acquisition of novel phonological forms in first and second language learning (Gathercole & Papagno, 1998; Baddeley, 2003). It contributes to vocabulary acquisition in both childhood and adulthood to such an extent that today it is well established that PWM plays a transcendental role in learning new words. The first studies to confirm so in L1 word learning were carried out by Gathercole and Baddeley (1989, 1990). In their first study (1989), they tested 104 school children, between the ages of 4 and 5, on two occasions: immediately after learning and a year later, to look for the possible effects of PWM and vocabulary learning. They used a nonword repetition test (40 nonwords) to account for PWM, a nonverbal intelligence test (Raven’s Progressive Coloured Matrices RPCM), a reading test (the single-word reading test (A) of the British Abilities Scales BAS), and a vocabulary size test (short form of the British Picture Vocabulary Scale BPVS). Their analysis was carried out with the data at the ages of four and five years old. The results showed that PWM was significantly correlated with vocabulary learning at both ages, and that performance in nonword repetition, at the age of 4, was a predictor of vocabulary skill at the age of 5. The analysis of nonverbal intelligence showed a correlation with nonword repetition and vocabulary skill at the age of 4, but not at the age of 5. The authors suggested that this highlights a relationship between nonword repetition ability, and thus PWM, and vocabulary learning in children, but that more research was needed to fully understand this relationship. In their second study

(Gathercole & Baddeley, 1990) the main tasks consisted of learning English names (English name learning task) and novel names (novel name learning task) for toy animals (e.g. grall). They created two experimental sets containing four different animals to be learned, and they used a nonword repetition task to classify their participants (N=118 schoolchildren) into two groups: low repetition and high repetition. The results showed that high and low repetition groups performed similarly in the English name-learning task; however, they differed in the novel name-learning task. To illustrate, the high repetition group needed fewer trials (M=7.17) than the low group (M=9.94) to learn the meaning of the novel words. Gathercole and Baddeley (1990) concluded that PWM aids novel word learning and its retention in long-term memory given that the ability to repeat nonwords (which have less support from previous existing lexical knowledge) rely on the phonological loop and predicts vocabulary learning. Gathercole and Baddeley's (1989, 1990) studies furthered the knowledge on and theoretical implications of the role of PWM and L1 novel word learning, and became central to disciplines related to word learning and working memory. Even though their findings cannot be extrapolated to adult novel word learning, they established the theoretical grounds for research on the role of PWM in L1 word learning.

The relationship between PWM and word learning not only occurs in the L1, but also in the L2. Baddeley et al. (1998) carried one of the first studies to confirm so where they examined the vocabulary learning of a patient, P.V., with a PWM memory deficit. P.V. (L1 Italian) was tested in nonword repetition spam, pair-associated word learning (L1), and pair-associated nonword learning (L2 Russian nonwords). The results of the tests showed that P.V. was able to learn L1 word pairs, but she showed difficulties in learning L2 word pairs. The authors concluded that one of the functions of PWM is learning new words, and that it extrapolates to L2 word learning.

The role of PWM and L2 word learning in participants without PWM deficits has also been examined. For instance, in a longitudinal study, Service (1992) tested 44 Finnish school children in L1 and L2 word learning over a period of three years. Participants' PWM was measured by a nonword repetition task. They were trained on 10 lists; half of the lists contained Finnish-like pseudowords (e.g. "laira"), and the other half contained English-like pseudowords (e.g. "rendence"). The results highlighted a connection between PWM and L2 vocabulary learning given that repetition accuracy in L2 English pseudowords was a word learning predictor. Another study investigating

PWM and its role in foreign vocabulary learning in participants with no PWM deficit is that of de Abreu and Gathercole (2012). They investigated the role of PWM, phonological awareness, and language proficiency in L1 (Luxembourgish), L2 (German), and L3 (French) vocabulary learning. Their participants were 98 children who were tested on complex span tasks, phonological simple span tasks, nonword repetition tasks, and vocabulary size tests. The results showed that L1 phonological processing abilities facilitated L2 learning of unfamiliar phonology and that PWM was uniquely linked to vocabulary learning. Service (1992) and de Abreu and Gathercole's (2012) studies clearly highlight that PWM contributes to L2 vocabulary learning. However, the studies are limited to young populations[9] who clearly have different learning characteristics than adult learners. The studies also fail to indicate if type of input (e.g. incidental or explicit) influences the role of PWM in vocabulary learning tasks. Therefore, more research on those lines is needed.

In the case of the role of PWM in L2 vocabulary learning in adults, Speciale, Ellis and Bywater (2004) showed its extents. They conducted two different experiments to research cognitive differences and their relationship with vocabulary learning. In the first experiment, 40 adult English native speakers were tested to determine the relationship between PWM, phonological sequence learning (PSI), and L2 (German) receptive and productive novel word learning. Results of the first experiment showed that: a) PSI was correlated with receptive and productive L2 vocabulary learning, b) PSI is a significant predictor of receptive vocabulary learning, and c) that PWM contributed to productive (spoken) L2 vocabulary learning. In the second experiment, 44 adult learners of Spanish participated in the study. They were enrolled in a 10-week Spanish programme, and their PWM capacity and phonological sequence learning were tested at the beginning of the course. At the end of the course, they undertook a Spanish nonword repetition task measuring their possible long-term retention of Spanish phonology, a Spanish receptive vocabulary task, and a written Spanish exam. The results indicated that PSI correlated with receptive vocabulary learning (and thus that it contributes to L2 word learning), and that PWM aided L2 receptive vocabulary learning. In general, the results from both experiments confirmed that there is an association between PWM ability and L2 vocabulary leaning, and that PWM capacity and the ability to learn phonological regularities are linked to productive and receptive L2 lexical knowledge. Speciale et al.'s (2004) study clearly emphasises that L2 adult

[9] See Nicolay and Poncelet (2013) for a detailed study on the link between PWM and L2 vocabulary learning in children.

vocabulary learning benefits from PWM capacity and PSI; however, the study does not provide any information on how type of input (e.g. incidental or explicit) may affect the role of PWM in L2 word learning.

The studies just reviewed pointed out the existing link between PWM and L1 and L2 vocabulary learning in young and adult populations. They also highlighted the lack of studies on the role of PWM in L2 English in L1 Spanish. For instance, Baddeley et al. (1998) researched L2 Russian in L1 Italian, Service et al. (1992) investigated L2 English in L1 Finnish, Speciale et al. (2004) had L2 German learning in L1 English, and de Abreu and Gathercole (2012) researched L3 French and L2 German in L1 Luxembourgish participants. Hence, there is a lack of research on L2 English with L1 Spanish speakers, and this is one of the issues this thesis will address. In addition, the studies mentioned above also illustrate that, to the best of the researcher's knowledge, there are no L2 studies looking into the possible effects of PWM in L2 lexical engagement of form, meaning, and use of novel items. The studies also evidenced that more research is needed to investigate how type of input may influence the role of PWM on L1 and L2 vocabulary learning.

2.3.3 Verbal Fluency

Another significant aspect in word learning is the possible role of verbal fluency. It refers to the cognitive ability of retrieving information from memory (Patterson, 2011) that can be related to language (Whiteside, Kealey, Semla, Luu, Rice, Basso & Roper, 2016). Commonly, there are two main types of linguistic information tested: semantic (category) fluency and phonemic (letter) fluency. Semantic categorization links already established concepts in the semantic memory, and groups them together, and for those concepts to be part of the same category they must have something in common (Harley, 2014). Verbal fluency, then, demonstrates the semantic capacity of an individual to categorise and retrieve concepts from their semantic storage[10]. Verbal semantic fluency is highly related to semantic memory, which is memory for general knowledge of the meaning and concepts that are not linked to specific events in one's life (Altarriba & Graves, 2013). The information stored in semantic memory is conceptual, such as vocabulary, and it can be referred to as the "mental encyclopedia" (Harley, 2014). Retrieving information from the semantic memory store taps into semantic processing and contributes to determining relationships between concepts to establish meaning

[10] Different models of semantic storage and semantic memory systems are beyond the scope of this work; therefore, they will not be discussed.

from phrases or narratives (Rindflesch & Aronson, 1993, as cited in Altarriba & Graves, 2013, p.578). Hence, through verbal fluency, relationships between semantic memory and semantic processing may be seen.

According to Troyer, Moscovitch and Winocur (1997), there are two types of components in verbal fluency: clustering and switching. The former refers to the retrieval of words within the same semantic subcategory and the latter refers to the ability to switch to a new category. Clustering involves cognitive processes such as verbal memory and word storage, whereas switching relies on shifting and strategic search processing (Troyer et al., 1997). For the purposes of this research, only clustering will be researched and given more theoretical attention. Verbal semantic fluency undoubtedly taps into the individual's mental lexicon since they have to retrieve and search for related words in their semantic memory stores (Troyer et al., 1997) and this is one of the reasons why it is used in first and second language research. Verbal fluency tests, tackling semantic fluency, are also widely used in neuropsychology research to detect neurological disorders such as dementia, epilepsy, cognitive impairment, and Alzheimer, amongst others (Zhao, Guo & Hong, 2013). Verbal semantic fluency tests usually ask the participant to retrieve as many words as possible from a specific semantic category in a specific time frame. This task taps into the participants' lexical retrieval ability and lexical knowledge (Shao, Janse, Visser & Meyer, 2014) as well as into their verbal memory (Troyer et al., 1997). Phonemic fluency tests generally ask the participants to retrieve as many words as possible from a letter category, i.e. S or N[11].

Different studies have shown the relevance of verbal fluency in word processing. For instance, Rommers, Meyer and Huettig (2015) in a study of verbal (verbal fluency capacity and vocabulary size) and nonverbal predictors (fluid intelligence) of anticipatory eye-movements, discussed the role of verbal fluency and vocabulary knowledge in language prediction. They used a category fluency task where participants had to recall as many words as possible from a specific category (animals and professions) in one minute to test verbal fluency capacity, and the Peabody Picture Vocabulary Test (Dunn & Dunn, 1997) to measure participants' vocabulary size. Their participants were eighty-one adult speakers of Dutch who listened to predictable

[11] For the purpose of this study, only semantic fluency was taken into account. Hence, the literature will only focus on semantic fluency.

sentences in their L1, such as "Neil Armstrong was the first man to set foot on the moon", while their eye-movements were recorded when looking at visual displays of four images each: three unrelated distractor objects and a critical object. Participants were expected to look at the target object (e.g. moon) before its onset. Their study had three conditions:

a) Target display: three unrelated images (e.g. a bowl, a fire, and a bag) and the target (e.g. moon).

b) Shape competitor display: two unrelated images (e.g. a fire, and a bag) and two images with a similar shape to that of the target (e.g. a tomato and a bowl).

c) A control display: three unrelated objects (e.g. a fire, rice, and a bag) and one object with a similar shape to that of the target (e.g. a tomato).

Overall, their results revealed that participants fixated on the target objects before their onset and that language prediction can include the target's shape. In terms of verbal fluency capacity, the results highlighted that anticipatory looks towards the target were associated with high scores in the verbal fluency task and similar results were also found for vocabulary size. Their results confirm that that verbal fluency and vocabulary size may have an effect on language prediction processes since a higher capacity related to anticipatory looks towards the target.

Luo, Luk and Bialystok (2010) showed the relevance of verbal fluency in language processing by conducting a study on verbal fluency performance in bilinguals. Their main aim was to assess correct retrieval responses, mean retrieval latency, and its time-course function. Their participants were 40 bilinguals and 20 monolinguals as a control. They took a vocabulary test, an expressive vocabulary task, a spatial span task, a non-verbal reasoning test, and verbal category and verbal phonemic fluency tests. They compared the performance of both types of speakers in every task and bilinguals were divided into two groups, according to their language vocabulary tests performances, high vocabulary and low vocabulary. The results revealed that bilinguals and monolinguals do not present significant differences in their category fluency but they do in their phonemic fluency where higher bilinguals outperformed both lower bilinguals and monolinguals. The authors argue that their categories in the category fluency task were rather large and this could have caused a lack of sensitivity to detect significant differences amongst participants. However, the relationship between verbal fluency and language processing is clear given that bilinguals with higher vocabulary knowledge showed better performance in the phonemic task. Hence, bilinguals with higher vocabulary knowledge might have an advantage in verbal retrieval processing. Even though this study did not specifically focus on word learning, it highlighted that verbal fluency ability contributes to language processing in bilinguals and that, methodologically speaking, large categories may not produce sensitive results.

The studies reviewed above shed light on the relevance of verbal fluency in L1 and L2 language processing, where higher verbal fluency capacity may be a predictor of language prediction, and can contribute to language processing in bilinguals with high vocabulary knowledge. The results of the above experiments also suggest that a category fluency task with large categories should not be used in future studies.

2.3.4 Vocabulary Knowledge

The number of words one knows has been associated with general intelligence, reading abilities, and even school success (Gathercole & Baddeley, 1995). However, not every person knows the same number of words in their L1 and L2. Some speakers have a wider range of words in their mental lexicon than others. The reasons for this difference in vocabulary knowledge are varied. For instance, native speakers are likely to have had more qualitative and quantitative input (Kaan, 2014) than second language learners and this might affect their vocabulary knowledge. When it comes to vocabulary knowledge in childhood, children may suffer from the so called "Matthew Effect" (Stanovich, 1986) where low literacy and language skills hinder the improvement and development of more advanced language skills, and this can also potentially affect vocabulary knowledge in adulthood both for L1 and L2 speakers (see Gibson & Hufeisen, 2003 for a study on the Matthew effect in L2 language processing and production). In addition, differences in vocabulary knowledge reflect differences in experience and expertise (Harley, 2014) and even in word learning (James et al., 2017) and these are some of the reasons it is relevant to investigate how differences in vocabulary size can affect word learning in L1 and L2 speakers.

The relevance of vocabulary knowledge in word learning studies has widely increased given the relationship between existing vocabulary knowledge and word learning and processing (Borovsky, Elman, & Fernald, 2012; Elman & Fernald, 2012; Yap, Balota, Sibley & Ratcliff, 2012; Henderson, Devine, Weighall & Gaskell, 2015; Borovsky, Ellis, Evans & Elman, 2016; James, Gaskell, Weighall & Henderson, 2017; Mainz, Shao, Brysbaert & Meyer, 2017). To illustrate, children with higher vocabulary knowledge are more efficient when consolidating new words because this type of previous knowledge facilitates learning and processing of new lexical items (Henderson et al., 2015; James et al., 2017) and this may also be the case for adults given that they consolidate new information faster due to their existing previous knowledge (Wilhelm, Diekelmann & Born 2008; Wilhelm, Rose, Imhof, Rasch, Büchel & Born, 2013). In addition, previous vocabulary knowledge may speed up learning of new words due to the context where the words are embedded (Perfetti, Wlokto, & Hart, 2005). For instance, when learning new words their memory traces may also extend to other lexical items in the context that contribute to their lexical consolidation process.

In a meta-analysis of previous word learning data, James et al. (2017) highlighted the role of existing vocabulary knowledge in word learning. They note that developmental language acquisition studies show that children with higher vocabularies present more efficient consolidation of new words, that weaker vocabulary knowledge can obstruct further vocabulary learning, and that adults' pre-existing vocabulary knowledge can aid the consolidation and integration of new information. This meta-analysis shows that vocabulary learning in adults can contribute to their word learning processes.

Borovsky et al. (2012), in a study on vocabulary skills and anticipatory and incremental looks, have highlighted the relevance of vocabulary knowledge and word predictive processing. One of their aims was to find whether or not speed processing would be influenced by vocabulary skill in both children and adults. Their participants were forty-eight adult monolinguals divided into two groups: high vocabulary and low vocabulary, according to their scores on a receptive vocabulary test. They employed a VW eye-tracking task modelled on Kamide et al.'s (2003) where participants heard sentences like "The pirate hides the treasure'' while looking at four different visual displays. Each display consisted of four images: the target (e.g. treasure), a distractor related to the agent of the sentence (e.g. ship), an image associated with the action of the sentence (e.g. bones), and an unrelated object (e.g. cats). Their results show that participants who scored higher in the receptive vocabulary test made faster predictive looks towards the target than those with lower vocabulary scores, and that age may not be a predictor of anticipatory looks. They concluded that even though they found that vocabulary skills aid predictive word processing, more research is still needed to fully account for the interactions between vocabulary knowledge and predictive processing. This study clearly demonstrates that vocabulary knowledge contributes to word processing given that higher vocabularies may speed language prediction in anticipatory looking tasks.

Higher vocabulary knowledge also aids word recognition as illustrate by Yap et al. (2012). They used an online behavioural database (Lexicon Project) with data from speeded pronunciation[12] and lexical decision tasks of approximately 1200 participants. Their main aim was to determine whether or not individual differences have an effect in word recognition. They analysed LDT data from 819 participants and found that their reaction times sped up according to their vocabulary skills and knowledge. To illustrate, participants with higher vocabulary knowledge were faster in word recognition than those with lower vocabularies. Even though this study included recognition of familiar words, it confirms that there is a link between higher vocabulary knowledge and word recognition.

The aforementioned studies shed light on the relevance of vocabulary knowledge in word learning and processing. Prior vocabulary knowledge in children and adults seems to aid lexical consolidation of new words. They also evidenced that higher vocabulary skill can contribute to faster predictive processes in both children and adults and faster word recognition. For the purposes of this study, vocabulary knowledge will be taken into account given its relevance in word learning and processing.

There are plenty of vocabulary size tests that measure previous vocabulary knowledge. Over the past years, valuable attempts have been made to validate, update, and make robust developments in vocabulary size tests. One of the most well-known L2 vocabulary size tests, for second language speakers, is that of Paul Nation (2007, 2012). His tests aim to determine how many words a learner knows in English as a second language, where some of them account for receptive vocabulary sizes. Meara and Miralpeix (2016) also cite useful tests to account for vocabulary sizes and the *lognostics* project (Meara, 2012) provides useful tools to test vocabulary size in English, either as a first or as a second language.

Given that the tests mentioned above have been theoretically driven and successfully accounted for, they will be used in the current research.

2.3.5 Language Aptitude

Language aptitude refers to the cognitive abilities learners have to process information during learning and performance in different contexts and at different stages (Robinson, 2005). It is also thought of as “the ability to successfully adapt to and profit from instructed or naturalistic exposure to the L2” (Dörney & Ryan, 2015, p. 38). In general,

[12] Given the aims of this thesis, results from the speeded pronunciation task will not be discussed.

aptitude can be perceived as a specific type of intelligence (Dekeyser, 2013); therefore, people may have more aptitude for languages or math, amongst many others.

According to Skehan (2012), foreign language aptitude includes the following four factors:

1) Phonemic coding ability: the capacity to retain, through appropriate coding, unfamiliar auditory material.

2) Inductive language learning ability: contributes to finding generalizations based on language input, and then being able to extrapolate and produce language based on those generalizations.

3) Grammatical sensitivity: shows the ability to identify the functions of words in sentences.

4) Associative learning: taps into the capacity to make links between verbal elements such as L1 and L2 words (p. 381).

Hence, language aptitude combines multiple linguistic factors where learners' performance can vary according to their cognitive abilities.

Language aptitude has been widely researched in diverse SLA aspects. For instance, oral proficiency (Anderson, 2012); working memory, where Shaofeng (2015) has mentioned that the executive aspects of working memory (EWM) are stronger predictors of language aptitude than PWM aspects; native-like learners (Abrahamsson & Hyltenstam, 2008); grammar acquisition (Li, 2015), see Skehan, 2015 for an overview; L2 anxiety (Sparks & Paton, 2013); advanced levels of L2 learning (Winke, 2013); amongst many others. Even though much research has been conducted on the subject, it is still a relevant topic to research when including individual differences as cognitive abilities are not fixed constructs. If aptitude is seen as those factors that prepare learners to learn at a particular point in time and under particular conditions (Dekeyser, 2013), it is valid to consider that research on language aptitude is a continuous process because learners' abilities vary across time and specific conditions. Therefore, it is arguably relevant to include language aptitude as an individual difference factor that may account to some extent for learning in SLA.

In order to measure language aptitude, which was initially used to identify individuals who could benefit from language learning instruction (Ellis, 2008), diverse tests have been developed. They usually give an indicator of the rate of learning (Ellis, 2008) and they measure aptitude in diverse ways and with different parameters. However, for the purposes of the present research, the aptitude test that will be use is the LLAMA test (Meara, 2005), since it covers a broad range of linguistic aspects and it has been successfully used in previous research (Granena & Long, 2013; Granena, 2014). It includes a vocabulary learning task, a sound recognition task, a sound-symbol correspondence task, and a grammatical inference task.

2.4 Chapter Summary and Conclusion

This chapter provided an overview of relevant literature on word learning and the factors that may be associated with it. It started by briefly describing the mental lexicon and how newly learned words are stored in the mental lexicon. This section highly contributed to the understanding of the organization of the mental lexicon and how new words are stored and learned.

Section two introduced a recent approach to word knowledge based on the concepts of lexical categorization and lexical engagement of Leach and Samuel (2007). It also proposed a framework for L2 word lexical engagement based on the approaches of Nation (2001) and Leach and Samuel (2007), and discussed relevant studies. This section contributed to the understanding of how L2 word knowledge is acquired and the relevance to further it through lexical engagement processes. This section also laid the theoretical foundations for the studies in this thesis.

Section three dealt with some cognitive factors affecting word learning, which helped to comprehend the relevance of individual differences when learning new words. It discussed Baddeley's (1974, 2000) working memory system, emphasizing PWM, and its role in L1 and L2 vocabulary learning. It also reviewed the role of verbal fluency and semantic memory (Troyer et al., 1997) and the relevance of vocabulary knowledge (James et al., 2017; Borovsky et al., 2012) in word learning. This section laid the theoretical foundations for the use of specific tests to tap into the learner's cognitive abilities in the studies for this thesis.

Section four considered how type and frequency of exposure contributed to learning vocabulary. The characteristics of incidental learning were discussed along with the need for quantitative and qualitative encounters with the target words.

In summary, this chapter laid the theoretical grounds for this work and for the methodologies to be used. It has highlighted that L2 lexical configuration and engagement with newly learned items is an emerging field that needs further research. This work fills a theoretical gap in L2 word learning studies by testing L2 lexical engagement of meaning, form, and use, of recently learned words. In addition, learning conditions, such as type and frequency of exposure, were discussed to emphasise their relevance in L2 word learning and lexical engagement processes. Finally, cognitive factors that affect word learning were pointed out to identify their relevance. This approach to L2 word learning, that takes into account lexical configuration and lexical knowledge of novel items together with different learning conditions and effects of individual differences, offers a more comprehensive understanding of how L2 emerging words are learned and processed in the L2 mental lexicon. This is a novel approach that can further our current knowledge and understanding of L2 word learning.

The chapter that follows moves on to review literature on L1 word learning processes tapping into lexical configuration and lexical engagement of meaning, form, and use.

CHAPTER 3 L1 WORD LEARNING AND PROCESSING

3.1 Introduction

The aim of this chapter is to briefly present general aspects involved in L1 word recognition and retrieval processes, word prediction, and resolution of word ambiguities. It discusses relevant studies that have tapped into L1 word learning through recognition and recall processes (lexical configuration), prediction of upcoming linguistic material, and resolution of subject-object ambiguities (lexical engagement).

3.2 L1 Visual Word Recognition

This section will first describe visual word recognition in general and then it will review experimental studies that have accounted for recognition of novel words in adult word learning processes. Visual word recognition, in simple terms, is the ability to recognise written words. It "is the foundation of reading" (Cortese & Balota; 2012, p. 159) and one of the most relevant processes in language comprehension (de Groot, 2011). It consists of retrieving the orthographic, phonological, and semantic characteristics of a word based on letter string input (Kroll & de Groot, 2005). It starts when there is a match between the printed word and one of its orthographic forms stored in the mental lexicon (de Groot, 2011); therefore, word recognition happens when the word's representation in the mental lexicon has been accessed (Harley, 2014). In order to recognise a word while reading, the mental processor analyses not only the orthography but also semantic and phonological information (Rastle, 2007). Recognition can occur through information that flows in two possible directions:

a) From features to letters, and finally words or,

b) From words to letters, and features (Gaskell & Brown, 2005).

One of the goals of visual word recognition is then to access the word's information as quickly as possible (Gaskell & Brown, 2005) because after recognition takes place, phonological and semantic processes start to activate. The relevant information has to be accessed in order to understand the word and the sentence where it is embedded (Gaskell & Brown, 2005); thus, the sentence context can facilitate recognition as most words within any given sentence are related in meaning (Eysenck & Kane, 2015). Frequency of exposure plays a role in visual word recognition. For instance, recognizing a high-frequency word such as "table" is quicker and more accurate than recognizing a low-frequency word such as “abyss” (Cortese & Balota, 2012). Hence, besides the cognitive processes underlying visual word recognition, other factors, such as word frequency and neighbourhood size are relevant in the recognition process.[13]

There are different theoretical frameworks to account for visual word recognition: however, it is beyond the scope of this thesis to describe them (see Coltheart, Rastle, Perry, Langdon and Ziegler’s (2001) dual route cascade model (DRC) of visual word recognition for one of the most robust frameworks and “the most comprehensive theory on visual world recognition” (Rastle, 2007, p. 80)).

3.2.1 Previous Studies on L1 Word Recognition

Visual word recognition of recently learned words in native speakers has been researched through online measures, such as lexical decision tasks and semantic tasks in experimental conditions (Batterink & Neville, 2011; Rodd, Berriman, Landau, Lee, Ho, Gaskell & Davis, 2012; Tamminen & Gaskell, 2013).

Studies on L1 word recognition have used lexical decision tasks (LDT) to account for word learning. They test if a series of letter strings are either words or nonwords; thus if the stimulus presented has a representation in the orthographic lexicon, one will recognise it either as a word (Rastle, 2007) or a nonword. One of the advantages of LDTs is that the speed of access and accuracy of word recognition can be simultaneously tested.

A seminal study on novel word learning and its recognition through LDT is that of Tamminen and Gaskell (2013). They tested the semantic integration of meaningful novel items in the adult mental lexicon through visual recognition in two experimental studies with primed lexical decisions. Their main aim was to test if recently learned novel items integrate into existing semantic networks by using the target novel items as primes of familiar words that had never been seen in association with the prime. If the novel items are able to act as effective primes of semantically related familiar words, they will show integration in existing semantic networks. In their first experiment, they tested 60 English adult monolinguals in an unmasked primed lexical decision task. Participants were divided into two word consolidation periods: short consolidation (novel words learned on the same day of testing) and long consolidation (novel words learned one or seven days before testing). Their stimuli consisted of 102 English-like novel words (e.g. feckton) and were divided into three lists. One list was used in each

[13] See Snodgrass and Mintzer (1993) and Lim (2016) for word frequency and neighborhood size effects in word recognition.

word learning consolidation period and one list for an untrained condition. Each novel word was paired with a meaning during training. The meanings consisted of a noun that referred to an existing object (e.g. cat) and two semantic features (e.g. "has stripes and is bluish-grey") to create new meanings that are not related to existing familiar concepts in the mental lexicon. Thus, for the novel word "feckton" participants learned that it is "a type of cat that has stripes and is bluish-grey" (Tamminen & Gaskell, 2013, p. 1008). In the training phase, participants had 17 encounters of each nonword in four different training tasks: a) word-to-meaning matching, b) meaning-to-word matching, c) meaning recall, and d) sentence plausibility judgment. In the word-to-meaning matching (a), the nonword was presented on the screen with two possible meanings, the participants had to choose the correct meaning of the novel word, and once participants made a choice, the correct definition remained on the screen for 1500ms. The meaning-to-word matching task (b) was very similar to the word-to-meaning matching, but in this case the meaning of the nonwords was presented together with two nonwords and participants had to choose the correct nonword that corresponded to the meaning. In the meaning recall task (c) the novel word appeared on the screen, participants had to type in the correct meaning of the word, and the correct answer was presented once participants had finished their response. For the sentence plausibility judgment (d) each novel word was presented 4 times in different sentences—3 sentences with correct usage and 1 with incorrect usage—and participants had to decide whether or not the novel word was appropriate for the sentence's context; feedback was provided after each sentence. Their second study was very similar to the first, however this time participants encountered the prime in a masked condition and its stimulus was shorter (47ms) than in study one (450ms). Participants were tested at three different times: 1) immediately after training, 2) the following day, and 3) seven days after training. The results of their first study did not show any effects of consolidation time, but revealed that reaction times to the primed trial were faster than in the unprimed trials. Therefore, the authors concluded that novel words act as lexical primes and facilitate semantic recognition of existing familiar words in lexical decisions, which shows their semantic integration into semantic networks. Results of the second study did not show any significant effects between consolidation days and priming, but they revealed that RTs were faster to primed trials than to unprimed trials. The authors concluded that the novel words integrated into existing semantic networks given that they showed semantic priming effects in both masked and unmasked priming lexical decisions tasks.

In their study of adult novel word learning, Tamminen and Gaskell (2013) proved that adult learners could semantically integrate and engage novel words into existing semantic networks. The novel words showed priming effects with semantically related words, with no associative links during training, and this highlights that participants recognized and retrieved the meaning of the novel words from semantic networks, and not just from short-term memory. This study reveals that after 17 encounters, adults are capable of learning meaningful novel words to such an extent to engage them into already existing semantic networks. This study sheds light on the possibility not only of word learning in adulthood, but also on lexical engagement with meaning of recently learned pseudowords. However, a more comprehensive study would also include whether individual variation affects novel word learning.

In another L1 word learning study, Batterink and Neville (2011) used electrophysiological evidence to tap deeper into mechanisms of word learning in adults. They measured implicit word learning through a prime semantic LDT (indirect memory test) and explicit learning through recognition and recall tasks (direct memory tests). One of their main aims was to determine if novel words were better encoded through implicit or explicit mechanisms. Their participants were twenty-one adult English monolinguals and they read four stories (between 4000 to 5000 words each) containing 10 target pseudowords, acting as nouns, which were presented in consistent meaningful contexts (M+) and inconsistent meaningless contexts (M-). In the meaningful contexts participants read sentences such as (1) below in which the target pseudowords (e.g. meeves) replaced real English words (e.g. clouds) that were originally in the context.

(1) Several white fluffy meeves spotted the clear blue sky.

In the inconsistent context the pseudowords replaced various real English words like in (2) and (3) below, thus their meaning was inconsistent throughout the story.

(2) Philip unearthed a rusty yet usable meeve and quickly pocketed it.
(3) Several white fluffy meeves spotted the clear blue sky (p.3184).

For the control condition, participants read the original sentences containing the English words like in (1) above. Twenty pseudowords were used as targets and they were divided into the three conditions mentioned above: M+, M- and a control in the learning phase. They expected reduced N400[14] effects over time in the M+ condition but not in the M- given that no specific meanings were assigned to the pseudowords in that

[14] A brain event-related potential linked to meaning processing (Kutas & Federmeier, 2011).

condition. For the control condition, they expected fewer N400 effects as semantic integration of familiar English words would be highly facilitated in that condition and that pseudowords tend to elicit greater N400 effects than real English words. Immediately after reading the stories, participants completed the prime LDT followed by a recognition task and a free recall task. The primes used in the LDT were the target pseudowords embedded in the M+ and M- conditions and the real English words from the control condition. The target items were half existing English words and half nonwords matched on word and syllable length. Semantically related English words were used as targets for those primes/pseudowords encountered in the M+ or control condition and semantically unrelated words were used for the primes embedded in the M- condition. Each prime was presented four times: preceding a semantically related item, a semantically unrelated item and twice before nonword targets. In the recognition task participants read a prime and a target and they were asked whether or not the words were semantically related. The primes in this test were target words from the M+ and control condition and the targets were semantically related or unrelated English words. In the free recall task, participants had to write a corresponding English word for the pseudoword targets presented in the M+ and M- conditions. Their findings can be summarized as follows: in the LDT participants responded faster to word targets than to nonword targets and in the control condition participants reacted quicker to semantically related targets. N400 effects were larger for nonword targets than for word targets as expected, and semantically unrelated targets showed larger effects than semantically related targets. Those targets preceded by pseudowords encountered in the M+ condition did not show a N400 reduction; thus, their semantic integration may not have yet been robust enough. Then, results of the recognition scores highlighted that participants recognized approximately 72% of the meanings in the M+ condition and that semantically unrelated targets, both in the M+ and the control condition, elicited larger N400 effects than semantically related targets. This indicated that explicit word learning took place. Moreover, participants' accuracy scores in the free recall task were of 63.8%.

According to the authors, results of both the behavioural and electrophysiological data suggest that novel word learning took place; however pseudowords embedded in the M+ condition developed faster explicit representations yet their implicit representations had not developed after 10 repetitions. Therefore, for implicit representations to develop, more exposure and consolidation period is needed.

In a study of adult novel word learning, Batterink and Neville (2011) demonstrated that meaningful novel word learning in adulthood occurs and rapidly develops after 10 exposures in a learning phase. Nevertheless, in order for implicit representations to take place, more repetitions of the novel items are needed as well as perhaps a longer consolidation period. For instance, a sleep consolidation period could have contributed to their results. It also shows that the use of pseudowords and prime LDT can account for word learning and its testing. However, the paper does not account for how cognitive individual variation may affect or enhance novel word learning in adulthood and this would bring a more comprehensive understanding of novel word learning and development in adults.

A relevant study on novel word learning in adults taking into account individual variations is that of Perfetti et al. (2005). They tested how very low frequency words integrated in the mental lexicon and whether their learning and processing varied according to participants' reading comprehension skills. If the words had been learned, participants would recognise them and understand their meaning in a language task. Twenty-four university students took part in this study, of which half were skilled readers and the other half less skilled readers according to their performance on the Nelson–Denny comprehension test. In the learning phase, they read sixty rare English words, such as "gloaming", on one side of a card with a short definition (e.g. "the twilight period before dark") on the other side of the card and were asked to study the words for 45 minutes. Prior to the learning task, participants undertook a paper and pencil word detection task with a total of 250 letter strings divided as follows: 135 rare words selected from a corpus of more than a million words, 51 common words, and 64 pseudowords. Based on each participant's results on the detection task, three different sets of lists, per participant, were created: a randomly selected list of 60 rare words, which were not marked as words, for the learning phase; a set of untrained rare words from the remaining rare words, which were not marked as words, and a set of familiar words that participants correctly marked as words.

Immediately after training, participants undertook a semantic decision task that consisted of judging whether word pairs were semantically related or not. The first word presented on the screen was randomly selected from any of the three sets of lists described above and was followed by a meaning probe. Participants had to decide whether or not the second word presented was semantically related to the first, and were given feedback at the end of each trial. Probe words were semantically related in half of the trials and semantically unrelated in the other half. The authors were expecting to find electrophysiological effects if the words were learned through late positivity (P600)[15] effects. Recently learned words would show different P600 effects than rare words and familiar words not present in the learning phase. N400 differences were also expected in the meaning judgment task when reading the probe word, where trained rare words and familiar words would elicit a reduced N400 effect. In terms of reading comprehension skills, Perfetti et al. (2005) expected skilled readers to learn the rare words more effectively than less skilled readers by stronger recognition and better performance at the meaning judgment task. Their results show that familiar words in the semantic judgment task were correctly answered in 87% of the trials, whereas trained rare words were correct in 83% and untrained rare words in 56%. In terms of reaction times, trained familiar words were answered faster in the semantically related condition and untrained rare words showed higher reaction times than trained and familiar words. Results from the ERP data revealed that they can indicate word learning and that rare trained words showed a late positivity effect similar to P600 effects seen in memory recognition. N400 effects were also found for familiar and trained words, semantically unrelated items elicited larger negative N400 deflections than semantically unrelated probes. Given that participants did not know the semantic characteristics of untrained rare words, their semantically unrelated probes did not elicit N400 effects. In terms of the individual variation on reading skills, their data demonstrated that in trained rare words, skilled readers outperformed less skilled readers by 10% on their accuracy scores. Skilled readers elicited a larger episodic memory effect, as reflected in their P600 deflections in rare trained words, which suggests that they have left stronger memory traces. The authors concluded that the trained rare words showed learning gains as they were correctly recognized in the meaning judgment task and by their effects on the P600 and N400 deflections, and that skilled readers may be better able to learn meaningful words than less skilled readers.

In Perfetti et al.'s (2005) study, they demonstrated that adults could learn the meaning of rare words through repetition and memorization during 45 minutes of exposure. Even though the learners in this study only encountered each rare word in explicit short definitions, the input was strong enough to leave robust memory traces captured in behavioural and electrophysiological data. One of the strengths of this study is that reading comprehension skills were taken into account, and this showed word learning

[15] A brain event-related potential linked to syntactic processing difficulty (Kutas & Federmeier, 2007)

effects according to participants' reading skills. This study illustrated that adult learners learn meaningful words in adulthood, but this can depend on their reading comprehension capacities and this study would have been much more comprehensive if it tested the effects of more individual differences in word learning.

3.3 L1 Word Recall

Recall is the method that makes information, which is stored in memory, ready for use. Retrieving words from the mental lexicon is a complex task for human cognition as it includes finding, activating, and processing specific memory representations (Rutherford, 2005). Word recall is the mechanism in which the information about the word, stored in the mental lexicon, is activated and made ready to be used. Given that the lexical properties of a word can consist of semantic, syntactic, or phonological components (Levelt, 1989), they may be retrieved separately. Tips of the tongue (TOT) have shown that speakers may know a word, they may remember its syntactic properties (e.g. it is a noun), they may even remember its semantic properties, but they cannot retrieve its full phonological form (Meyer & Belke, 2007). Hence, TOTs give informal evidence that word retrieval may consist of different retrieval processes, including syntactic, phonological, and semantic components.

Different models of word recall (Dell, 1986; Levelt, 1992; Caramazza, 1997; Roelofs, 1997, 2004) have attempted to explain the mechanisms and the architecture of how humans retrieve lexical units. They suggest that word retrieval is a process that takes into account different characteristics of the word, such as its semantic, syntactic, morphosyntactic, and phonological aspects. It is beyond the scope of this thesis to analyse and describe word retrieval models (see Levelt, Roelofs and Meyer's (1999) word model for one of the most comprehensive and, so far, most influential models of word retrieval (Meyer & Belke, 2007)).

3.3.1 Previous Research on L1 Word Recall

A relevant study tapping into L1 word recall is that of Rodd et al. (2012). In a series of three experimental studies, they tested adults learning new meanings of old words. The main aims of the study were to investigate the effect of semantically relatedness on adults' abilities to learn new meanings, the time course of novel word integration in the mental lexicon, and its possible effects in online comprehension. A total of 36 target words functioning as nouns were used for the studies, and each word was embedded 5 times into a paragraph (86 to 94 words long) solely designed to account for a new meaning semantically related to the word's old meaning. In the training phase, participants read the semantically related paragraphs described above as well as a set of semantically unrelated paragraphs. In the first experiment 22 participants completed the following tasks immediately after training: a rating task: after reading each paragraph, participants were to rate, on a 1-7 Likert scale, the novelty of the word's meaning, its plausibility, and the context clarity; a vocabulary size test which was a computerized test acting as filler between the reading task and the target tests; and a cued-recall test in which target words were presented one by one in isolation and participants had to type as many characteristics of the words' meaning they could remember. Responses were correct if at least one of the characteristics they recalled was correct.

The results of the first experiment highlighted that participants rated the semantically related paragraphs as less novel, more plausible, and clearer than the unrelated paragraphs. Results of the cue recall test showed that participants correctly recalled 70% of the meaning of the target words embedded in the semantically related paragraph and 26% in the semantically unrelated paragraphs. The authors concluded that a semantic relationship between old and new meanings of a word aids the learning of form and meaning of novel items.

In their second experiment Rodd et al. (2012) extended the learning phase across 6 days and participants (n=15) were tested 24 hours after training, not immediately like in experiment 1. In the training phase participants were instructed to take printed booklets home and read the paragraphs at home over six days. Six memory tests (one per day) related to the meaning of the paragraphs were administered in order to guarantee that participants read the texts each day at home. They also completed the rating and the cue-recall tasks mentioned above, as well as a lexical decision task. The results showed that in the cue recall they retrieved the meaning of all the word targets in the semantically related paragraphs and 52% in the nonrelated trials. In the LDT, words previously encountered in the learning phase elicited faster responses than words which were not included in the training task; however, there were no significant differences in reaction times and accuracy scores resulting from whether the words were learned in the semantically related or unrelated paragraphs. From these results, the authors concluded that the new meanings were learned to an extent were they could be explicitly recalled from memory, but they were not yet fully integrated into the mental lexicon.

In their third experiment Rodd et al. (2012) changed the learning session. Participants (n=16) read the booklets used in experiment 2 across 4 days, but they also completed recognition and recall tasks of the meaning of the target words spread across 4 different worksheets: participants were given a short definition of the target words and they had to match the meaning of each target word with the paragraph in which they were embedded; participants had to write a new sentence exemplifying the meaning of the target words; participants took a quiz related to the meaning of the paragraphs; and participants had to create a story using all the target items in a meaningful manner. Hence, participants completed one worksheet per day of training while the order of the worksheets was randomised. The results showed that overall, participants performed better in each worksheet in the semantically related paragraphs than the nonrelated, but the difference was statistically significant only for the first worksheet. In the LDT, words previously encountered in the learning phase elicited faster responses than words which were not included in the training task and target words in the semantically related paragraphs elicited faster times and higher accuracy scores. In the cue-recall participants' retrieval of the meaning of the target words was higher in the semantically related context (M=0.93) than in the semantically unrelated (M=0.77). Taking the results from the three experiments together, the authors concluded that semantically relatedness contributes to establishing new meanings of old words in the mental lexicon.

In their innovative study of novel word learning, Rodd et al. (2012) used multiple retrieval tasks to account for word learning meaning, such as cue recall, writing a sentence defining the meaning of the target word, and creating a story using the correct meanings of the target words. This study highlighted not only the relevance of the semantically relatedness when learning new meanings for familiar words, but also a relevant retrieval mechanism that can account for word retrieval. Even though this study took into account learning new meanings of familiar words in adulthood, it sheds light on word learning recall mechanisms in sentence processing. However, this study would have covered more ground if it had included the possible effects of learners' individual differences.

Tamminen, Lambon Ralph and Lewis (2013) highlighted the role of word retrieval in adult novel word learning in their study on semantic memory consolidation and sleep processes. The main aim of the study was to research semantic integration processes through novel word learning and possible effects of sleep consolidation. Sixty-four novel words and their meanings were created for the study and were controlled for semantic neighbourhood size in the following way: 32 new concepts with a high number of semantic associates and 32 with few semantic associates. The training session was comprised of four word learning tasks: meaning matching task: participants read each novel word with a possible meaning (6 exposures) and had to decide whether or not the meaning matched the target word; repetition task: Participants listened to every target word twice and had to repeat them; sentence generation task: the targets and their meanings were presented twice and participants had to create a meaningful sentence containing the target word; cued recall task: The novel words were presented three times and participants had to recall their meanings.

Novel word learning was tested through free recall (e.g. participants had to recall as many target words as possible in three minutes) and meaning recall (e.g. participants saw a list of the target items and had to recall their meaning) and by speed of access in four different tasks: animacy decision task: participants read each target word and had to decide whether if it corresponded to an animate or inanimate concept; synonym judgement task: novel words were presented together with three other words and only one was semantically related to the target and participants had to decide which one was the semantically related word; reading aloud task: participants had to read, as quickly as possible, the novel word presented; and a progressive demasking task where participants saw each target with a mask (e.g. ####) in which the words' presentation progressively increased while the mask decreased. Participants had to indicate when they recognised the word.

The reaction times of the participants (n=24) were recorded through electroencephalogram responses in three different sessions: the first comprised of an evening training and immediate testing of the 32 targets with the high-density neighbourhood size and a sleep consolidation process of one evening at the laboratory. Participants were tested again the following morning (second session). In the second session, participants were tested the following morning. The third session took place a week after session one. Participants were tested once more on the words learned in session one, in addition to the 32 low-density neighbourhood size novel words. This was followed by another sleep consolidation process. A week later, participants were tested once again on the 32 low-density novel words. The overall results showed significant effects of type of session in every experimental task. For instance, free recall and meaning recall were higher in the first learning session but there were no significant effects of neighbourhood size. Synonym judgment and reading aloud elicited faster RTs in the second session than in the first session and in the low-density neighbourhood novel words. Results of the animacy task revealedthat high-density neighbourhood speeded RT from session 1 to session 2, and that low-density targets elicited faster RTs from session to session. Finally, in the progressive demasking task both high-density and low-density neighbourhood novel words elicited faster RTs from session one to session two, and then from session two to session three. Their results on sleep consolidation revealed that in general there were no significant effects of neighbourhood size between the different sleep stages (sessions one to three) but it did aid semantic integration of the novel words.

The findings of Tamminen et al.'s (2013) research showed that meaning retrieval of recently learned words can be accounted for through offline tasks tapping into lexical configuration knowledge such as cue recall and sentence generation tasks, or online tasks such as timed reading aloud. This study also highlights that adult learners are capable of integrating new word meanings into their existing semantic networks and that sleep consolidation may aid the learning process. One of the strengths of this study is that it tested the learning of novel word meanings in adults; however, it could have been more comprehensive if it took participants' cognitive differences into account.

3.4 L1 Word Prediction

Word prediction refers to the ability to predict upcoming linguistic material. It helps language interaction since language users may communicate faster, by producing an overt response more quickly, when knowing what language material is coming (Kutas, DeLong, & Smith, 2011). Therefore, language users may not need to receive all the input at once in order to communicate rapidly and effectively.

When predicting upcoming material, native speakers not only use their lexical, syntactical, and semantic knowledge about a lexical item to predict upcoming material (Kaan, Dallas & Wijnen, 2010), but they also have to pre-activate that knowledge (Federmeier, 2007); thus, language users may predict different aspects (e.g. semantic, syntactic) of the upcoming linguistic material (Fine, Jaeger, Farmer & Qian, 2013). However, for the prediction to actually take place, lexical information (e.g. semantic, syntactic) of the linguistic context has to be activated, comprehended, and used immediately (Huettig, Olivers & Hartsuiker, 2011), otherwise the upcoming material will unfold and the prediction does not take place. This suggests that language users have to engage the lexical items in the linguistic context with the lexical aspects of the words yet to appear to make the prediction. Hence, if the speaker does not understand the contextual information or some of the linguistic aspects of the upcoming material, the linguistic prediction may not occur. In addition, the modality of the linguistic material to be predicted, either through written or auditory stimuli, may be more challenging for the speaker. For instance, given that auditory input unfolds over time and cannot be returned to, it may make the prediction more difficult (Dijkgraaf et al., 2017).

Speakers use context information to make linguistic predictions and this speeds up processing (Dijkgraaf et al., 2017) if the predicted material is accurate; however, when the upcoming material does not match the prediction, reanalysis and reprocessing costs are likely to take place. This mismatch accommodates future predictions and minimizes the chance of future errors (Jaeger & Snider, 2013), but it has processing costs. For instance, longer fixation times in visual tasks or incorrect overt responses are likely to occur if the predicted material does not match the incoming input. To illustrate, if one listens to a sentence like 1 below, soon after listening to the verb "drinking" one is likely to predict an upcoming "drinkable" object (e.g. water). However, if the upcoming object (e.g. glass) does not match the prediction, linguistic processing (e.g. overt response) may slow down.

(1) I love drinking water [glass].

Even though the extent and informativeness of linguistic predictions from written stimuli is relevant, the scope of this work is only on the auditory modality.

3.4.1 Previous Studies on L1 Prediction

Even though the extent and informativeness of linguistic predictions from written stimuli is extremely relevant, the scope of this work is only on the auditory modality. Hence, the following studies are based on auditory input.

A fundamental study in L1 linguistic prediction is that of Altmann and Kamide (1999). They tested prediction of upcoming linguistic material through two visual-world eye-tracking studies. Their main aim was to test whether or not L1 speakers were able to predict upcoming linguistic material based on their semantic knowledge of familiar verbs. They tested this by checking if, after verb onset, participants' eyes moved first to the target picture and then to the other pictures in the visual display. They argued that semantic information from the verb could guide participants' gaze to appropriate visual stimuli, based on the verb's semantic information, before the semantic characteristics of the object become available. For instance, upon hearing a sentence such as "The boy will move the cake" the participants' gaze may be directed towards "the cake" in visual stimuli before actually listening to it in the auditory input. In their first experimental study, they tested participants' anticipatory eye-movements in visual scenes containing the target object (e.g. cake) and agent (e.g. the boy), and three or four distractors (e.g. toy car) in sentences such as 1 and 2 below:

(1) The boy will move the cake.

(2) The boy will eat the cake.

For sentences like 2 above, the visual stimuli displayed objects whose selection restrictions allowed only one target object to be accurate (e.g. cake), whereas for sentences like 1, more than one object could be refereed to post-verbally (e.g. cake and toy car). Their participants were 24 adult English monolinguals and they were presented with a total of sixteen sets of stimuli and 16 sets functioning as fillers. Participants were asked to judge if the sentence they listened to corresponded to the picture presented, and they were to press a response button to proceed to the next visual scene. The findings of this first experiment showed that after verb onset participants fixated on the target object in 90% of the trials. Sentences whose selection restrictions only allowed more than one object to be referred to post-verbally, like in 1 above, were fixated in 92% of the trials whereas when the other condition was fixated in 88% of the trials. The mean fixation proportions of looks towards the target revealed that prior to noun onset, target objects in displays where only one object could correspond to the auditory stimuli generated more fixations (M=0.54) than in visual scenes where more than one object could be refereed to (M=0.38). The authors concluded that semantic information extracted at the verb could guide participants' eye movement and generate linguistic predictions; however, it could have been influenced by metalinguistic judgement. Hence, they carried out a second study with the same stimuli and procedures, but they did not ask participants to make any metalinguistic judgments of the visual scene. Twenty-four adult English monolinguals participated in the second experiment. The results showed that after verb onset participants fixated on the target object in 93% of the trials and in each condition, and the fixation probabilities towards the target object were greater in the visual display where only one object could be referred to post-verbally. They concluded that L1 speakers can extract and process information from the verb in order to make anticipatory eye-movements towards a target, and thus that language prediction may be possible through the semantic characteristics of the target verb. This is one of the first studies pointing out that predicting upcoming linguistic material is possible through processing verbs' arguments and semantic characteristics.

In another visual world eye-tracking study, Kukona, Fang, Aicher, Chen and Magnuson (2011) tested prediction of upcoming words in passive and active sentences. Their main aim was to determine whether or not local thematic priming between words influences predictive processes. They carried out two different experiments. In the first experiment they used active sentences containing predictive and non-predictive verbs, like 1 and 2 below, respectively:

(1) Toby arrests the crook.

(2) Toby notices the crook.

The visual display consisted of two semantic associates of the verb but with different thematic roles. For instance, for the verb "arrest" the target patient (e.g. crook) and the agent (e.g. policeman) are both semantically related to the verb but are thematically different. Their participants were 16 adult monolingual speakers. A total of forty predictive/non-predictive sentence pairs were used and divided into four counterbalanced lists. Each list consisted of 20 sentence pairs. The results from this first experiment indicated that: 1) fixation proportions were larger for the predictive verbs than for those of the non-predictive verbs and 2) fixation proportions were similar in each semantic associate and thematic role.

In the second experiment, Kukona et al. (2011) used passive sentences to tap deeper into possible sentence-level influences on anticipatory looks. Once again, the sentences contained predictive and non-predictive verbs like 2 and 3 below:

(2) Toby was arrested by the policeman.

(3) Toby was noticed by the policeman.

The stimuli consisted of 24 predictive and non-predictive sentences and their participants were sixteen adult monolingual speakers. Their findings on the second study revealed that like in experiment 1, fixation proportions were larger for the predictive verbs than those of the non-predictive verbs, and that fixation proportions were larger towards the target in semantic and thematic associate targets.

From the combined results from both experiments Kukona et al. (2011) concluded that predicting upcoming linguistic material may be influenced by active predictive linguistic processes and non-predictive thematic priming, since strong thematic relations can influence activation of upcoming material. Even though this study points out that L1 speakers are able to predict upcoming linguistic material based on semantic and syntactic cues, it could have been more comprehensive if it included possible effects of learners' individual differences, such as phonological working memory.

The studies just reviewed did not use recently learned words as the items to extract information from; however, they highlighted that speakers make anticipatory eye-movements based on their semantic knowledge of verbs. This indicates that the mental lexicon engages the meaning of target verbs with other lexical items (e.g. words in the auditory input) and lexical levels (e.g. syntactic structure of the auditory sentence).

3.5 L1 Syntactic Ambiguities

In reading processes, in order to understand a sentence, one needs to retrieve the meaning of the words, group them together syntactically, and make relationships between them to apply the grammatical roles of subject, verb, and complement (Dussias, Valdés Kroff & Guzzardo Tamargo, 2013). Hence, one's knowledge of the words in the sentences has to be robust enough to accurately perform the processes mentioned above. This requires comprehension and the ability to understand words in context.

One of the most effective ways to tap into deeper lexical comprehension is the processing of lexical ambiguities. Warren (2011) has mentioned that encountering ambiguities or language violations, while reading, can contribute to deep understanding of language, since readers need to resolve the lexical ambiguity in order to comprehend the material they are reading. When encountering a lexical ambiguity while reading, the reader syntactically analyses the sentence to understand what is being read and this taps into parsing processes (e.g. grammatical analyses). These processes are guided by the syntactic information of the lexical items stored in the mental lexicon, which are activated once the parser recognises the words he/she is reading (de Groot, 2013). Hence, the reader has to have a robust knowledge of the syntactic and semantic properties of the words in order to recognise them, retrieve their lexical characteristics, and engage with other words in the sentence. The parser's lexical knowledge of the words also has to be robust enough for accurate parsing given that it unveils the sentence's grammatical structure and identifies the parts of the sentence as verbs, subjects, or objects (de Groot, 2013).

Word lexical knowledge is not the only element that L1 parsers need to resolve lexical ambiguities. Aspects such as working memory, type of verb argument in the sentence structure, and prosody may interfere in L1 parsing (Gibson & Pearlmutter, 1998, as cited in Clahsen & Felser, 2006). In addition, when parsing lexical ambiguities, readers seem to prefer the structurally simplest analysis and this leads to the well-known garden-path effect. This effect will be briefly discussed in the next section.

3.5.1 Garden-Path Model in Sentence Processing

The garden-path model has been one of the most comprehensive theories to account for ambiguities in sentence processing. Proposed by Frazier and Rayner (1982) it conveys the idea that structural principles lead sentence processing, and that readers parse input in a word by word manner. When the initial structural analysis is challenged, and hence interpretation is disrupted by incoming linguistic material, the sentence structure has to be revised and reanalysed (Juffs & Rodríguez, 2014).

The garden-path model has been used in language research to account for how learners parse and comprehend semantic and syntactic ambiguities. This model relies on the fact that parsing is a two-stage process: 1) the parser relies on syntactic information only, but if the upcoming material is ambiguous, 2) a second reading becomes necessary to revise the structural parse tree and the first initial structural attachment (Harley, 2014). The initial attachment is then driven by syntactic elements and is based on the principles of minimal attachment and late closure. The former refers to the use of the simplest syntactic structure, by the parser, to process the sentence. This would include the minimal nodes in a syntactic tree when parsing the sentence to interpret it. For instance, incoming material is processed through the simplest syntactic structure by using the fewest nodes possible (Harley, 2014). The latter consists of parsing the current sentence and adding upcoming linguistic elements into the current parse, if it is grammatically possible (Juffs & Rodríguez, 2011). These two principles do not clash given that in case of conflict, the minimal attachment outweighs late closure (Harley, 2014).

3.5.2 Previous Studies on L1 Subject-Object Resolution

One of the first studies to test the garden-path theory in sentence processing is the one by Frazier and Rayner (1982). They tested analysis and reanalysis in short and long closure and attachment sentences containing noun ambiguities. They used late and early closure sentences such as 1 and 2 and attachment sentences like 3 and 4 below:

(1) Since Jay always jogs *a mile and a half* this seems like a very short distance to him.

(2) Since Jay always jogs *a mile and a half seems* like a very short distance to him.

(3) The lawyers think his second wife will claim *the entire family inheritance.*

(4) The lawyers think his second wife will *claim the inheritance* (Frazier & Rayner, 1982, p. 184).

They wanted to test if, while processing ambiguities in early and late closure sentences, and in minimal and nonminimal attachment sentences, parsers follow:

a) The parallel processing hypothesis: There is no difference in the general processing times in the sentences, but increased reading times in the unambiguous region of every sentence;

b) The minimal commitment hypothesis: There is no difference in reading times across any part of the sentences but longer reading times in the disambiguating region of every sentence; or

c) The garden-path hypothesis: Reading times in the ambiguous region should be longer than in the unambiguous region in every sentence and reading times are longer in early closure and nonminimal attachment sentences (Frazier & Rayner, 1982, p. 187-188).

In total, they had 16 closure and 16 attachment experimental sentences, and their participants were 16 undergraduate students. Their results indicated that parsers tend to follow the garden-path theory when detecting structural anomalies in sentence processing. Longer reading times and fixation durations in the disambiguation region of both the early closure and nonminimal attachment, with short ambiguous phrases, support the theory. In addition, they found that parsers seem to detect the ambiguities only when their sentence analysis is compatible with material following.

Frazier and Rayner's (1982) study provided the first proof of the garden-path theory in sentence processing. They demonstrated, through the analysis of eye-movements, the mechanisms parsers use when encountering ambiguities which brings valuable insights on readers' language processing. To illustrate, through the garden-path model they showed that in sentence reading the parser prioritises structural principles over real world knowledge and that input is likely to be received word-by-word (Juffs & Rodríguez, 2015). Hence, in real-time sentence processing, parsers are likely to be affected first by structural ambiguities while processing every word in the input. Their findings clearly provided the foundation for a new series of studies tackling syntactic and semantic ambiguity phenomena in both L1 and L2 sentence processing.

A study testing subject-object ambiguities in L1 sentence processing is that of Pickering and Traxler (1998). In a series of three eye-tracking experiments they tested processing of plausible and implausible sentences containing subject-object ambiguities. Their aims were to investigate whether or not there is a difference in plausible and implausible sentence processing; the semantic influences in syntactically ambiguous fragments, and the effects of sentence context in plausibility resolution. In the first experiment they tested plausibility effects in subordinate clause-ambiguities, such as 1a and 1b below where *the magazine about fishing* can be interpreted either as the object of *edited* or *sailed*, or as the head noun of *amused*. Their hypothesis was that if readers initially processed the magazine about fishing as an object, processing costs would arise when reading sentences such as 1b where processing it as an object is semantically implausible. They compared the ambiguous sentence processing with unambiguous sentences such as 1c and 1d below:

(1a) As the woman edited the magazine about fishing amused all the reporters.

(1b) As the woman sailed the magazine about fishing amused all the reporters.

(1c) As the woman edited, the magazine about fishing amused all the reporters.

(1d) As the woman sailed, the magazine about fishing amused all the reporters.

Their participants were 32 adult English native speakers. They identified four regions of interest for their analyses: the head noun of the noun phrase (e.g. magazine), the post noun region (e.g. about fishing), the verb region (e.g. amused), and the post-verb region (e.g. all the reporters), and they only analysed the eye-movements signalling regressions, first-pass time, and total reading times. In general, the data on regressions demonstrated that readers adopted correct analysis when the comma was presented in the sentences, and that readers made more regressions to the noun and post-noun regions in implausible object analyses. Total times revealed processing difficulties in the noun region of implausible sentences and longer reading times than in unambiguous sentences. The authors concluded that participants misanalysed the ambiguous sentences, that sentences with implausible objects were more difficult to process at the noun phrase, and that plausible object sentences were presented processing difficulties at the disambiguating verb region. The second experiment included experimental sentences with complement-clause ambiguities, such as 2a and 2b below, and unambiguous controls, such as 2c and 2d, but they were preceded by a context sentence like in 3 below:

(2a) The criminal confessed his sins which upset kids harmed too many people.

(2b) The criminal confessed his gang which upset kids harmed too many people.

(2c) The criminal confessed that his sins which upset kids harmed too many people.

(2d) The criminal confessed that his gang which upset kids harmed too many people.

(3) The chief criminal went to see his priest because his conscience started to nag at him and he was having trouble sleeping. The criminal confessed (that) his sins/gang which upset kids harmed too many people.

The same participants from experiment one participated in experiment two. The same regions of interest as in the previous experiment were analysed. Results from experiment two are similar to those of the first experiment where regressions and total reading times showed that readers misanalysed ambiguous sentences. Sentences with implausible objects showed processing difficulties at the noun phrase and plausible sentences had processing difficulties at the disambiguating verb phrase. The third experiment differed from the previous ones as it tested the processing of literal and non-literal expressions, and their effects in syntactically ambiguous sentences. The participants were 32 adult English speakers and they read passages containing target sentences such as 4c preceded by contexts such as 4a and 4b below:

(4a) The janitor polished bronze statues of the old maths professor that the principal hated and the dean of the art school.

(4b) The janitor polished bronze statues for the old maths professor that the principal hated reviewed the spring term teaching schedule.

(4c) While the janitor was polishing (,) the professor that the principal hated reviewed the spring term teaching schedule (Pickering & Traxler, 1998, p. 952).

The results of the third experiment demonstrated that: plausible sentences were less demanding until reaching the disambiguation; implausible sentences were less demanding after processing the disambiguation, and parsers use contextual cues to process sentences in discourse. Taking into account the overall results, the authors concluded that readers semantically and syntactically commit to their initial analysis in plausible and implausible sentences, plausible sentences carry out more semantic processing, and parsers find it difficult to abandon initial analyses if they require more semantic processing. This study marked a turning point in L1 literature on ambiguity resolution as it proved how readers behave when parsing semantic and syntactic ambiguities.

3.6 Chapter Summary and Conclusion

The aim of this chapter was to provide a review of different L1 word learning processes and relevant studies associated with them.

The first section focused on recognition processes. It reviewed relevant studies on L1 word meaning recognition that highlighted appropriate methodologies and tasks, such as LDT or meaning judgments, for semantic word recognition, and the relevance of taking into account individual variations and word consolidation processes.

The second and third section discussed word recognition and recall and up to date experimental studies with relevant methodologies that have contributed to testing word recognition and word retrieval in adulthood. These sections also revealed that there is a lack of studies accounting for aspects such as form recognition and recall and grammatical functions since all the studies reviewed only took into account meaning recognition and recall. In addition, the studies pointed out that there is an inconsistency on the number of exposures, per novel target item, for a lexical item to develop semantic representations. To illustrate, Tamminen and Gaskell (2013) used 17 encounters with the novel items in their training phase while Battering and Neville (2011) only 10 encounters, Rodd et al. (2012) had five exposures of the novel items, and Tamminen et al. (2013) six exposures. This exposure variation across experimental studies on recognition and recall of novel words is likely to create mixed results as they have not followed a similar number of encounters per target item. Hence, this thesis will address that inconsistency by taking into account Leach and Samuel's (2007) consideration that at least 24 encounters with the target items are needed for lexical engagement, and Webb's (2008) recommendation of 10 or more exposures in the training phase for the lexical item to show recognition gains in offline vocabulary tasks. Moreover, the first and second experimental studies on this thesis will not only test meaning recognition and recall, like the studies reviewed in the sections mentioned above, but also recognition and recall of form and the grammatical use of the novel items to shed light on different aspects of novel word learning. The fourth section provided the theoretical basis to understand the prediction of upcoming linguistic material. It pointed out the relevance of prediction for language communication and understanding and it explored different studies tapping into word prediction, which highlighted that the visual-world paradigm can be an effective online methodology to test prediction of upcoming linguistic material. The studies also demonstrated that most of the literature up to now has not taken into consideration prediction of upcoming linguistic material based on the linguistic information of recently learned words. For instance, Altmann and Kamide (1999) looked at linguistic information extracted at verbs that were already known to the participants, and Kukona et al. (2011) examined different thematic verbs that were also known to the participants. Overall, these studies highlight the need to research prediction of upcoming linguistic material based on the linguistic information of recently learned words; hence, the third experimental study of this thesis will address this gap by using recently learned words as the target items to extract information from in order to make prediction of upcoming linguistic material.

The last section reviewed L1 lexical ambiguities and the garden-path model. It discussed seminal studies on L1 parsing, and the resolution of subject-object ambiguities and how they shed light on deeper lexical engagement processes. The section demonstrated that garden-path sentence processing can inform word knowledge and lexical engagement of grammatical functions given that it identifies the parts of the sentence as verbs, subjects, or objects (de Groot, 2013). Hence, if any of those parts (e.g. verbs) are recently learned words, the parser will need to identify and parse them in relation to the rest of the sentence's syntactic structure, and this can shed light on the robustness of the word knowledge. Garden-path sentence processing is then a good illustration of lexical knowledge and engagement of the grammatical use of recently learned items. This can be of particular interest in incidental word learning given that the words' grammatical functions are learned as a by-product of another language process (e.g. reading). Thus, garden-path sentence processing can reveal the extent of incidental word learning since the parser has to make use of the grammatical functions of the recently learned words in order to comprehend the sentence, which will be addressed in one of the studies of this thesis.

To summarize, this chapter laid the theoretical foundations for understanding some of the mechanisms of L1 word learning in adulthood through recognition, recall, prediction, and lexical ambiguity processes.

The following chapter reviews literature on L2 word learning processes tapping into lexical configuration and lexical engagement of meaning through recognition, recall, prediction, and lexical ambiguity processes.

CHAPTER 4 L2 WORD LEARNING AND PROCESSING

4.1 Introduction

The purposes of this chapter is to present general aspects involved in L2 word recognition and retrieval processes, word prediction, and resolution of syntactic ambiguities. It discusses relevant studies that have tapped into L2 word learning through recognition and recall processes (lexical configuration), prediction of upcoming linguistic material, and resolution of subject-object ambiguities (lexical engagement).

4.2 L2 Word Recognition

Similarly to monolinguals, second language learners go through the process of word recognition while reading. However, L2 recognition processes may differ from those of L1 speakers. For instance, when bilinguals are presented with initial letter strings they may activate lexical candidates from either language (Dijkstra, 2005), which does not occur in monolingual word recognition. This parallel activation may lead to different lexical access in L2 recognition processes. To illustrate, L2 lexical recognition can occur via language- selective access or non-selective access. The former states that when a L2 reader, for instance a Spanish native speaker with L2 English, reads the English word “grand” the Spanish word “grande” would not activate, and the latter highlights that “grande” will activate. Nonetheless, L2 lexical access could also be either selective or non-selective (Kroll & De Groot, 2005) which opens up theoretical discussion on L2 word recognition. Undoubtedly, the L2 reader knows which language the target word belongs to; however, whether its recognition and lexical selection occurs through the selective, non-selective or both routes is as yet unclear and in constant theoretical development.

4.2.1 L2 Word Recognition and Receptive Knowledge

L2 word recognition has been associated with receptive knowledge in the SLA literature. Receptive knowledge involves knowing the lexical item to such an extent to be able to obtain communicative value from it in speech or writing (Schmitt, 2010). In terms of L2 word receptive knowledge, Nation (2001) mentioned that it involves recognising its form while listening or reading and retrieving its meaning (p. 47). Nation (2001) listed different features of what it is to know the form, meaning, and use of a word receptively as previously highlighted in the second chapter of this thesis.

Traditionally, L2 receptive word knowledge has been assessed through offline recognition vocabulary post-tests. In those tests participants have to recognise the meaning, form, or use of a target word. One of the disadvantages of offline vocabulary post-tests is that they are direct memory tests that tap into the learners' factual knowledge of the lexical items. Those tests fail to provide insight on unconscious operations L2 learners may be able to perform with their receptive knowledge of the target words. Only until recently, online methodologies such as lexical decision tasks (Bordag et al., 2017) and eye-tracking with text (Pellicer-Sánchez, 2015) have been employed to test L2 word recognition processes. The use of online tasks provides deeper understanding of incidental L2 word recognition and its lexical engagement.

4.2.2 Previous Studies on L2 Word Recognition and Receptive Knowledge[16]

One of the first studies testing meaning recognition of novel words from incidental reading in L2 adults is that of Pitts, White, and Krashen (1989). They replicated Saragi, Nation and Meister's (1978) "Clockwork Orange study" in which L1 participants read Burgess' (1962) novel *A Clockork Orange* containing 241 slung Russian-like words ("nadsat"). However, in Pitts et al.'s (1989) study, L2 learners read only the first two chapters of the novel for a total of 123 nadsat words out of which only 30 were chosen for the vocabulary post-test. Participants were 51 intermediate adult learners of English as a second language and a control group (n=23). They were divided into two experimental conditions: in group 1 participants (n=35) were given one hour to read the two chapters. After a 10 minute break the offline multiple-choice vocabulary post-test was administered. In group 2, prior to the incidental reading, participants (n=16) were given background knowledge of the novel via watching the first two scenes of the book's film adaptation. Then, they had 40 minutes to read the two chapters and the offline-vocabulary post-test was administered 10 minutes after they finished the reading.

Pitts et al.'s (1989) results highlighted that both experimental groups learned novel words from incidental reading; nevertheless learning gains were rather small. To illustrate, mean scores on the vocabulary post-test for group one was of 6.4% and 8.1% for group 2 (control M=0%). Even though this study only tested meaning recognition, it was one of the first studies demonstrating that L2 adult learners gain knowledge of

[16] Most L2 studies on vocabulary learning test recognition and recall; thus, the studies reviewed in this section also examine word recall.

novel words from incidental reading. Its findings led to numerous studies on recognition of novel words in L2 vocabulary learning

A study examining not only meaning recognition but also other word knowledge aspects is that of Webb (2007). Through the use of ten different offline tests, the following word knowledge aspects were tested: orthographic form, meaning and form, grammatical function, syntax, and semantic association. The target items were ten existing words replaced with pseudowords embedded in different contexts. The frequency of exposures per target item was manipulated across four experimental groups: group one, one exposure; group three, three encounters with the target; group seven, seven encounters; and group ten, ten encounters. 121 university students learning English as a foreign language in Japan took part in the study. Results demonstrated that participants were able to recognise not only the meaning and form of the pseudowords, but also their syntax, spelling, grammatical functions, and semantic associations. There were more receptive and productive learning gains after three encounters with the target when compared to only one encounter. Word recognition after three and seven encounters does not vary significantly; however, recognition and productive learning gains were significantly higher after ten encounters with the target pseudowords.

This study demonstrated that L2 word recognition may be possible even after only one encounter with the target item; however, ten or more repetitions are required for more robust receptive and productive word knowledge learning gains. Even though this is a study on L2 vocabulary knowledge, it fails to consider how word knowledge relates to and engages with other lexical items in the mental lexicon. One major drawback of using only offline tests is that they only account for factual knowledge of recently learned items; thus, they do not consider unconscious recognition and engagement of the target words with other lexical items in the mental lexicon.

A more recent study deviating from the traditional use of offline vocabulary post-tests and tapping into deeper word learning processes is that of Pellicer-Sánchez (2015). She employed offline and online methodologies to account for incidental word learning from and while reading. The main aims were to find whether or not L2 learners acquire vocabulary from incidental reading, if the online reading of novel items changes across different encounters, and if there is a relationship between online reading of novel items and their vocabulary gains. Participants were 23 L2 advanced learners of English and 25 L1 English native speakers as controls. L2 learners completed a self-rating test of English proficiency prior to testing. Six target nonwords, acting as concrete nouns, and six control words were embedded in a short story written for the study. They were matched in length, six letters and two syllables long, and there were eight repetitions of each target word in the story. Most of the lexical items in the context (96.82%) belonged to the 3000 most frequent words of the British National Corpus; the remaining items were from the 5000 to 9000 frequency bands. Participants' eye-movements were recorded during the story's online reading followed by immediate true-false comprehension questions. Three offline vocabulary post-tests—form recognition, meaning recognition, and meaning recall—were administered after the reading task and in a delayed testing session two weeks after the experiment. Results of the L2 offline vocabulary tests revealed that there were more learning gains on the form of the target nonwords (M=85.50) than in their meaning recognition (M=78.26) and meaning recall (M=60.87). Similarly, L1 learners had more learning gains on form (M=91.30) rather than on meaning recognition (M=86.60) and meaning recall (M=65.30). Analyses on first fixation duration, gaze duration, number of fixations, and total reading times elicited the following results:

a) Overall both L1 and L2 learners took longer to read the target nonwords than the controls.

b) More encounters with the target word sped up reading times and decreased the number of fixations when compared to the control words. For instance, L2 gaze duration decreased after three encounters; number of fixations and total reading times sped up by the fourth encounter; and targets and controls' reading times were similar after the eighth encounter. L1 fixation number and total reading times were faster after one repetition; L1 gaze duration decreased after three exposures; and first fixation durations sped up by the fourth exposure.

c) L2 learners took longer to read the targets they recalled in the offline vocabulary post-tests.

Taking the offline and online results together, the author concluded that participants learned most of the novel items after eight repetitions with meaning recall being the most difficult aspect to learn; that more encounters with the target items decreases reading times and number of fixations; and that longer reading times may contribute to meaning recall learning gains.

Pellicer-Sánchez' (2015) study clearly exemplifies that the use of online methodologies improves and expands on the quantity and quality of L2 word learning from incidental reading. However, the study does not consider learners' individual differences and their possible effects in incidental word learning, which would have enriched this work.

4.3 L2 Word Recall

L2 word recall is a complex process in which L2 learners retrieve semantic, orthographic, and phonological information (Dijkstra, 2005). It is linked to productive mechanisms, lexical access, and lexical selection. Its main focus has been on how bilinguals select lexical representations either from the language at rest or the language at use (Costa, 2005). There is not much research on language production when compared to language comprehension (Harley, 2014); hence, L2 word retrieval mechanisms have not been as highly researched (Costa, 2005). Nevertheless, models of L2 language production have been developed.

4.3.1 L2 Word Recall and Productive Knowledge

L2 word recall is associated with productive knowledge. L2 productive knowledge consists of retrieving the form, meaning, and use of a word when needed for communication in speech or writing (Schmitt, 2010). Nation (2001) describes different characteristics of what it entails to know a word productively, as discussed in the second chapter of this thesis.

L2 productive word knowledge has mostly been examined through offline recall vocabulary post-tests. For instance, participants have been asked to translate the meaning of a target word, to write meaningful sentences containing the target item, or to orally name the target word. The main limitation of these tasks is that they tap into the learners' memory of the factual knowledge and do not examine unconscious productive knowledge of the target words.

The following section will review relevant studies that have accounted for L2 word retrieval and productive knowledge.

4.3.2 Previous Studies on L2 Word Recall and Productive Knowledge

Webb (2008) used offline vocabulary tasks to test recognition and recall of the meaning and form of recently learned words. One of the main aims of the study was to determine the effect of context informativeness when incidentally learning the meaning of a target word. A total of ten target pseudowords were used in the study, six nouns and four verbs, embedded in short contexts taken from graded readers. Context informativeness was manipulated across four different contexts classified from least informative to most informative, like 1-4 below:

1) Extremely unlikely that the target word can be guessed correctly. The text contains no contextual clues and may be misleading.

2) It is unlikely that the exact meaning of the target word can be inferred. However, information in the context may lead to partial knowledge of the target word's meaning.

3) Information in the context may make it possible to infer the meaning of the target word. However, there are a number of choices. Participants may gain partial knowledge.

4) Participants have a good chance of inferring the meaning correctly. There are few meanings that are logical apart from the correct meaning. Participants should gain at least partial knowledge.

His participants were 50 Japanese adult learners of English. The reading task consisted of reading short stories in three sets of ten sentences each. Only one target word was embedded in each sentence. After reading the short stories, four vocabulary tests were administered in the following order: form recall was tested through listening to the target words and writing them down; a multiple choice test assessing form recognition; a L2-L1 translation task measuring meaning recall; and a multiple choice task testing meaning recognition. Results on the recall tests showed that meaning recall in the more informative contexts (M=1.31) was higher than in the less informative (M=0.13), and form recall was very similar in both the more informative (M=5.96) and less informative (M=5.46) contexts. The author concluded that context informativeness plays a relevant role when acquiring the meaning and form of recently learned words. Though Webb's (2008) study sheds light on relevant aspects of receptive and productive L2 word learning, it does not account for learners' individual variations. This study also fails to provide information on the robustness of word learning as it only took into account memory retrieval of the factual knowledge of the words.

Elgort et al. (2016) is a good illustration of a L2 productive word knowledge study taking into account learners' individual differences. The main aim was to investigate whether or not writing unfamiliar words facilitates form-meaning mapping in contextual word learning. They conducted two separate experiments: in experiment one participants were 47 intermediate to high-intermediate Chinese learners of English and experiment two was conducted with 50 intermediate to advanced Dutch learners of English. In each experiment participants were assigned to two learning conditions:

contextual learning with word-writing practice (WW) in which learners read the sentences for meaning and had to copy the target word into a booklet; and contextual learning with explicit meaning (ME) in which participants read the sentences for meaning and they had to infer the target word's meaning and type it. 48 target items, acting as concrete nouns, were used in the study. Half of the items were low-frequency words and the other half were nonwords. Each target item was embedded in three different sentence contexts like 1a-1c below:

(1a) A floor-to-ceiling door makes *egress* easy.

(1b) The mouse jumped down to the floor and ran around the room, trying to find an *egress*.

(1c) Beside the bed was a trap-door that permitted *egress* to the floor below.

Participants had three exposures of each target word. The first exposure was in a familiarization treatment where they read the sentences for meaning and were exposed to an audio recording of the target word. The second and third exposures were either in the WW or ME condition. At the end of the reading session participants read a short definition of the target items; they took vocabulary size and working memory tests; a lexical decision task, and two vocabulary post-tests: a dictation task testing productive retrieval of orthography, and a de-contextualized meaning generation task to account for meaning retrieval from form.

Results of the first experiment highlighted that in the WW condition participants' knowledge of form retrieval (M=56.9) was higher than meaning retrieval (M= 27.3) whereas in the ME condition it was much lower (M=18.2 and M=15.3, respectively). Participants with higher WM span retrieved approximately 40% more words in the WW when compared to the ME condition. In the lexical decision task, the low-frequency words generated faster reaction times than the nonwords in the correct trials, but slower reaction times when answered incorrectly. Participants with higher vocabulary knowledge reacted faster to the low-frequency words in the LDT than to the nonwords.

Results of the second experiment showed that in the WW condition participants form retrieval (M=89) was higher than meaning retrieval (M= 67.6) whereas in the ME condition it was lower (M=56.3 and M=45.4, respectively). In the LDT correct answers were higher and faster in the low-frequency words than in the nonwords, participants with higher WM span reacted faster to the target words, and the WW condition generated faster RT than the ME condition. On terms of vocabulary size, it was a learning predictor of meaning and form.

In their study Elgort et al. (2016) highlighted that retrieval of novel words might be mediated not only by productively paying attention to the form of the words (word-writing) but also by vocabulary knowledge and WM span. This is a relevant study exemplifying how recognition and recall retrieval processes have been accounted for in offline and online L2 word learning tasks and the possible effects of individual variations. However, the study does not address how different input (e.g. incidental or explicit) may affect L2 productive word learning.

4.4 L2 Word Predictive Processing

L2 language prediction contributes to efficient language communication as it speeds up L2 comprehension. Similarly to L1 users, L2 speakers pre-activate and make use of their lexical, syntactical, and semantic knowledge about a lexical item (Kaan et al., 2010; Federmeier, 2007) to predict upcoming linguistic material. However, even though L2 speakers may have all the necessary information to predict the upcoming material, it is yet unclear if L1 and L2 speakers predict to the same extent (Dijkgraaf et al., 2017; see Hopp, 2013, and Dussias et al., 2013 for results on L2 native-like predicting processes). Factors such as frequency of information and the competing information in the bilingual mental lexicon interfere in L2 predictive processes. To illustrate, L1 speakers have received more quantitative and qualitative input of the target language (e.g. English) than non-native speakers (Kaan, 2014) and this influences predictive mechanisms. In addition, given that that the bilingual mental lexicon activates both languages during the parsing of either, L2 speakers may activate more linguistic information while predicting upcoming material and this is likely to have an effect on their predictive processing (Lagrou, Hartsuiker & Duyck, 2013). Hence, they may present non-native predictive patterns due to their lack of suppression of irrelevant candidates, either from their L1 or L2, while making predictions (Kaan, 2016). However, whether L2 learners present native or non-native predictive mechanisms is still under current debate.

Another significant aspect in L2 prediction is the modality of the linguistic material to be predicted (e.g. written or auditory)[17]. In L2 auditory lexical prediction, L2 speakers decode the unfolding auditory input while processing its semantic and syntactic characteristics, which places a great demand on the L2 mental lexicon . The spoken input can influence L2 linguistic predictions due to cross-language co-activation in listening misinterpretations (Dijkgraaf et al., 2017). For instance, an L2 speaker may simultaneously activate L1 and L2 lexical representations while the auditory material unfolds and misinterpret the auditory stimuli.

The following section will review relevant studies that have accounted for L2 word prediction of upcoming linguistic material.

4.4.1 Previous Studies on L2 Prediction of Upcoming Linguistic Material[18]

Hopp (2015) analysed whether L2 learners integrate semantic and morphosyntactic information while auditory material unfolds. In a VW eye-tracking paradigm, he tested 46 intermediate and near-native L2 learners of German. One of the main aims was to find whether or not L2 learners integrate case and the verbs' semantic characteristics to make linguistic predictions. The stimuli consisted of 16 visual images paired with two sentences, as in 1 and 2 below:

(1) Der Wolf tötet gleich den Hirsch / The wolf will soon kill the deer (SVO).

(2) Den Wolf tötet gleich der Jäger / The hunter will soon kill the wolf (OVS).

The visual display contained four different images: one related to the noun; one acting as an agent; one as a patient; and one as a distractor. Overall, the findings revealed that intermediate and advanced L2 learners predicted upcoming linguistic material based on the verbs and nouns' semantic information; however, they do not use morphosyntactic cues to generate predictions. One of the strengths of this study is that it demonstrated that L2 learners integrate and engage semantic and syntactic information to generate on-line predictions of upcoming linguistic material. However, it does not take into account if or how individual differences have an effect on L2 predictive processing.

[17] Given that this work does not test prediction of upcoming material in written stimuli, it will not be further discussed and reviewed. For studies on L2 predictive processes in written stimuli see Martin, Thierry, Kuipers, Boutonnet, Foucart and Costa, 2013; Martin, Branzi & Bar, 2018).

[18] Refer to the second chapter of this thesis for more studies on L2 prediction of upcoming linguistic material.

4.5 L2 Syntactic Ambiguities

L2 learners use semantic and pragmatic information to process ambiguous input (Clahsen & Felser, 2006) and to recover from it. When they encounter a lexical ambiguity they have to "resolve" it in order to comprehend the material they are reading[19]. For instance, if an L2 learner does not recognise the semantic or syntactic properties of a word and/or its coherence in a sentence, language comprehension breaks down (de Groot & van Hell, 2005). This breakdown leads to misunderstandings of the current sentence, and/or subsequent sentences, and to repair mechanisms that slow down comprehension but maintain a coherent sentence parsing (Tokowics & Perfetti, 2005).

Most researchers investigating L2 semantic and syntactic ambiguities and comprehension breakdowns have utilised garden-path[20] sentences (Jegerski, 2012; Roberts & Felser, 2011; Marinis, Roberts, Felser & Clahsen, 2005; Juffs, 2004, among many others). These sentences shed light on L2 word lexical engagement because learners have to process the semantic and syntactic properties of the L2 words to comprehend what they are reading. Thus, if L2 learners have deep and sufficient knowledge of the words they are parsing, they will be garden-pathed and re-processing costs (e.g. longer reaction times, fixation times, or total reading times) are likely to take place.

Another significant aspect of L2 lexical ambiguities is the extent to which L1 and L2 sentence processing differs. Clahsen and Felser (2006) developed one of the best known theoretical accounts of L2 sentence processing; hence, it will be briefly reviewed in the following section[21].

4.5.1 Clahsen and Felser's (2006) Shallow Structural Hypothesis

The shallow structural hypothesis suggests that the syntactic representations L2 learners compute and parse are shallower and less detailed than those of L1 speakers. Therefore, there are differences between L1 and L2 speakers when processing lexical ambiguities.

Clahsen and Felser (2006) investigated online grammatical processing in L1 children and L2 adults to determine if there were differences in L1 and L2 sentence processing.

[19] It is beyond the scope of this work to theoretically discuss how L2 learners resolve lexical ambiguities given that it is a broad field involving grammatical phenomena, which is not the main aim of this work.
[20] See the third chapter of this thesis for a review of the garden-path model.
[21] Current debates on L2 grammatical parsing mechanisms will not be discussed as it not the main focus of this work.

They found out that in L2 adult lexical ambiguity processing, learners use semantic and pragmatic information similarly to L1 speakers. However, they differ on their use of syntactic information when parsing ambiguous clause-attachment sentences, as in 1 below, and syntactic dependencies, as in 2:

(1) The doctor recognised the nurse of the pupils who was feeling very tired.

(2) The nurse who the doctor argued that the rude patient had angered is refusing to work late.

Clahsen and Felser (2006) mentioned that L2 learners do not present intermediate gap effects when processing filler-gap syntactic dependencies in sentences such as 2 above. According to the authors, this indicates that L2 learners cannot project the syntactic structures needed to accommodate the gaps. Therefore, L2 learners do not use syntactic information, as L1 learners do, when parsing ambiguities because they are driven by semantic and pragmatic information.

Even though this hypothesis has been criticised (Ullman, 2006) and continues to be re-formulated (Clahsen & Felser, 2017), it brings valuable insights on L2 sentence processing of grammatical ambiguities.

4.5.2 Previous Studies on L2 Subject-Object Ambiguities

A considerable amount of studies have shown that L2 learners are sensitive to lexical ambiguities (Cunnings, 2017; Roberts & Felser, 2010; Juffs, 2004; Dussias, 2003; Juffs & Harrington, 1996; see Papadopoulou, 2005 for a review); however, for the purposes of this work, only studies on L2 subject-object ambiguities will be reviewed.

Jegerski (2012) tested subject-object ambiguity resolution in L2 Spanish through self-paced sentence reading. Participants were 23 advanced learners of L2 Spanish and 33 adult L1 Spanish natives as a control. An offline judgment task was administered to rate the sentences' grammatical acceptability on a scale of one to four, one being the lowest score and four the highest. The aim of the task was to measure participants' lexical knowledge of the verbs to be tested in the online self-paced reading task. Participants also answered a language background questionnaire. The experimental stimuli comprised of sentences with transitive and intransitive verbs, such as 1 and 2 below:

(1) Cuando el escultor acabó (transitive) la obra tenía tres metros de altura*
(2) Cuando el escultor volvió (intransitive) la obra tenía tres metros de altura*

* When the sculptor finished/came back the piece was ten feet in height.

Twenty target items, embedded in transitive and intransitive sentences, together with 120 distractors were used as stimuli. Each sentence was followed by a comprehension question to stimulate participants to pay attention to the meaning of the sentences while reading. Results of the offline grammatical acceptability task and the comprehension questions elicited very similar scores among L1 and L2 speakers. Results of the online self-paced task were analysed in three regions of interested: the post-verbal noun phrase (NP), verb in the main clause, and the sentence's final region. Significant results were found only on the post-verbal NP, which could be interpreted either as the object of the preceding verb or as the subject of the following sentence, like in 1 above. To illustrate, the NP *la obra/the piece* can act as the direct object of the verb *acabó/finished* or as the object of the NP *la obra tenía tres metros de altura/the piece was ten feet in height*. L1 and L2 learners slowed down when parsing the NP in the intransitive sentences and they behaved similarly in the transitive condition. Further analysis on transitivity and speed revealed that slower L1 readers took longer to parse the NP *la obra/the piece* in the intransitive condition than faster L1 readers; however both fast and slow L2 learners elicited higher reading times when the NP was followed by an intransitive verb. From the results just mentioned Jegerski concluded that high advanced L2 and L1 speakers rely more on syntactic information in their initial sentence processing in transitive and intransitive sentences. For this reason, the NP is processed first as the object of the preceding verb. High-advanced L2 language users may behave similarly to native speakers when processing subject-object ambiguities; however, L2 learners did not show a clear significant garden-path effect.

The findings of this study confirmed that high-advanced L2 learners may process subject-object ambiguities similarly to L1 speakers in null-subject languages like Spanish. This, in turn, leads to less significant garden-path effects for high-advanced L2 learners. Even though the study only took into account processing of familiar verbs and not novel items, its findings further the theoretical debate of whether or not L2 learners behave differently than L1 speakers when parsing subject-object ambiguities. Another weakness of this study is that it does not consider possible effects of individual differences when parsing subject-object ambiguities.

A study on L2 parsing of subject-object ambiguities that takes into account individual differences is that of Havik, Roberts, van Hout, Schreuder and Haverkort (2009). The main aims were to analyse the parsing of temporarily ambiguous sentences containing subject-object ambiguities and the effects of working memory capacity (WM) in L2 sentence processing. Participants were adult native speakers of German learning Dutch as an L2 and a German control group. Their memory span was tested through L1 and L2 reading span tests. The researchers carried out two experimental studies manipulating sentences' ambiguities relative to the subject (1 and 2 below) and object (3 and 4 below) and their length. For instance, in short sentences (1 and 2 below) the disambiguating region was placed immediately after the second NP, whereas in long sentences (3 and 4 below) a padding phrase was inserted between the second NP and the disambiguating region:

(1) "Daar is de machinist die de conducteurs heeft bevrijd uit het brandende treinstel. / That is the engine-driver who the guards has saved from the burning train carriage.

(2) Daar is de machinist die de conducteurs hebben bevrijd uit het brandende treinstel. / That is the engine-driver who the guards have saved from the burning train carriage.

(3) Daar is de machinist die de conducteurs na het ongeluk met de trein heeft bevrijd uit het brandende treinstel. / That is the engine-driver who the guards after the accident with the train has saved from the burning train-carriage.

(4) Daar is de machinist die de conducteurs na het ongeluk met de trein hebben bevrijd uit het brandende treinstel. / That is the engine-driver who the guards after the accident with the train have saved from the burning train-carriage" (p.82).

Participants read a total of 60 experimental sentences and 16 filler sentences. Comprehension questions were inserted after each experiment item to ensure that participants understood the meaning of the sentences. In the first experiment, analyses on the reaction times (RTs) showed effects of WM in L1 and L2 learners. In order to interpret the result, participants were divided into high and low WM span groups according to their WM median split with the following results: L1 learners read the subject-relative sentences faster than the object- relative; the high WM group had a processing advantage in subject ambiguity in the short sentences; L2 learners also had processing advantages in the subject relative sentences for the high WM group similar to the low L1 group.

The second experiment was run to verify the results obtained in the first experiment and to determine if reading focusing on comprehension has an effect in sentence processing. Participants read the same number of fillers and experimental items, but comprehension questions were followed only after 25% of the target sentences. The analysis of RTs revealed effects of WM in L1 learners. Further analysis, after performing a WM median split, indicated that: low and high L1 WM groups and L2 learners read the short sentences slower than the long sentences at the disambiguating region; L1 high WM group had a processing advantage in subject relative sentences, and L2 learners did not show any processing advantage in any sentences, either subject/object relative or short/long.

The authors concluded that when reading for comprehension, L2 online processing may differ because L2 learners do not use syntactic information as L1 speakers do; however high WM L2 learners may perform similarly to low L1 WM speakers. The authors noted that participants' L2 proficiency levels may not have been robust enough for the task's complexity; therefore, it could have influenced the results. This study of L2 processing of subject-object ambiguities illustrates that L2 learners are able to parse temporary ambiguities focusing on meaning and that WM has an effect on their processing. Even though the experiments were carried out on familiar words, they explore L2 online processing of subject-object ambiguities integrating semantic and syntactic characteristics.

Even though the studies reviewed did not take into account recently learned items, they pointed out that L2 learners process and resolve subject-object ambiguities based on their semantic and syntactic knowledge of the lexical items in the sentence.

4.6 Chapter Summary and Conclusion

The aim of this chapter was to provide a review of different L2 word learning processes and relevant studies associated to them. It laid the theoretical foundations to understand the L2 word recognition and recall process, prediction of upcoming linguistic material and L2 parsing of subject-object ambiguities.

The first and second sections focused on recognition and recall processes. It discussed studies on word recognition and recall processes highlighting that L2 learners can show lexical configuration knowledge through their scores in offline and online recognition and recall tasks. The studies also demonstrated that there is a lack of L2 studies accounting for word knowledge beyond lexical configuration. For instance, Pitts et al (1989) and Webb (2007, 2008) only tested word knowledge through offline measures of lexical configuration (vocabulary post-tests) which do not explore the robustness of word knowledge through its engagement with other lexical items and levels in the mental lexicon. Even though Pellicer-Sánchez (2015) and Elgort et al. (2016) deviated from the traditional use of offline methodologies, they only tested meaning and form recognition and retrieval. In addition, all the studies reviewed in these sections did not take into consideration how different types of input (e.g. incidental, explicit) shed light on the effectiveness of word knowledge through written stimuli. Another aspect that the studies revealed, which was also pointed out in the third chapter of this thesis, is the lack of exposure consistency across the studies. To illustrate, in Webb's (2008) research some items were seen from three up to ten times in the learning phase, Elgort et al. (2016) included only three exposures of the target words and Pellicer-Sánchez (2015) only eight exposures. Thus, this thesis will address the issues just mentioned through the use of lexical configuration and lexical engagement measures of the novel words' recognition and recall of form, meaning, and use. In addition, it will take into account Leach and Samuel's (2007) consideration that at least 24 encounters with the target items are needed for lexical engagement, and Webb's (2008) recommendation of ten or more exposures in the training phase for the lexical item to show recognition gains in offline vocabulary tasks.

The third section reviewed L2 predictive processes and a recent study on L2 prediction of upcoming linguistic material. The study highlighted that L2 learners are able to integrate and engage semantic and syntactic information of known words to predict upcoming linguistic material. This section also demonstrated that there is a lack of studies on L2 prediction of upcoming material based on semantic and syntactic knowledge of novel items. Therefore, this thesis will look at L2 language prediction based on the semantic and syntactic information of recently learned words.

The fourth section dealt with L2 lexical ambiguities and it briefly described Clahsen and Felser's (2006) Shallow Structural Hypothesis. It reviewed relevant studies on L2 subject-object ambiguities which pointed out that L2 adult learners are able to parse temporary subject-object ambiguities in garden path sentences. The studies also highlight that there is lack of research on L2 studies using recently learned words as the target items in the subject- object temporary ambiguity and that research on lexical ambiguities on L2 English is needed as Jegerski (2012) tested L2 Spanish and Havik et al. (2009) L2 Dutch Hence, this work will use recently learned words as targets in the subject-object ambiguity L2 English garden-path sentences. This section contributed to one's understanding of the relevance of semantic and syntactic garden-path ambiguities, and their resolution, in L2 word learning and engagement.

The next chapter describes two experimental studies designed to account for lexical configuration knowledge of recently learned pseudowords in Spanish speaking learners of English as a second language.

CHAPTER 5 L2 LEXICAL CONFIGURATION

5.1 Introduction

This chapter presents the results of two studies carried out to investigate L2 lexical configuration knowledge, through recognition and recall vocabulary post-tests of recently learned pseudowords. Different individual differences (IDs) and the extent of incidental learning were also taken into account.

Study 1 examined whether L2 adult Spanish speaking learners of English would recognise and recall the meaning, form, and use of novel items learned through incidental reading from authentic texts. The effects of learners' individual differences were also tested.

Study 2 took into account the findings of study 1 and investigated incidental vocabulary gains through recognition and recall vocabulary post-tests in adult Spanish speaking learners of English and English learners. The extent of incidental learning was assessed through its comparison with other types of exposure (explicit only, and incidental and explicit combined).

5.2 Study 1: Introduction

This study set out to investigate whether adult Spanish speaking learners of English obtained vocabulary learning gains from incidental reading of authentic texts. The main aim was to find out if L2 learners were able to recognise and recall the meaning, form, and use of recently learned pseudowords, and if individual differences in working memory, language aptitude, and vocabulary size have an effect on incidental vocabulary learning.

5.2.1 Study 1: Methodology

The methodology of this study is similar to that adopted by Webb (2007). An incidental offline word learning study determined, through scores on offline vocabulary post-tests, if participants recognised and recalled newly learned pseudowords (e.g. nonwords made out of strings of letters that can be pronounced (Eysenck & Keane, 2015)). The offline tests were introspection-based methods tapping into lexical configuration knowledge and did not explore possible interactions between the novel items and unconscious lexical processes like online-based methods do.

Each pseudoword was embedded in seven newspaper articles (Appendix 1) read with no time constraints. Participants had twelve encounters of each target word spread among the written input given that ten or more encounters are needed to obtain learning gains from incidental reading (Webb, 2007; Pellicer-Sánchez & Schmitt, 2010).

5.2.1.1 Study 1: Research Question 1

Are adult Spanish speaking learners of English able to recognise and recall the meaning, form, and use of recently learned pseudowords from incidental reading?

Hypothesis 1: Given that incidental L2 vocabulary learning from reading is possible (Webb, 2007; Pellicer-Sánchez & Schmitt, 2010), Spanish speaking learners of English will recognise and recall the meaning, form and use of the recently learned pseudowords.

Hypothesis 2: Given that nouns may be easier to learn than verbs (Bornstein, 2005; McDonough et al., 2011), nouns will present more significant results in both recognition and recall tasks.

5.2.1.2 Study 1: Research Question 2

Is there an effect of vocabulary size and language aptitude on the recognition and recall scores of vocabulary post-tests for Spanish speaking learners of English?

Hypothesis 1: Given that language aptitude contributes to L2 vocabulary learning (Ellis, 2008), participants with higher aptitude scores will score higher on the recognition and recall tests.

Hypothesis 2: Given that existing vocabulary knowledge is linked to word learning (James et al., 2017), more vocabulary knowledge will result in higher scores on the recognition and recall tests.

5.2.1.3 Study 1: Participants

Participants were 17 Spanish speaking learners of English (female=10, male=7), with a mean age of 22.94 (SD=1. 9, min=20, max=26) studying at the University of Costa Rica. All participants were on their final year of the English Teaching degree to ensure an advanced English level. Their vocabulary size mean score was of 8624 (SD=945, Max=10200, Min=6100) which guaranteed adequate unassisted comprehension of the texts (Hu & Nation, 2000) given that it was above the 6000 to 7000 word-families needed to get 98% coverage of a written text (Nation, 2006).

All participants had normal vision or corrected-to-normal vision and normal hearing.

5.2.1.4 Study 1: Stimuli

Seven target pseudowords, created with a nonword data base generator (Rastle, Harrington & Coltheart, 2002), were used for this study. They varied in length between four and five letters and complied with English phonotactics. They replaced real words from specifically chosen newspaper articles where only one sense of the target word’s meaning was available (Table 1). In order to reflect a naturalistic context, the position of the target items in the sentences in which they were embedded was not controlled.

The articles were selected from the same newspaper section to provide a similar topic where the target items could be encountered and embedded. One of the benefits of using authentic texts (e.g. texts originally created to achieve a specific a social purpose in the language community for which they were created (Crossley, McCarthy, Louwerse & McNamara, 2007) is that they offer a naturalistic context and are likely to prepare learners to read outside of the classroom (Barnett, 1989, as cited in Pellicer-Sánchez & Schmitt, 2010). In addition, the use of expository texts (e.g. newspapers) instead of narrative texts (e.g. stories) in incidental L2 vocabulary learning enhances incidental acquisition of unknown words (Shokouhi, 2009). The articles with the embedded pseudowords were piloted with a native English speaker studying at a university in the United Kingdom and a high-advanced Spanish speaker learner of English studying at the University of Costa Rica[22]. Given that both participants reported to have understood the articles and the embedded pseudowords, these articles were used for the study.

Using pseudowords ensures that participants have not previously encountered the target items; therefore, any lexical gains will be due to the treatment. Pseudowords have been employed in L2 vocabulary learning studies with great success (Godfroid et al., 2013; Bordag et al., 2015; Ma et al., 2015; Pellicer-Sánchez, 2015); hence, they are suitable for this study.

[22] More participants in the piloting would have provided more ecological validity for this study.

Table 5. *Pseudowords' Lexical Categories and Meanings*

	Lexical Category	Meaning
Chuth	Adjective	Iconic
Knush	Noun	Deflation
Boaf	Noun	Liquidity
Rird	Verb	Mastermind
Thafe	Adjective	Fragile
Pib	Noun	Investor

5.2.1.5 Study 1: Vocabulary Knowledge Post-tests

The tests were modelled on Webb (2007) (Appendix 2) and are summarised in Table 6. The receptive tests were administered before the productive in the following order: receptive knowledge of orthographic forms, receptive knowledge of grammatical functions, receptive knowledge of association, productive knowledge of orthographic forms, productive knowledge of grammatical functions, and productive knowledge of association.

All the tests were piloted with the L1 and L2 learners mentioned in the previous section. Given that both participants obtained learning gains, no modifications to the tests were made[23].

5.2.1.5.1 Tests of Orthographic Forms (Form)

The receptive test (form recognition) examined if whether participants were able to recognise the correct spelling of the target words. The productive test (form recall) tested whether participants could write the correct spelling after listening to the target words three times. Each item in the receptive test was scored as correct if participants correctly identified its spelling. The productive test was scored in a similar way, if participants wrote the correct spelling of the word, the item was given a 1 otherwise it was given a 0.

[23] More participants in the piloting would have enriched the validation of the instruments used.

5.2.1.5.2 Tests of Grammatical Functions (Use)

The receptive test (use recognition) examined if participants could identify the appropriate grammatical use of the target word embedded in the sentences. The productive test (use recall) measured participants' ability to write sentences using the correct grammatical characteristics of the target words. For the receptive test, each item was scored as correct, and given a 1, if participants recognised the accurate grammatical function, otherwise it was given a 0. In the production test, sentences were scored with 1 if participants wrote the correct grammatical use of the target word, otherwise it was given a 0.

5.2.1.5.3 Tests of Association (Meaning)

A test of meaning association was chosen to account for meaning recognition and recall due to the lexical variability among the written input. In addition, given the participants' high proficiency level and the lack of control of the sentences where the pseudowords were embedded a traditional meaning recognition and recall vocabulary post-test (Webb 2007, 2008, Pellicer-Sánchez & Schmitt, 2010) was not used. Therefore, tests of meaning association were employed instead of other offline meaning recognition and recall tests.

The receptive test (meaning recognition) analysed whether participants could identify a semantic associate of the target items. A multiple-choice test was employed with a correct semantic association of a target item and two distracters. Some of the distracters were either of the same lexical category of the target or from a different one, but they belonged to the same lexical category. For instance, for the pseudo-adjective "thafe" (fragile) the distracters were two nouns: bath and hospital. To avoid a semantic priming effect, none of the distracters appeared on the same sentence with the target pseudoword on the written input.

The productive test (meaning recall) examined if participants could write and retrieve semantic related representations of the pseudowords. Each item in the receptive test was scored as correct, and therefore with a 1, if participants identified the appropriate semantic/paradigmatic association, otherwise it was scored as incorrect. In the production test, a 1 was given for each correct association and a 0 was given to semantically incorrect associations[24].

[24] The tests were scored only by one researcher. For future studies, two or more researchers should score the tests for inter-rater reliability.

Table 6. *Vocabulary Learning Post-Tests*

Word Aspect	Test
Receptive Knowledge of Orthographic Form	Multiple-Choice
Receptive Knowledge of Grammatical Functions	Multiple-Choice
Receptive Knowledge of Association	Multiple-Choice
Productive Knowledge of Orthographic Forms	Spelling
Productive Knowledge of Grammatical Functions	Sentence Construction
Productive Knowledge of Association	Write an Associate

5.2.1.6 Study 1: Tests of Individual Differences

The individual differences battery comprised the following tests:

a) Vocabulary size (Nation 2012): A test of decontextualized receptive knowledge of written input.

b) Language Aptitude Tests (Meara, 2005):

- LLAMA B-Vocabulary Learning Task that measures ability to learn large amounts of vocabulary in a short time (p. 5).
- LLAMA D-Phonetic Memory based on Service (1992), Service and Kohonen (1995), and Speciale et al. (2004). It is designed to recognise short stretches of spoken language that participants were exposed to (p. 8).
- LLAMA E- Sound-Symbol Correspondence task that presents 22 recorded syllables and their transliteration in an unfamiliar alphabet (p. 11).

5.2.1.7 Study 1: Procedures

Each participant was seen for approximately 100 minutes. The session began with the battery of ID in the following order: vocabulary size, and LLAMA tests. Soon after it participants were exposed to the main task, which consisted of reading the newspaper articles in no particular order and without time constraints. Immediately after the exposure task surprise vocabulary post-tests were administered. Participants took the receptive tests prior to the productive ones[25].

5.2.1.8 Study 1: Ethical Considerations

Like with any research study, it was relevant to ensure that the appropriate informed consent had been created. Participants read and signed an informed consent and agreed to take part in the study. A short debrief session was given at the end of the study[26].

5.2.2 Study 1: Results

First, the mean scores of the vocabulary post-tests are briefly discussed to establish whether or not participants obtained lexical configuration knowledge of the recently learned pseudowords. Then, the recognition and recall scores will be separately analysed to determine the possible effects of word type and IDs. Table 7 presents the descriptive statistics of the vocabulary post-tests of form, meaning, and use. Receptive scores (M=84.3) were higher which was expected (Webb, 2007, 2008; Pellicer-Sánchez & Schmitt, 2010). In addition, there is a ceiling effect on meaning recognition (94%) and form recognition (91%). A possible explanation for this may be that the multiple choice tests used had items that were not difficult to recognise or discard. Given the low number of participants (n=17) and experimental items in this study (n=6), all items and participant scores will be used for further analyses. Nevertheless, caution will be applied when interpreting the significance of the effects obtained (Salkind, 2010).

Table 7 displays the descriptive statistics of the vocabulary post-tests. It shows that there is a ceiling effect on meaning recognition (94%) and form recognition (91%).

[25] For future studies, productive tests should be administered first.

[26] These ethical considerations apply to all the studies in this thesis.

Table 7 *Descriptive Statics of Vocabulary Post-Tests*

	Mean	St. Deviation	Minimum	Maximum
Form Recognition	0.91	0.29	0.00	1.00
Form Recall	0.62	0.49	0.00	1.00
Meaning Recognition	0.94	0.24	0.00	1.00
Meaning Recall	0.30	0.46	0.00	1.00
Use Recognition	0.68	0.47	0.00	1.00
Use Recall	0.35	0.48	0.00	1.00

5.2.3 Study 1: Data Analysis

Recognition and recall scores were analysed separately by a series of generalized linear models, using the “glm” package (Davies, 1992) in the R environment (R Studio Development Core Team, 2015). Scores were annotated as the outcome variable , and word type and IDs as predictors. To illustrate how the analyses were run, the codes used for each research questions are shown in each data analysis section.

5.2.4 Study 1: Data Analysis-Research Question 1

For RQ1 scores on each test (e.g. form, meaning, and use) were analysed separately. The general linear model had scores as the outcome variable, and word type as predictor. The word type predictor had three levels: nouns, verbs, and adjectives. It was expected that nouns would outperform verbs and adjectives.

5.2.4.1 Research Question 1: Recognition Scores

The analysis of the form[27] (Table 8), meaning[28] (Table 9), and use[29] (Table 10) scores did not show any significant main effects.

Table 8. *Generalized Linear Model on Recognition Scores of Form*

	β	SE	t	p
Adjectives	-14.59	2399.54	-0.006	0.995
Nouns	-13.79	2399.54	-0.006	0.995
Verbs	-14.55	2399.54	-0.006	0.995

Table 9. *Generalized Linear Model on Recognition Scores of Meaning*

	β	SE	t	p
Adjectives	-13.83	2399.54	-0.006	0.995
Nouns	-13.79	2399.54	-0.006	0.995
Verbs	-13.79	2399.54	-0.006	0.995

Table 10. *Generalized Linear Model on Recognition Scores of Use*

	β	SE	t	p
Adjectives	-14.59	1455.40	-0.010	0.992
Nouns	-14.87	1455.40	- 0.010	0.992
Verbs	-15.68	2399.54	-0.011	0.991

The tables above illustrate that the recognition scores did not provide any significant results. There are four likely causes for these results: first, the low and unbalanced number of items per word type may have not provided enough data for significant statistical analyses. Second, the low number of participants (n=17) could have also

[27] glm(formula = SCORE ~ wordtype, family = binomial(logit), data = RecogRMotherForm)
[28] glm(formula = SCORE ~ wordtype, family = binomial(logit), data = RecogRMotherMeaning)
[29] glm(formula = SCORE ~ wordtype, family = binomial(logit), data = RecogRMotherUse

affected the statistical results. Third, the possible influence of the context informativeness on the results obtained cannot be ruled out. To illustrate, the lack of adequate vocabulary control in the reading task could have facilitated or inhibited participants' vocabulary learning process. It is not possible to ascertain whether or not the context informativeness influenced the results obtained; thus, for future studies, the learning context should be controlled for. Fourth, given that the receptive tests were administered first, participants may have benefited from them.

5.2.4.2 Research Question 1: Recall Scores

The results of the form[30] (Table 11), meaning[31] (Table 12), and use[32] (Table 13) scores did not show any significant main effects.

Table 11. *Generalized Linear Model on Recall Scores of Form*

	β	SE	t	p
Nouns	0.5692	0.4338	1.312	0.189
Verbs	-0.3542	0.5962	-0.594	0.552

Table 12. *Generalized Linear Model on Recall Scores of Meaning*

	β	SE	t	p
Nouns	0.7609	0.4742	1.605	0.10859
Verbs	-1.5939	1.1072	-1.440	0.14999

Table 13. *Generalized Linear Model on Recall Scores of Use*

	β	SE	t	p
Nouns	0.3199	0.4425	0.723	0.4698
Verbs	-0.4411	0.6792	-0.649	0.5161

[30] glm(formula = SCORE ~ wordtype, family = binomial(logit), data = RecallRMotherForm)
[31] glm(formula = SCORE ~ wordtype, family = binomial(logit), data = RecallRMotherMeaning)
[32] glm(formula = SCORE ~ wordtype, family = binomial(logit), data = RecallRMotherUse)

It can be seen from the data in Tables 11 and 12 that the recall scores of form and meaning of nouns elicited closer to significant results than those of verbs. These differences might be explained in part by the fact that nouns may be easier to learn than verbs (Bornstein, 2005; McDonough et al., 2011), and that there were more target items acting as nouns than verbs in the written stimuli. However, given that the results were not statistically significant, such differences might not be relevant for this study.

5.2.5 Study 1: Data Analysis Research Question 2

For RQ2 scores on each test (e.g. form, meaning, and use) were analysed separately. The general linear model had scores on each test (e.g. meaning, form, and use) as the outcome variable, and word type and IDs as predictors. The wordtype predictor had three levels: nouns, verbs, and adjectives, while the IDs predictor only had one level. It was expected that higher phonological working memory (LLAMA D) and vocabulary size would contribute to higher scores on each task.

5.2.5.1 Research Question 2: Recognition Scores

The analysis of the scores from form[33] and meaning[34] did not show any significant main effects or interactions (Appendix 3). The scores from use[35] revealed a significant effect with LLAMA D (β =0.016443, SE=0.006846, t= 2.402, $p<0.01$). In order to better understand this result, participants were divided into low and high phonetic memory groups according to a median split on their LLAMA D tests (*Mdn*=40). It was found that the high capacity group outperformed the low capacity in their scores on grammatical use of the novel items (M=0.77 vs. M=0.59 respectively). These results confirm the associations between the phonological loop and L2 vocabulary learning (Baddeley, 2012) and L2 receptive competence (Speciale et al., 2004); however, they also support current debate in that the phonological loop may facilitate grammar acquisition (Baddeley et al., 2015). This finding also suggests that learners with higher phonological working memory capacity achieve higher recognition of recently learned words. A possible explanation for these overall results may be that recognizing the form and meaning of the recently learned pseudowords is not as cognitively demanding as recognizing their use. Hence, a higher vocabulary size and overall language aptitude do

[33] glm(formula=SCORE~LLAMAB*LLAMAD*LLAMAC*VocabS, family = binomial(logit), data = RecogRMotherForm)
[34] glm(formula = SCORE ~LLAMAB*LLAMAD*LLAMAC*VocabS,family= binomial(logit), data = RecogRMotherMeaning)
[35] glm(formula = SCORE ~LLAMAB*LLAMAD*LLAMAC*VocabS,family= binomial(logit), data = RecogRMotherUse)

not significantly interfere with scores on recognition and form. Moreover, participants' advanced proficiency levels may have been robust enough to comprehend the context where the novel items were embedded; hence, they did not require higher vocabulary knowledge to receptively learn the form, meaning, and use of the target items.

5.2.5.2 Research Question 2: Recall Scores

The analysis of the scores on form[36] did not show any significant main effects or interactions (Appendix 3). Nevertheless, the analyses on meaning and use revealed significant effects with LLAMA D: (β =0.014118, SE= 0.006644, t= 2.125, $p<0.05$) and (β= 0.02966, SE=0.01357, t= 2.187, $p<0.05$), respectively. In order to interpret these result participants were divided into low and high phonetic memory groups according to a median split on their LLAMA D scores (*Mdn*=40). The high capacity group outperformed the low capacity in the overall scores on meaning (M=0.38, SD=0.46 vs. M=0.24, SD=0.43 and use (M=0.43, SD=0.50 vs. M=0.29, SD=0.49) (Figure 9).

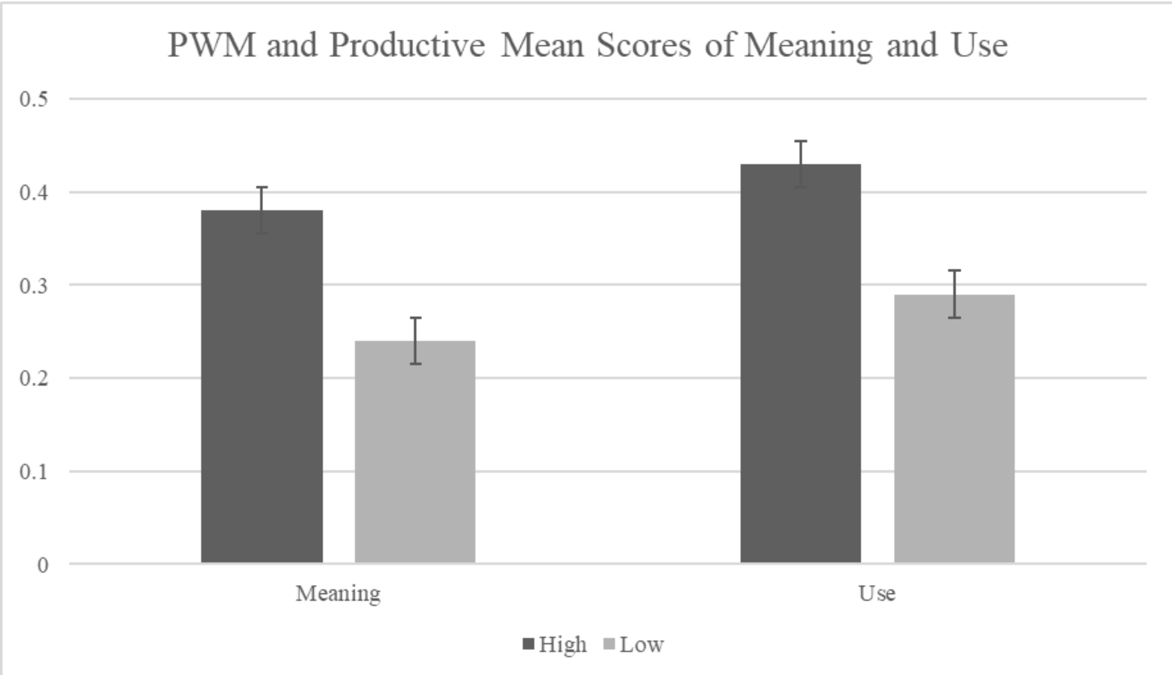

Figure 3 High and Low PWM groups and their Mean Scores on Productive Tests of Meaning and Use

In Figure 3, it is apparent that the high PWM capacity group scored higher than the low PWM capacity group. These differences can be explained in part by the fact that PWM aided L2 vocabulary learning (Baddeley, 2012) but particularly the productive aspects of meaning and use.

[36] glm(formula=SCORE~LLAMAB*LLAMAD*LLAMAC*VocabS, family = binomial(logit), data = RecogRMotherForm)

Not finding significant effects of vocabulary size in the productive scores may be due to participants' proficiency levels, as previously mentioned.

5.2.6 Study 1: Conclusions

The main goal of the current study was to determine if L2 learners were able to recognise and recall the meaning, form, and use of recently learned pseudowords, and if the individual differences in working memory, language aptitude, and vocabulary size have an effect on incidental vocabulary learning.

One of the most significant findings to emerge from this study is that PWM has an effect on L2 incidental vocabulary learning (Service, 1992; Baddeley et al., 1998; Speciale et al., 2004; Baddeley, 2012; de Abreu & Gathercole, 2012; Baddeley, 2015). To illustrate, it aids L2 recognition of the use of novel items and recall of meaning and use which supports the premise that the phonological loop may also facilitate grammar acquisition (Baddeley et al., 2015).Thus, it is concluded that language aptitude (PWM) has an effect of L2 incidental vocabulary learning, and that vocabulary knowledge made no significant difference to L2 incidental vocabulary learning given the conditions of this study.

The findings further support that L2 adults can incidentally acquire lexical configuration knowledge of meaning (association), form (orthographic), and use (grammatical functions) of recently learned pseudowords from incidental reading (Waring & Takaki, 2003, Webb, 2007; 2008; Pellicer-Sánchez & Schmitt, 2010;Pellicer-Sánchez, 2015). These findings may be somewhat limited by the lack of a thorough piloting and the tests' order (receptive tests followed by the productive) as previously mentioned. Nevertheless, the lexical items used in this study were controlled for (e.g. pseudowords to ensure that any learning gains are due to the treatment, and they were selected from a nonword database generator (Rastle et al.,2002)). Thus, the lexical items used shed light on the vocabulary gains obtained given that participants had not previously encountered them.

This study lays the methodological groundwork for the following study on L2 incidental vocabulary learning from reading and the possible effects of learners' individual differences. To exemplify, given that the current findings demonstrated that PWM has an effect on L2 incidental vocabulary learning, a more accurate PWM test should be employed in the following studies. Moreover, context informativeness should be more accurately controlled for.

5.3 Study 2: Introduction

This study was designed to investigate whether L2 Spanish speaking learners of English were able to recognise and recall the meaning of recently learned pseudowords through incidental sentence reading. One of the aims of the study was to determine whether lexical configuration knowledge is influenced by the individual differences in phonological working memory, verbal fluency, and vocabulary knowledge. The study established the extent of incidental learning by comparing it to two other types of exposures (explicit only, and incidental and explicit combined).

5.3.1 Study 2: Methodology

The methodology used in this study is similar to that adopted in study 1. Offline recognition and recall vocabulary post-tests determined, through participants' scores, lexical configuration knowledge of meaning. It was also of interest to research if participants' individual differences and different types of exposure had an effect on lexical configuration knowledge. Even though it is relevant to account for multiple aspects of word knowledge in L2 vocabulary learning (Webb, 2007; Pellicer-Sánchez, 2015), this study will only focus on lexical knowledge of meaning in order to deeper explore its extent and limitations.

Fourteen target pseudowords functioning as verbs, and seven fillers acting as nouns were used in the study. All 21 pseudowords had three types of conditions across participants: incidental only, explicit only, and incidental and explicit combined. The aim was to determine the extent of incidental learning by comparing it to other types of exposures, with the same participants and design, and without compromising participants' reading process in every condition. Every target pseudoword rotated through each experimental condition, and they were encountered between eight to ten times in each type of exposure according to the number of participants in the experiment (Table 14). In the incidental only condition, participants read meaningful English sentences containing the target pseudowords. In the explicit only condition participants read the sentences but a short definition, modelled on Tamminen and Gaskell's (2011) work, of each pseudoword was provided (i.e. Gwap: "to eat in a fast manner"). Definitions for the seven filler items, acting as nouns, were also provided (i.e. *Fowd*: "type of sweet and dry wine"). Each novel word appeared in the definitions just once. In the combined condition participants read half of the sentences incidentally and half in the explicit condition.

In total, every participant had twenty-four encounters with each pseudoword, but the exposure conditions varied as previously explained. Three counterbalanced sets of stimuli were created and each target item rotated across sets: set A was comprised of twelve incidental encounters and twelve explicit, set B only had twenty-four explicit encounters, and set C only twenty-four incidental exposures (Figure 4).

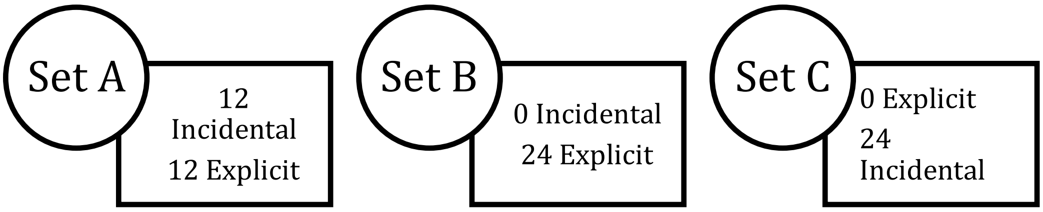

Figure 4 Counterbalanced sets of stimuli

Table 14. *Details of the exposure conditions per pseudoword and learner*

		Incidental	Explicit	Incidental & Explicit
Wofted	Spanish	9	10	8
	English	9	10	9
Grodded	Spanish	8	9	10
	English	9	9	10
Gwapped	Spanish	8	9	10
	English	9	9	10
Hirp	Spanish	8	9	10
	English	9	9	10
Flel	Spanish	8	9	10
	English	9	9	10
Enched	Spanish	8	9	10
	English	9	9	10
Nushed	Spanish	9	10	8
	English	9	10	9

5.3.1.1 Study 2: Research Question 1

Are there any differences between Spanish speaking learners of English and English native speakers on their recognition and recall scores of recently learned pseudowords?

Hypothesis 1: Given that L1 and L2 lexical and reading processes differ (Dijkstra, 2005; Tokowicz, 2015), there is a difference between both types of learners. English learners would show higher recognition and recall scores.

5.3.1.2 Study 2: Research Question 2

Is there an effect of type of exposure on the recognition and recall scores of recently learned pseudowords for Spanish speaking learners of English and English native speakers?

Hypothesis 1: Given that explicit instruction can speed language acquisition (Ellis, 2015), it would elicit higher recognition and recall scores of the recently learned pseudowords.

Hypothesis 2: Given that learning requires incidental and explicit aspects (Sun, Zhang & Mathews, 2009), a combination of incidental and explicit exposures would contribute to higher recognition and recall scores of the recently learned pseudowords than the incidental exposure.

5.3.1.3 Study 2: Research Question 3

Is there an effect from the individual differences of phonological working memory, vocabulary size and verbal fluency on recognition and recall scores of recently learned pseudowords for Spanish speaking learners of English and English native speakers?

Hypothesis 1: Given that PWM aids L1 and L2 vocabulary learning (Baddeley, 2012, 2015), participants with higher PWM will present higher scores on the recognition and recall tests.

Hypothesis 2: Given that verbal fluency taps into semantic memory (Troyer et al., 1997), participants with higher verbal fluency will score higher on the recognition and recall tests of meaning.

Hypothesis 3: Given that existing vocabulary knowledge is linked to word learning (James et al., 2017), higher vocabulary knowledge will result in higher scores on the recognition and recall tests.

5.3.2 Study 2: Participants

The participants were 28 L2 adult Spanish native speakers (female=15, male=13, mean age 30.82, SD=6.57, min=19, max=42) studying at a university in the United Kingdom with a high-advanced level of English as a second language. All participants had taken the IELTS tests and scored at least seven in all abilities, with a mean score of 7.7 (SD=0.47, min=7, max=8.5). In the control group were 28 English native speakers, studying at a university in the United Kingdom (female=20, male=8, mean age 22.46, SD=5.56, min=18, max=45). Participants vocabulary size was measured, the mean score for L2 learners was 7456 (SD=827. 66, min=6090, max=9166) and that of English native speakers was 8594 (SD=1117. 90, min=6024, max=9966).

All participants had normal vision or corrected-to-normal vision and normal hearing.

5.3.3 Study 2: Stimuli

The stimuli for this study consisted of 14 English-like pseudowords acting as verbs, embedded into meaningful English sentences. The pseudowords were created with the ARC Nonword Database (Rastle et al., 2002) and were piloted with ten English native speakers for phonotactic validity. All pseudowords were four letters long and only those that were pronounced near-identically across the native speakers were taken into account for the study. (Appendix 4 shows the target pseudowords chosen for the study and their definitions for the explicit condition).

Given that in reading processes in order to learn semantic representations of new words readers use the context to infer the meaning (Bordag et al., 2015), it is paramount that L2 learners understand and comprehend the context where the target word is embedded. Therefore, the sentences that served as input for the study were highly and extensively piloted. The aim of the piloting was to normalise the sentences for context informativeness to ensure that the context supported the guessing of the meanings of the pseudowords. If L2 learners are able to use contextual cues to obtain the meaning of the words, this may enhance possible emerging semantic representations (Elgort et al., 2018) and thus learning.

Thirty adult Spanish speakers with an advanced English proficiency level who majored either in English or English Teaching, and thirty English monolinguals participated in the piloting phase. First, fifteen different sentences per each pseudoword were created for the piloting, which accounts for approximately three hundred and fifty sentences. Every sentence included one target pseudoword per twenty running words to achieve a text coverage of 95% (Hu & Nation, 2000), and all words in the sentence belonged to the 3000 most frequent words in the English language (Pellicer-Sánchez & Schmitt, 2010; Pellicer-Sánchez, 2015). Some sentences were taken from graded reader texts to ensure that L2 learners had a basic knowledge of the L2 context where the pseudoword was embedded (de Groot & van Hell, 2005). Participants were asked to guess the meaning of the pseudowords in each sentence. A total of five different sentences per target pseudoword were given to each participant. Responses were rated by a Spanish native speaker with a high English proficiency level and by an English monolingual who did not take part in the study.

Appropriate modifications to have meaningful and grammatically accurate English sentences for the pseudowords were needed. For instance, sentences in which the meaning of the word guessed fit the context but varied across L1 and L2 participants were either modified and piloted again, or not selected for this study. To illustrate, a pseudoword was guessed to mean stay, play, and walk, all meanings that fit the context; however, they were very diverse and hence the sentence was not used in the study. The piloting phase also revealed that in some sentences different meanings for the target items would be correct. For example, the pseudoword grod was guessed as wash and clean and both meanings fit the contexts. Therefore, they were taken as correct. After extensive piloting, twelve sentences per pseudoword with very similar or identical guesses by both L1 and L2 speakers were selected for the study.

5.3.3.1 Study 2: Offline Vocabulary Tests

The offline vocabulary tests (Appendix 5) were modelled on Webb (2008). The test of meaning recognition examined whether participants were able to recognise the correct meaning of the target words in a multiple-choice exercise. They had to choose between five options: one containing the correct meaning of the target, three distracters, and an “I don’t know” option to avoid guessing.

The test of meaning recall aimed to find whether participants were able to translate the target items into their L1. It was a backward translation test (L2-L1) via word association (Kroll & Stewart, 1994) that access direct links between the L2 and L1 items in the mental lexicon (Harley, 2014). One of the advantages of using a backward translation test is that it accesses and retrieves semantic information since it is semantically mediated (Harley, 2014).

A list containing the 14 target pseudowords and the seven fillers acting as nouns was given to participants. If they wrote the correct translation of the target item the answer was given a 1, otherwise it was given a 0. Participants were instructed to leave the item blank if they could not write a correct translation to avoid guessing (Pellicer-Sánchez & Schmitt, 2010).

5.3.3.2 Study 2: Individual Differences' Tests

5.3.3.2.1 Verbal Fluency Task

A task modelled on Mayer and Huettig's (2015) work with the category of animals[37] was used. It was carried out in the participant's first language to access their semantic storage and thus measure their verbal ability. Participants were asked to recall as many words as possible that belonged to the semantic category of animals in 60 seconds (Troyer et al., 1997). Answers were recorded with a voice recorder and analysed in line with Shao et al. (2014) and Luo et al. (2010). The total of words generated excluded errors, words that did not belong to the semantic category, and repetitions. The accuracy of the responses from L1 learners was rated by a British English Native Speaker studying a postgraduate program at a University in the United Kingdom who did not take part in this study. The accuracy of the responses from the Spanish speaking learners of English was rated by a Spanish native speaker studying on a postgraduate program at a University in the United Kingdom and by a Spanish native speaker who majored in psychology and who did not take part in the study[38]. Table 15 displays the descriptive statistics of L1 and L2 results.

Table 15. *L1 and L2 Descriptive Statistics of Verbal Fluency Results*

	Mean	St. Deviation	Minimum	Maximum
English Learners	27.39	8.31	6.00	49.00
Spanish Learners of English	24.68	5.69	16.00	38.00

37 Mayer and Huettig, 2015 took into account two different semantic categories in their test; however, the present study only employed one. For future studies more than one category should be used.
38 Rating agreement was reached by the two Spanish speaking raters in all the ID tests.

5.3.3.3 Phonological Working Memory (PWM)

A Spanish nonword repetition test (NWR) (Speciale et al., 2004) was used for both L1 and L2 learners (Appendix 6). NWR is one of the most effective tests to measure PWM since its performance relies on the capacity to perceive, store, recall and reproduce phonological sequences (Juffs & Harrinton, 2011), and it can give a "purer assessment of phonological storage quality" (Gathercole 2006, p. 520).

The test was read by a Spanish native speaker without lexical stress or pitch. Participants were asked to carefully listen to each word and to repeat them as accurately as possible. Participants' answers were recorded with a voice recorder. Repetition accuracy was rated as correct if all syllables of the nonword were correctly repeated; hence, the scores of this test varied between 1 and 32 (Speciale et al., 2004). A Spanish native speaker, studying a postgraduate program at a University in the United Kingdom, and a Spanish monolingual who majored in psychology and who did not take part in the study rated the accuracy of the repetition task. Given that Spanish native speakers are more acquainted with Spanish nonwords than English learners, no comparison between L1 and L2 scores was made. The following table illustrates the descriptive statistics of L1 and L2 results.

Table 16. *L1 and L2 Descriptive Statistics of PWM Results*

	Mean	St. Deviation	Minimum	Maximum
English Learners	18.18	4.76	7.00	28.00
Spanish Learners of English	27.46	2.41	22	31

5.3.3.4 Vocabulary Size

An online vocabulary size test (Meara, 2015) was used. This test is part of the *lognostics* project that provides tools for research in vocabulary teaching and learning. The scores given at the end of each test were recorded to account for vocabulary size. The following table summarises the descriptive statistics of L1 and L2 results.

Table 17. *L1 and L2 Descriptive Statistics of Vocabulary Size Results*

	Mean	St. Deviation	Minimum	Maximum
English Learners	8587.33	1088.26	6024	9966
Spanish Learners of English	7455.89	813.44	6090	9166

5.3.4 Study 2: Procedures

Participants were seen individually in a quiet and silent room. First, they took the battery of individual differences tests in the following order: nonword repetition task, verbal fluency task, and the vocabulary size test. Then, they were presented with the written stimuli (learning phase) on a computer screen. The display screen lasted for five seconds followed by a fixation cross which lasted 1500ms. Participants had to press the space bar on the keyboard to see the next screen with the input. Comprehension questions followed after every eighth trial in order to maintain participants' attention. Each question was related to the last sentence read. It did not refer to the meaning of the pseudoword, and did not include it.

Overall, participants read twenty-four English meaningful sentences per target word, where all the sentences were semantically and grammatically correct and they had three different types of exposure as previously mentioned in the methodology section of this chapter (section 5.3.1). In the incidental condition participants were instructed to read the sentences and they were not aware of the use of pseudowords as targets. In the explicit only condition participants were instructed to read the sentences and to read the novel words' definitions with no time constraints. Given that learners were explicitly instructed to read the novel items' meanings, that the knowledge was represented declaratively (Roehr-Brackin, 2015), and that explicit knowledge can be obtained through controlled processing when the person is not under any time pressure (Ellis, 2004, 2005, as cited in Roehr-Brackin, 2015), this is considered an explicit learning condition for the purposes of this study.

Immediately after participants read the input, they took surprise recognition and recall tests. The recall test was administered before the recognition test.

5.3.5 Study 2: Results

First, the mean scores of the vocabulary post-tests are briefly discussed in order to establish whether or not participants obtained lexical configuration knowledge of the recently learned pseudowords. Then, recognition and recall scores will be separately analysed to determine the possible effects of language background and type of exposure, and the section finishes with the IDs results. Table 18 presents the descriptive statistics of L1= English Learners and L2= Spanish Learners of English vocabulary post-tests.

Table 18. Descriptive *Statistics of L1 and L2 Vocabulary Post-tests*

	Mean	St. Deviation	Minimum	Maximum
L1 Recognition	0.74	0.44	0.00	1.00
L1 Recall	0.41	0.49	0.00	1.00
L2 Recognition	0.64	0.48	0.00	1.00
L2 Recall	0.31	0.46	0.00	1.00

Data from Table 18 illustrates that both L1 and L2 learners obtained vocabulary learning gains. However, L1 learners scored higher on both recognition and recall post-tests.

5.3.5.1 Study 2: Data Analysis

Recognition and recall scores were analysed separately by a series of generalized linear models, using the "glm" package (Davies, 1992) in the R environment (R Studio Development Core Team, 2015). Scores were annotated as the outcome variable, and first language (L1), exposure, and IDs as predictors. To illustrate how the analyses were run, the codes used for each research question are presented below in each data analysis section.

5.3.5.1.1 Study 2: Data Analysis Research Question 1

For RQ1 the general linear model had scores as the outcome variable and first language as predictor. The L1 predictor had two levels: English and Spanish. It was predicted that English learners would outperform Spanish learners in both recognition and recall tasks.

The analysis of the recognition scores[39] showed a significant main effect of first language (β = -0.5933, SE= 0.1556, t= -3.812, p<0.05). It is mainly because English learners (M=0.74) scored higher than Spanish speaking learners (M=0.64) on the recognition tests. The analysis of the recall scores[40] also revealed a significant main effect of first language (β = -0.3110, SE= 0.1361, t= -2.286, p<0.05) because English learners (M=0.41) scored higher than Spanish speaking learners (M= 0.31) on the recall tests.

These results show that L1 learners outperformed L2 learners in both recognition and recall tests. Given that English learners have had more qualitative and quantitative input of the English language (Kaan, 2014) than L2 learners, they may have had a lexical advantage understanding the general context where the pseudowords were embedded. Nevertheless, both types of learners had the same qualitative and quantitative input of the pseudowords; hence, English learners outperforming Spanish speaking learners is not caused by previous knowledge of the pseudowords, but probably by differences in their lexical processing (Segalowitz, 2014; Tokowics, 2015; Dronjic & Bitan, 2016). For instance, the competing information in the monolingual mental lexicon is not as great as that of the bilingual mental lexicon, and this can hinder L2 lexical processing and learning.

5.3.5.1.2 Study 2: Data Analysis Research Question 2

For RQ2 the general linear model had scores as the outcome variable, and the exposure condition and L1 as predictors. The exposure predictor had three levels: incidental only, explicit only, and incidental and explicit.

It was predicted that the explicit condition would generate higher scores on both recognition and recall processes for both types of learners.

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[39] glm (formula = SCORE ~ L1, family = binomial(logit), data = RecogR)
[40] glm (formula = SCORE ~ L1, family = binomial(logit), data = RecallR)

5.3.5.2 Data Analysis RQ2: L2 Learners

The analysis[41] revealed a significant main effect of condition (β = -0.4947, SE= 0.1458, t= -3.392, p<0). It is caused by the fact that the explicit condition generated higher scores (M=0.79) than the incidental and explicit (M=0.68), and the incidental (M=0.49). These results suggest that recognition of the meaning of recently learned pseudowords is higher when they were explicitly learned. Directing learners' attention to the meaning of novel items elicited higher scores than incidental learning. This in turn suggests that L2 incidental learning of novel items occurs, but to a lesser degree than explicit learning.

The analysis of the recall scores[42] revealed a significant main effect of the incidental only condition (β = -0.23471, SE= 0.1369, t= -1.714, p<0.1). This effect was caused because the incidental only condition elicited lower recall scores (M=0.20) than the incidental and explicit (M=0.27), and the explicit only (M=0.47). These differences demonstrate that every exposure condition elicited learning gains; however, the explicit instruction speeded the acquisition of the meaning of the recently learned pseudowords (Ellis, 2015).

5.3.5.3 Data Analysis RQ2: L1 Learners

The analysis of the scores on recall[43] revealed a significant main effect of condition (β = -0.3519, SE= 0.1327, t= -2.652, p< 0.01). This effect was elicited by the fact that the explicit condition generated higher scores (M=0.51) than the incidental and explicit (M=0.33), and the incidental (M=0.26). Similarly to L2 learners, English learners scored higher when the novel items were explicitly learned.

The analysis of recognition scores[44] revealed a significant main effect of the incidental only condition (β = -0.8895, SE= 0.2913, t= -3.054, p< 0.001). This is caused because the incidental condition generated lower scores (M=0.65) than the incidental and explicit (M=0.80), and the explicit (M=0.82). Clearly, L1 learners benefited more from explicit instruction than from incidental learning.

5.3.5.3.1 Study 2: Data Analysis Research Question 3

For RQ3 the general linear model had scores as random factors and the individual differences as predictors.

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[41] glm (formula = SCORE ~ CONDITION, family = binomial(logit), data = L2RecogRMother).
[42] glm(formula = SCORE ~ CONDITION, family = binomial(logit), data = L2RecallRMother).
[43] glm(formula = SCORE ~ CONDITION, family = binomial(logit), data = L1RecallRMother)
[44] glm(formula = SCORE~ CONDITION, family = binomial(logit), data = L1RecogRMother).

5.3.5.3.1.1 Data Analysis RQ3: L2 Learners

It was expected that effects of each ID in both recognition and recall scores would be found.

The analysis of recognition scores[45] showed a significant main effect of vocabulary size (β = -6.456e-03, SE= 1.798e-03, t= -3.592, p<0.05) and PWM (β = -1.917e+00, SE= 4.892e-01, t= -3.919, p<0.05). In order to interpret these results participants were divided into low and high groups according to a median split on their scores on the vocabulary (*Mdn*=7358) and PWM tests (*Mdn*=28). It was found out that the high vocabulary knowledge group outperformed the low group in their recognition scores (M=0.73 vs M=0.54). Surprisingly, the contrary was found for the high PWM group (M=0.61) who scored lower than the low group (M=0.72). These results state that higher vocabulary knowledge contributed to obtaining higher recognition scores, and that PWM did not help them to achieve higher scores.

The analysis of the recall scores[46] showed significant main effects of every ID: PWM (β = 8.025e+00, SE= 3.675e+00, t= 2.184, p<0.01), verbal fluency (β = 1.061e+01, SE= 4.265e+00, t= 2.488, p<0.01) and vocabulary size (β =2.748e-02, SE= 1.276e-02, t= 2.153, p<0.05). Once again participants were divided into high and low groups based on their median splits: PWM (*Mdn*=28), verbal fluency (*Mdn*=25), and vocabulary size (*Mdn*=7358). It was found that the high vocabulary group outperformed the low group (M=0.35 vs M=0.26); however, the contrary occurred for PWM and verbal fluency as the low groups outscored the high groups (M=0.30 vs M=0.34 and M=0.28 vs M=0.35, respectively).

These results indicate that greater vocabulary knowledge contributed to higher recall scores; nevertheless, this is not the case for verbal fluency and PWM. Contrary to expectations, this study did not find that participants with higher PWM scored higher in their receptive knowledge of recently learned pseudowords. This can be attributed to the fact, amongst others, that the phonological loop processes and stores speed-based information (Eysenck & Keane, 2015) and, in this study, participants only encountered written input.

[45] glm (formula = SCORE ~ PWM*VocabSize*VerbalF, family = binomial(logit), data = L2RecogRMother)

[46] glm (formula = SCORE ~ PWM*VocabSize*VerbalF, family = binomial(logit), data = L2RecallRMother)

5.3.5.3.1.2 Data Analysis RQ3: L1 Learners

It was expected that effects of each ID in both recognition and recall scores would be found.

The analysis of the recognition scores[47] showed significant main effects of verbal fluency (β = -0.124648, SE= 0.060786, t= -2.051, p<0.01) and vocabulary size (β = 0.0005906, SE= 0.0001060, t=5.573, p<0.01). After dividing participants into high and low groups according to their median splits of verbal fluency (*Mdn*=29) and vocabulary size (*Mdn*=8912) it was found that the high verbal fluency group slightly outperformed the low group in their scores (M=0.75 vs M=0.74), and that the high vocabulary knowledge group outscored the low group (M=0.88 vs. M=0.61).

These results show that English learners require more lexical knowledge and verbal fluency to obtain more vocabulary learning gains. L1 learners seem to rely on their lexical knowledge to recognise the meaning of the recently learned pseudowords. Recognition processes involve the activation of semantic, phonological, and orthographic knowledge of the word (Rastle, 2007), through a series of nodes that interact with each other. Hence, having more knowledge of lexical items can potentially contribute to the activation of the different aspects of the word and its correct recognition.

The analysis of the recall scores[48] showed significant main effects of every ID: PWM (β = -0.182143, SE=0.083246, t= -2.188, p<0.05), verbal fluency (β = -0.106491, SE= 0.048319, t= -2.204, p<0.05), and vocabulary size (β = 0.0003370, SE= 0.0001036, t= 3.253, p<0.01). After dividing participants into high and low groups according to their median splits of PWM (*Mdn*=23), verbal fluency (*Mdn*=26), and vocabulary size (*Mdn*=7986) it was found that the high PWM group scored lower than the low group (M=0.33 vs. M=0.36), that the high verbal fluency group outperformed the low group (M=0.39 vs. M=0.33), and that the high vocabulary group scored higher than the low group (M=0.43 vs. M=0.29).

These results indicate that L1 learners with more verbal fluency capacity and vocabulary knowledge obtained more vocabulary learning gains. It is surprising that higher PWM capacity did not aid higher recall scores. A possible explanation for this result may be the lack of auditory stimuli in the study given that the phonological loop

[47] glm (formula = SCORE ~ PWM*VocabSize*VerbalF, family = binomial(logit), data = L1RecogRMother)

[48] glm (formula = SCORE ~ PWM*VocabSize*VerbalF, family = binomial(logit), data = L1RecallRMother)

processes and stores speed-based information (Eysenck & Keane, 2015). Thus, it is probable that participants' phonological store and processing did not contribute to higher recall scores as they only encountered written stimuli. Nevertheless, the possible interference of participants' proficiency level and the sentences' context cannot be ruled out.

5.4 Chapter Summary and Conclusion

The purpose of this chapter was to report the results of two studies carried out to investigate L2 incidental lexical configuration knowledge, through recognition and recall vocabulary post-tests, of recently learned pseudowords. They also aimed to find the extent of incidental learning and whether individual differences have an effect on lexical configuration knowledge of recently learned pseudowords.

Study 1 demonstrated that L2 adult Spanish speaking learners of English acquired lexical configuration knowledge of meaning, form, and use of recently learned pseudowords in authentic texts. However, their recognition is higher than their recall and they present more learning gains in knowledge of meaning. This study also highlighted that PWM plays a role in L2 incidental vocabulary learning

Study 2 highlighted that L2 adult Spanish speaking learners of English and English learners are able to acquire lexical configuration knowledge of meaning from sentence reading; nevertheless, English learners outperformed Spanish speaking learners. This study also showed that L1 and L2 incidental learning is not as effective as explicit learning or as the combination of incidental and explicit exposures. In terms of the effects of the IDs, it was demonstrated that L1 and L2 meaning recognition and recall are mediated by vocabulary knowledge. Verbal fluency capacity was only significant for L1 recognition and recall, whereas PWM did not show any significant effects for the learners in this study.

Taking together the results of these studies, it is concluded that:

a) L2 incidental vocabulary learning from reading authentic texts aids lexical configuration knowledge of the form, meaning, and use of novel items.

b) PWM has an effect on L2 incidental learning of the grammatical use of novel words.

c) Incidental learning achieves L1 and L2 lexical configuration knowledge of the meaning of recently learned pseudowords, but to a lesser degree than explicit learning or a combination of incidental and explicit exposures.

d) L2 incidental learning of the meaning of recently learned pseudowords is mediated by vocabulary size.

e) L1 incidental learning of the meaning of recently learned pseudowords is mediated by vocabulary size and verbal fluency.

The next chapter describes a study designed to account for L2 lexical engagement of the form of recently learned pseudowords.

CHAPTER 6 L2 LEXICAL ENGAGEMENT OF SPOKEN FORM

6.1 Study 3: Introduction

This chapter presents the results of a study carried out to account for lexical engagement of spoken form through prediction of upcoming linguistic material in an online visual task. It aimed to find whether the spoken form of recently learned pseudowords lexically engages with other lexical levels (e.g. the meaning of the recently learned pseudowords) and lexical items (e.g. the upcoming linguistic material and other words in the auditory input). It also tested the extent of incidental learning through its comparison with other types of exposure (explicit only, and incidental and explicit combined) and whether or not the individual differences of phonological working memory, verbal fluency, and vocabulary have an effect on anticipatory eye-movements.

A visual-world eye-tracking study containing sentences such as *The boy will gwap the simple sandwich* and *The boy will carry the simple sandwich* was designed to account for anticipatory eye-movements towards the target object. If learners were able to predict upcoming linguistic material based on the spoken form and semantic information of recently learned pseudowords, lexical engagement would have taken place.

6.2 Study 3: Methodology

The methodology of the study is similar to that adopted by Altmann and Kamide (1999). A visual-world eye-tracking study determined through participants' anticipatory eye movements if they were able to predict upcoming linguistic material before listening to the target auditory input. Each visual scene was paired with a sentence containing a pseudoword and a sentence containing a real word such as (1) and (2) below:

(1) The boy will gwap [eat] the simple sandwich.

(2) The boy will carry the simple sandwich.

Each visual scene was comprised of three visual objects (Schumacher et al., 2017): the target (e.g. the sandwich), a distractor (e.g. drums), and an agent (e.g. the boy), as in Figure 5. For the visual scenes containing pseudowords, their linguistic characteristics made it so only one visual object could possibly be referred to post-verbally (e.g. sandwich). For the other scenes, the verb's characteristics allowed two visual objects, including the target, to be referred to post-verbally (e.g. sandwich and drums). Eye-movements will reveal, through anticipatory looks towards the target, the learners' phonological and semantic processing of the recently learned pseudowords. Their ability to predict upcoming linguistic material, based on the phonological and semantic characteristics of the recently learned pseudowords, will show lexical engagement with other lexical levels and items.

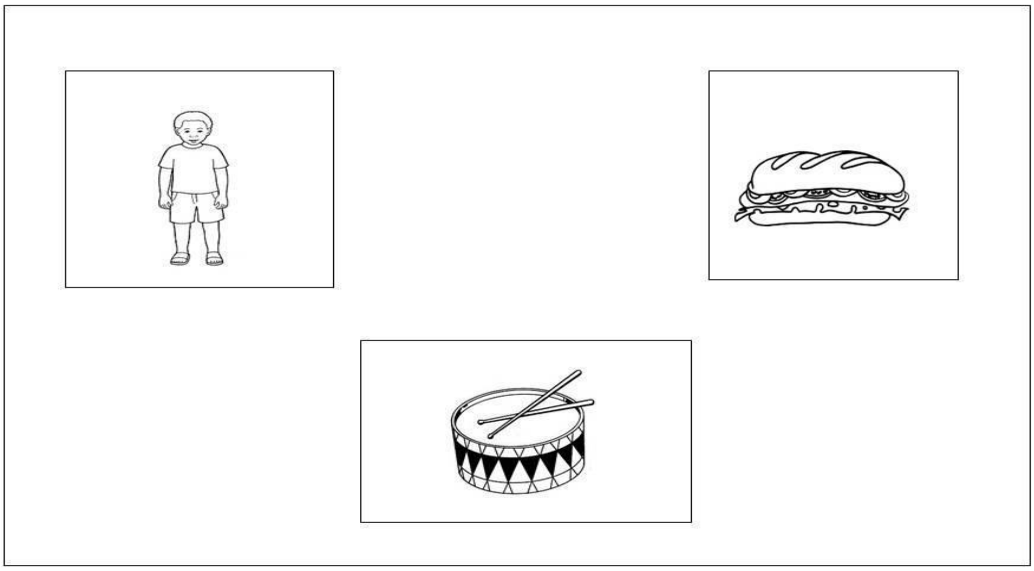

Figure 5 Visual Display for Experimental Items (1) and (2).

6.2.1 Study 3: Research Question 1

Are Spanish speaking learners of English and English native speakers able to predict upcoming linguistic material, measured through anticipatory looks towards a target, using the phonological and semantic information of recently learned pseudowords? If so, is there a difference between Spanish speaking learners of English and English native speakers in their anticipatory looks towards the target?

Hypothesis 1: Given that adult learners are able to predict upcoming linguistic material based on information extracted at verbs (Altmann & Kamide, 1999), both types of learners will produce anticipatory eye-movements in the word and pseudoword conditions.

Hypothesis 2: Given that only one object can be referred to post-verbally in the pseudoword condition (Altmann & Kamide, 1999; Dijkgraaf et al., 2017), both types of learners will generate more fixations towards the target object in the pseudoword condition than in the word condition.

Hypothesis 3: Given that English learners have had more qualitative and quantitative input of the English language than L2 learners (Kaan, 2014), their fixation proportions towards the target object in the word condition will be higher than those of L2 learners.

6.2.2 Study 3: Research Question 2

Is there an effect of type of exposure in the anticipatory looks towards the target, based on the phonological and semantic information of recently learned pseudowords, for Spanish speaking learners of English and English native speakers?

Hypothesis 1: There is an effect of exposure in the fixation proportions towards the target for both types of learners. Given that explicit instruction can speed language acquisition (Ellis, 2015), the explicit condition would elicit more anticipatory looks towards the target than the other types of exposure.

Hypothesis 2: Given that learning requires incidental and explicit aspects (Sun et al., 2009) a combination of incidental and explicit exposures contributes to more anticipatory looks towards the target than the incidental only condition.

6.2.3 Study 3: Research Question 3

Is there an effect of the individual differences of phonological working memory (PWM), verbal fluency, and vocabulary size in the anticipatory looks towards the target, based on the phonological and semantic information of recently learned pseudowords, for Spanish speaking learners of English and English native speakers?

Hypothesis 1: Given that the phonological loop draws attention to information that comes from speech (Eysenck & Keane, 2015), PWM has an effect on the fixation proportions towards the target. Higher PWM capacity generates more anticipatory looks towards the target object.

Hypothesis 2: Given that verbal fluency taps into semantic memory (Troyer et al., 1997), it has an effect on the fixation proportions towards the target. Higher verbal fluency capacity generates more anticipatory looks towards the target.

Hypothesis 3: Given that vocabulary size is a predictor of anticipatory looks towards a target (Borovsky et al., 2012), it has an effect on the fixation proportions towards the target. Greater vocabulary knowledge will produce more anticipatory looks towards the target object.

6.2.4 Study 3: Participants

Twenty-six L2 Spanish native speakers (female=14, male=12, mean age 30.52, SD=6.27, min=19, max=42) studying at a university in the United Kingdom with a high-advanced level of English as a second language took part in this study. All participants had taken the IELTS tests and scored at least seven on all abilities with a mean score of 7.73 (SD=0.47, min=7, max=8.5). Twenty-seven English native speakers, studying at a university in the United Kingdom, (female=19, male=8, mean age 22.36, SD=5.64, min=18, max=45) took part as a control group. The descriptive statistics of their individual differences results are displayed in Table 19.

Table 19. *Descriptive Statistics of Participants' Individual Differences*

	L1		L2	
	Mean	SD	Mean	SD
Vocabulary Size	8693	1125	7460	803
PWM	18.03	4.97	27.60	2.38
Verbal Fluency	27.98	7.60	24.93	5.93

All participants had normal vision or corrected-to-normal vision and normal hearing.

6.2.5 Study 3: Stimuli and Tests of Individual Differences

The stimulus for this study consisted of the 14 pseudowords used in the second study in Chapter 5 of this thesis. The pseudowords comprised three different types of exposure: incidental only, explicit only, and incidental and explicit combined. Hence, the fourteen pseudowords had three types of exposures across participants without compromising their reading process in every condition, as described in Chapter 5. Participants encountered each target item twenty-four times in the learning phase in accordance with Leach and Samuel (2007) who saw evidence of lexical engagement after twenty-four repetitions with target novel words.

Twenty-one sets of stimuli modelled on Altmann and Kamide (1999) were created with the 14 pseudowords acting as verbs and matched with 14 real words in sentences like 1 and 2 above. The subject of the sentence was kept constant across both trials (Altmann & Kamide, 1999; Dijkgraaf et al., 2017), and an adjectival phrase such as *the simple* was included in order to give participants time to saccade, after listening to the verb, to the target visual items. Every adjectival phrase consisted of the determiner "the" and a two-syllable adjective (e.g. simple). Each pair of sentences was arranged in blocks that were randomized to avoid having the same targets displayed right after each other.

Each visual scene consisted of three images. One of them functioned as the target, while the other two corresponded to the distractor and the agent (Figure 11). The position of the distractor was 394x554, the agent's location was 675x122, and the target's position was 133x122. The agent and target's positions were randomized in each trail to avoid a possible learning effect of the target's position. The visual scenes were created using commercially available images. All images where black and white and had a size of 236x187 pixels, 7.7°x4.6° degrees of visual angle and 10.8cm x 6.5 cm. They were presented on a 17" monitor screen.

All the experimental visual scenes and the accompanying sentences were piloted with high proficient adult L2 learners of English (n=5) with a mean age of 30.8 (SD=3.347, min=26, max=34) and adult L1 English monolinguals (n=5)[49] as a control with a mean age of 31.8 (SD=4.919, min=24, max=36). The piloting aim was to find whether or not the materials were suitable for the study and if they were displayed correctly. Given that all participants indicated that they understood the visual images and the audio materials, there were no changes made to the experimental items.

6.2.6 Stimuli Recordings

Given that bilinguals may respond faster to stimuli without L2 accent (Lagrou, Hartsuiker & Duyck, 2012), it was decided that the recordings should be done by an English native speaker. Therefore, a male native speaker of British English who majored in philosophy recorded the sentences in a quiet room. Each sentence was

[49] Higher number of participants, for the experimental piloting, would have enriched this work.

recorded three times and the instance with the least prosody was used for the study (Dijkgraaf et al., 2017)[50]. Sound files lasted either 3000ms or 4000ms.

6.2.7 Study 3: Procedures

This study was completed along two consecutive days. The procedures of day 1 are the same as those of the second study described in Chapter 5 of this thesis.

On day 2 participants were seen individually in a quiet and silent room where they took the visual eye-tracking task, which lasted approximately 12 minutes. Each participant was seated in front of a 17" display with their chins and forehead supported on an Eye Link 1000 plus desktop mount, with their eyes 20cm away from the display screen, and the eye-tracker camera was positioned 40 to 70 cm away from the participants' eyes. The session started with calibration and validation procedures. Then, participants were instructed to listen carefully to the upcoming sentences and to look at the visual scenes while listening to the sentences. They were not aware that there was a target image to look at. There were two experimental trials before the main experimental set. A drift correct, in the form of a black centrally located circle, appeared between each trial, and participants were asked to look at it and press the space bar on the keyboard while doing so. The drift correct was shown in order to allow re-calibration of the eye-tracker before each trial and to direct the participant's gaze to avoid looks towards the target prior to the onset of the target stimuli (Barr, Gann & Pierce, 2011). The experimental screens were shown for 500ms before the sound file to allow participants to become familiarized with the visual display. All the trials were randomized.

The fact that the study was carried out over two consecutive days provided an overnight sleep consolidation process for both types of learners. Recent studies in language learning have mentioned that sleep consolidation is necessary for word learning (Mirković & Gaskell, 2016; James et al., 2017); hence, an overnight sleep can potentially benefit the word learning process for the participants in this study[51].

6.3 Study 3: Results

First an explanation of how data was treated and an overview of fixation proportions towards the target are presented. Then, the results of word type and first language are

[50] For a complete "neutral" audio, the recordings could have been digitalized; however, it was believed that it was not needed given that the audios comprised very neutral prosody.

[51] This study does not focus on sleep consolidation processes and word learning; therefore, this will not be further discussed.

examined, followed by the results of exposure, and then the section ends with the analysis of the individual differences.

6.3.1 Data Treatment

The starting point of analysis and the choice of time windows was stimulus driven (Rommers et al., 2015) and determined by the facts that sentences had different time durations and that it takes approximately 200ms to compute and make a saccade (Matin, Shao & Boff, 1993). The time frame for analysis started 200ms after the verb's onset (0ms) until the noun's onset (averaged across every target trial). In addition, in order to account for the effects of each condition (word and pseudoword), the first four hundred milliseconds prior to the verb's onset up to its onset were analysed (Rommers et al., 2015; Dijkgraaf et al., 2017) and aggregated into 200ms time bins.

The proportion of fixations towards the target and the competitor were analysed, blinks and out of screen samples (Schumacher, Roberts & Järvikivi, 2017; Dijkgraaf et al., 2017) were taken into account for the fixation count, and transformed using Barr's (2008) empirical logit formula. The log odds of looks of the competitor were subtracted from the log odds of the target per item, subject, and time window to generate the dependent variable (Rommers et al., 2015; Schumacher et al., 2017). A series of linear mixed-effects models, using the "lmertest" package (Kuznetsova, Brockhoff & Christensen, 2017) in the R environment (R Studio Development Core Team, 2015) were run for all of the analysis. The outcome variable was the difference between the subtracted log odds mentioned above with the factors: language: L1 and L2; type of word: word and pseudoword; exposure: incidental, explicit, incidental and explicit; and individual differences: phonological working memory, verbal fluency, and vocabulary size.

6.3.2 Overview of Fixation Proportions

Figures 12 and 13 show the time course probability of fixating the target, based on the log odds' subtracted difference, per type of learner and condition.

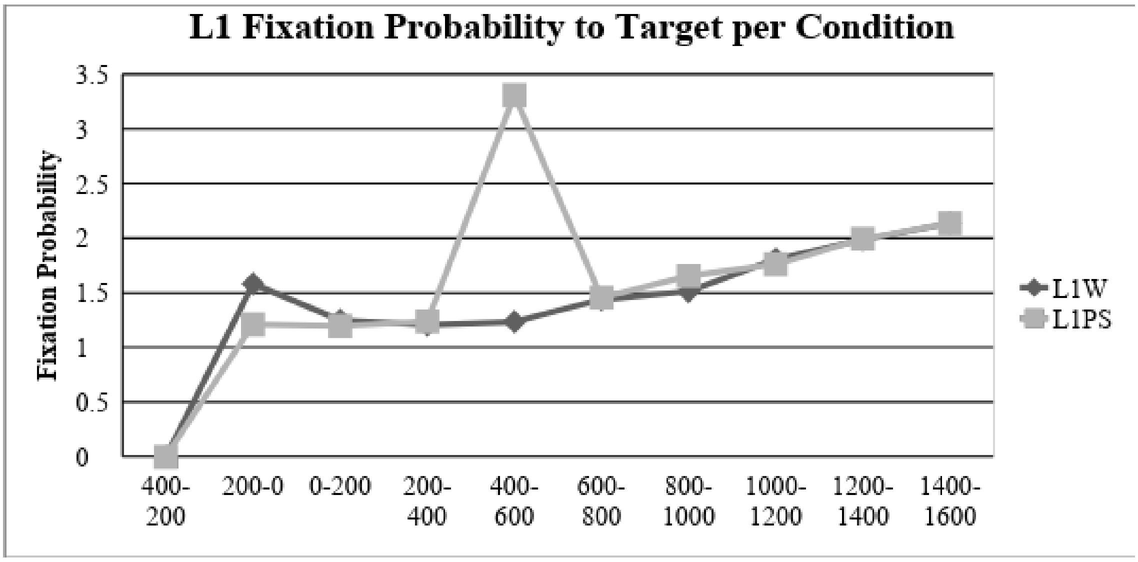

Figure 6 Time Course of L1 Fixation Probability to target by type of condition (word and nonword).

Figure 6 illustrates that L1 fixation proportions in the word and pseudoword condition diverged prior to the verbs' onset and particularly between the 200ms bin up to 800ms where fixation proportions were higher in the pseudoword condition, and that L1 learners' fixation proportions did not diverge by type of condition towards the end of the sentences. What stands out in this figure is the general pattern of anticipatory looks towards the target in each condition, which indicates that learners engaged the spoken form of the recently learned pseudowords with their semantic properties and made linguistic predictions based on that information. There were higher fixation proportions towards the target (M=-1.78[52]) than to other referents in the sentences (M=-3.49) between verb's onset up to noun onset. This in turn suggests that they predicted upcoming linguistic material based on the phonological and semantic properties extracted from the verbs.

Figure 7 shows that L2 fixation proportions in the word and pseudoword condition did not diverge before the verbs' onset, and only slightly at towards the end of the sentences. Thus, L2 fixation proportions towards the target might not be mediated by type of word as L2 learners similarly fixated on the target object in the word and the pseudoword condition.

[52] Fixation proportions are in negative numbers given that they are log odds that have been transformed using Barr's (2008) empirical logit formula.

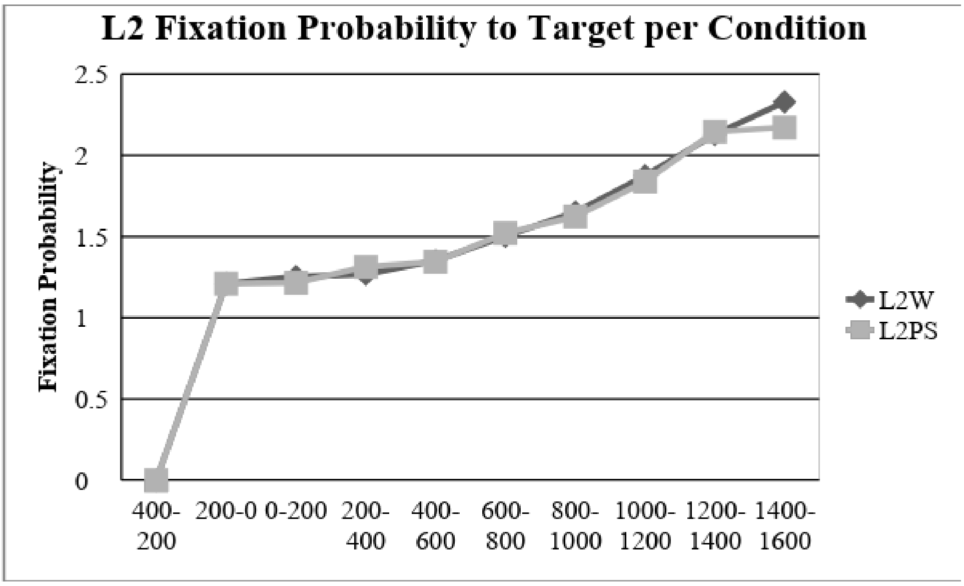

Figure 7 Time Course of L2 Fixation Probability to target by type of condition (word and nonword)

What can be clearly seen in this figure is that L2 learners made anticipatory looks using the phonological and semantic information of the recently learned pseudowords to a similar extent to pre-existing English words. Therefore, L2 learners' knowledge of the novel items is robust enough to process and engage their meaning and form with pre-existing L2 lexical items and to show similar behaviour, in anticipatory looks, to that of English words. This initial observation suggests that there may be a link between the memory traces left by a high number of repetitions (recall that participants had 24 encounters of each pseudoword in the learning phase) and lexical engagement of the spoken form of the words with their semantic characteristics. In addition, there were greater fixation proportions towards the target (M= -1.74) than to other referents (M=-3.49) and this implies that L2 learners processed and engaged their linguistic knowledge of the novel items with that of other L2 lexical items to predict upcoming linguistic material.

The data reported here support the hypothesis that both types of learners predicted upcoming linguistic material based on the semantic information and the spoken form extracted from the recently learned pseudowords.

6.3.3 Study 3: Analysis Research Question 1[53]

For research question 1, the linear mixed-effects model had subjects as random factors and first language (L1) and word type as predictors. The L1 predictor had two levels: L1 and L2, and the same for word type: word and nonword (Table 20 summarises the

[53] Further discussion of the results can be found in Chapter 9

results)[54]. All the codes used for the analysis of each time window along with their regression tables can be seen in Appendix 7. Given that in the time bin from -400ms to -200ms there were no looks towards the target object, this was not included in the analysis.

Table 20. *Time Course Analysis from 200ms before the verb's onset for the fixed factors Language (L1/L2) and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Language		Word Type		Interaction	
		β	t	β	t	β	t
1	-200 to -0	1.708e-02	1.893	1.021e-02	1.051	-2.737e-02	-2.143*
2	0 to 200	5.639e-03	0.794	-1.489e-02	-2.320*	-2.057e-03	-0.227
3	200 to 400	5.734e-03	0.743	-1.213e-02	-1.461**	6.978e-03	0.640
4	400 to 600	7.234e-03	0.526	-1.584e-02	-1.290	1.090e-02	0.638
5	600 to 800	8.531e-03	0.555	-3.672e-03	-0.299	7.782e-03	0.449
6	800 to 1000	-6.047e-03	-0.370	-6.390e-03	-0.459	2.660e-02	1.355
7	1000 to 1200	3.313e-02	1.479**	1.399e-02	0.733	-6.686e-03	-0.248
8	1200 to 1400	9.386e-03	0.399	-1.056e-02	-0.537	2.053e-02	0.746
9	1400 to 1600	-0.01546	-1.204	0.00543	0.482	1.167e-02	0.618

*p<.0.05 ** p<.0.1

The data analysis showed a significant interaction of language and word type in the 200ms bin prior to verb onset. L2 learners made more fixations to the target object in the pseudoword condition (M=-2.92) than L1 learners (M=-2.94), but the contrary effect was found in the word condition where L1 learners' fixation proportions were larger (M=-2.93) than those of L2 learners (M= -2.94). Given that L1 learners have had more quantitative and qualitative input of English words than L2 learners (Kaan, 2014), this could have caused more fixation probabilities in the word condition. Nevertheless, there

[54] lmerTest::lmer(DV~WordType*Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_200_0)

is an effect of condition prior to verb's onset suggesting that learners' fixation proportions could be mediated by type of word (word vs. pseudoword).

An effect of word type from 0ms to 200ms was found[55]. This was due to the fact that there were more fixation proportions towards the target in the pseudoword (M=-3.46) condition than in the word (M=-3.48) condition, but this effect did not interact with type of learner. There is an anticipatory preference to look at the target in the pseudoword condition, which confirms that learners made anticipatory looks based on the semantic information and the spoken form of the recently learned pseudowords. This corroborates the hypothesis that learners would make more anticipatory looks towards the pseudowords because only one object could be referred to post-verbally in this condition. In addition, it rejects the hypothesis that L1 learners would make more anticipatory looks in the word condition, as there was no interaction with type of learner.

6.3.4 Study 3: Analysis Research Question 2

For research question 2, subjects were specified as random factors and with the predictors of word type and exposure. Word type had two levels: pseudowords and words; and the exposure predictor had three levels: incidental only explicit only, and incidental and explicit combined. The codes used for the analysis of each time window along with their regression tables can be seen in Appendix 7.Given that in the time bin from -400ms to -200ms there were no looks towards the target object, this was not included in the analysis.

In order to deeply analyse the effects of prediction and exposure in each type of learner, L2 learners were analysed separately from the native English learners. L2 learner results will be discussed first.

1.5.1.1 Study 3 Analysis RQ2: L2 Learners

Results[56] highlighted an effect of exposure 200ms prior to verb's onset (Table 21 summ aries the results). L2 learners' fixation proportions towards the target were higher in the incidental condition (M=-2.91) than in the explicit (M=-2.94) and the incidental and exp licit combined (M=-2.92). This initial observation suggests that there may be a link bet ween type of exposure and fixation proportions of looks towards the target.

[55] lmerTest::lmer(DV~WordType*Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_0_200)
[56] lmerTest::lmer (DV ~ WordType * Exposure + (1 | Subject) + (1 | item), Data: X_200L2)

There is an effect of word type from 0ms to 200ms[57] because fixation proportions in the word condition were smaller (M=-3.47) than in the pseudoword condition (M=-3.46). L2 learners were expected to generate more anticipatory looks towards the target in the pseudoword condition, and it was also expected to find an effect of type of exposure. However, no effects of exposure were found and this rejects the hypotheses that the explicit condition would elicit more anticipatory looks and that a combination of incidental and explicit exposures contributes to more anticipatory looks than the incidental only condition.

Table 21. *L2 time Course Analysis from 200ms before the verb's onset for the fixed factors Exposure (Incidental, Explicit, Incidental & Explicit) and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Exposure IE		Exposure IO		Word Type	
		β	t	β	t	β	t
1	-200 to -0	3.329e-02	2.044*	2.723e-02	1.753**	3.440e-03	0.260
2	0 to 200	2.179e-02	1.803**	1.885e-02	1.637	-0.017043	-2.160*
3	200 to 400	4.918e-03	0.329	-1.243e-02	0.871	-5.282e-03	-0.633
4	400 to 600	2.967e-02	1.304	1.380e-02	0.636	-0.004843	-0.365
5	600 to 800	-1.991e-02	-0.858	6.475e-03	0.292	4.120e-03	0.319
6	800 to 1000	5.230e-03	0.204	8.687e-03	0.356	0.02021	1.417
7	1000 to 1200	-0.04275	-1.484	-0.02006	-0.730	-0.01495	-0.641
8	1200 to 1400	-1.289e-02	-0.353	-1.253e-02	-0.359	0.009998	0.478
9	1400 to 1600	1.535e-02	0.406	-8.953e-03	-0.248	3.599e-03	0.171

*p<.0.05 ** p<.0.1

Given that the results from verb onset up to noun onset did not show any significant effects by type of exposure, it can therefore be assumed that the memory traces generated in every type of exposure, and thus in the incidental only condition, were robust enough to achieve lexical engagement of spoken form and meaning of the

[57] lmerTest::lmer(DV ~ WordType * Exposure + (1 | Subject) + (1 | item), Data: X_0_200L2)

pseudowords. A possible explanation for this may be that having 24 encounters with the pseudowords, in the learning phase, can facilitate their lexical engagement. Even though the number of repetitions in the learning phase was greater than in other L2 incidental word learning studies (Webb 2007, 2008; Pellicer-Sánchez & Schmitt, 2010; Bisson et al., 2014; Pellicer-Sánchez, 2015), this finding raises the possibility that lexical engagement of the spoken form of novel items occurs through incidental reading. This provides some support for the premise that incidental vocabulary learning, through reading, generates lexical engagement of spoken form in high-proficient adult learners of English, and that both incidental and explicit exposures contribute to L2 lexical engagement of form

6.3.4.1 Study 3 Analysis RQ2: L1 Learners

Table 22 displays the results obtained.

Table 22. *L1 Time Course Analysis from 200ms before the verb's onset for the fixed factors Exposure (incidental, explicit, and incidental and explicit) and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Exposure IE		Exposure IO		Word Type	
		β	t	β	t	β	t
1	-200 to -0	-0.011307	-0.700	-0.011307	-0.731	0.002407	0.183
2	0 to 200	-2.908e-04	-0.028	7.411e-03	0.734	-0.01580	-2.687*
3	200 to 400	1.205e-03	0.095	9.991e-03	0.823	-0.012249	-1.440**
4	400 to 600	0.00442	0.216	-0.01668	-0.850	-0.02075	-1.245
5	600 to 800	-1.384e-03	-0.067	-2.140e-02	-1.082	-1.217e-02	-0.726
6	800 to 1000	6.074e-03	0.251	1.315e-02	0.568	-6.395e-03	-0.474
7	1000 to 1200	-6.812e-05	-0.002	1.476e-02	0.474	1.947e-02	0.736
8	1200 to 1400	3.472e-02	1.046	-2.547e-03	-0.080	-0.01058	-0.572
9	1400 to 1600	4.076e-02	1.148	5.096e-02	1.499**	-0.01051	-0.531

* p<.0.05 ** p<.0.1

There is an effect of word type from 0ms to 200ms[58] because fixation proportions in the word condition were smaller (M=-3.48) than in the pseudoword condition (M=-3.47). L1 learners made more predictive looks towards the target in the pseudoword condition, which supports the hypothesis that learners would make more looks towards the target in that condition; however, there was no interaction with type of exposure.

The data did not show any main effects or interactions of word type and exposure condition. Thus, one can infer that regardless of how the pseudowords were encountered in the learning phase, English learners made linguistic predictions of upcoming material based on their knowledge of the recently learned pseudowords. L1 novel items have reached enough linguistic knowledge in every exposure condition to engage with other lexical items and lexical levels to anticipate upcoming linguistic material. This finding opens up the possibility that incidental vocabulary learning can contribute to lexical engagement after a high number of exposures with the target item.

Overall, these findings raise intriguing questions regarding the nature and extent of memory traces in L1 incidental vocabulary learning through reading and lexical engagement of recently learned pseudowords. It may be possible that adult L1 learners learned meaningful novel items from incidental reading to such an extent to engage them with other lexical levels and items. This is an important issue for future research that should be addressed and tested with other L1 populations.

6.3.5 Study 3 Analysis Research Question 3

For research question 3 subjects were determined as random factors and with the predictors of word type: pseudoword and word; and individual differences: phonological working memory, verbal fluency, and vocabulary size.

In order to deeply analyse the effects of word type and individual differences in each type of learner, L2 participants were analysed separately from L1 participants. L2 results will be discussed first. The codes used for the analysis of each time window along with their regression tables can be seen in Appendix 7.

Given that in the time bin from -400ms to -200ms there were no looks towards the target object, this was not included in the analysis.

58 lmerTest::lmer(DV ~ WordType * Exposure + (1 | Subject) + (1 | item), Data: X0_200L1)

6.3.5.1 Study 3 Analysis RQ3: L2 Learners

The results of every individual difference are reported in Tables 23 (PWM), 24 (vocabulary size) and 25 (verbal fluency).

The analysis revealed a main effect of word type and verbal fluency in the 200ms[59] bin prior to verb onset. In order to interpret this result participants were divided into high and low verbal fluency groups after a median split of their verbal fluency capacity (*Mdn*=25). It was found that the high group presented the same fixation proportions towards the target in the word and pseudoword condition (M=-2.94). The low capacity group elicited larger fixation proportions in the pseudoword condition (M=-2.91) than in the word condition (M=-2.94). This finding, while preliminary, suggests that L2 learners' verbal fluency capacity might be associated with their fixation' proportions of looks in the pseudoword condition. It might be the case that higher verbal fluency capacity does not contribute to more looks towards the target, as the lower group outperformed the high group in the pseudoword condition. However, given that the finding is prior to verb onset, it only indicates that verbal fluency might not be a predictor of looks towards the target; hence, other significant effects are needed to support it.

The interaction between phonological working memory and word type is significant in the aggregated bin from 0ms to 200ms. One possible explanation for this interaction is that the proportion of looks towards the target is larger in the pseudoword (M=-3.46) than in the word condition (M=-3.47). However, in order to deeply analyse this result L2 learners' PWM capacity was divided into two groups: low and high, following a median split from their overall PWM median score (*Mdn*=28). It was found that the high capacity group made more anticipatory looks towards the target (M=-3.46) than the low capacity group (M=-3.47) which highlights that higher PWM capacity relates to more L2 anticipatory looks towards the target. The fixation proportion of looks in both the pseudoword (M=-3.45) and word condition (M=-3.47) was also larger for the high capacity group than the low capacity (M=-3.46 vs. M=-3.48 respectively) (Figure 14). It can, therefore, be suggested that higher PWM may facilitate more anticipatory looks towards the target object.

[59] lmerTest::lmer(DV ~ WordType *PWM*VocabS*VerbalF + (1 | Subject) + (1 | item), Data: X_200L2)

Table 23. *L2 Time Course Analysis per time window for fixed factors Phonological Working Memory and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Word Type		PWM		Interaction	
		β	t	β	t	β	t
1	-200 to -0	-0.077688	-1.979**	-0.003420	-1.265	0.001223	0.321
2	0 to 200	1.413e+00	2.092*	2.987e-02	1.580	-5.395e-02	-2.189*
3	200 to 400	2.100e-01	2.170*	2.436e-03	0.986	-7.802e-03	-2.232*
4	400 to 600	1.311e+01	1.072	-1.798e-01	-0.561	-4.866e-01	-1.126
5	600 to 800	2.295e+01	1.840**	-2.189e-01	-0.570	-8.452e-01	-1.917**
6	800 to 1000	2.432e+01	1.768**	-2.930e-01	-0.716	-8.450e-01	-1.739**
7	1000 to 1200	1.553e+01	1.003	-9.178e-01	-1.834**	5.533e-01	-1.011
8	1200 to 1400	5.200e+00	2.539*	1.159e-01	1.897**	-1.845e-01	-2.468*
9	1400 to 1600	1.963e+01	0.949	-4.856e-01	-0.958	-7.233e-01	-1.009

* $p<.0.05$ ** $p<.0.1$

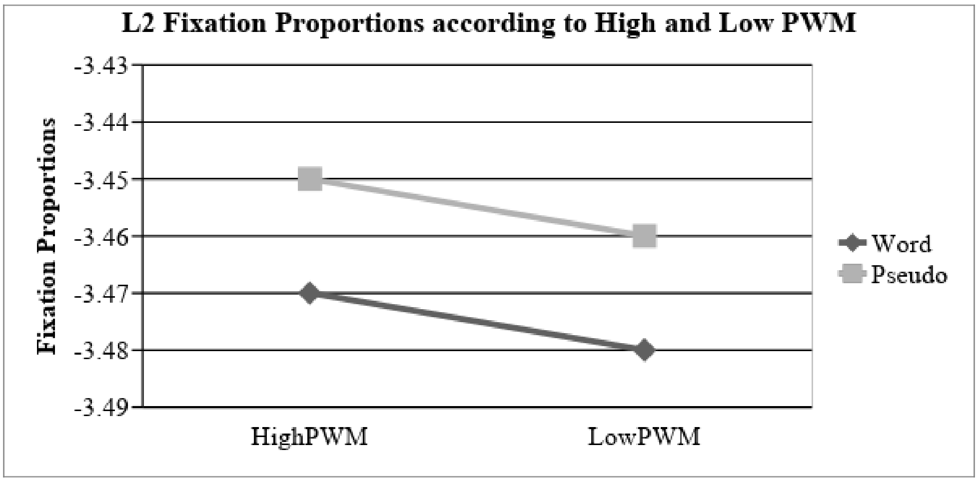

Figure 8 L2 Fixation Proportions according to High and Low PWM Groups

As can be seen in Figure 8, the higher PWM capacity group reported higher fixation proportions than the low group. However, these results need to be interpreted with caution given that the participants of this study were high proficient learners; nevertheless, the data reported here support the assumption that higher PWM facilitates more looks towards the target object when predicting upcoming linguistic material based on the spoken form of recently learned pseudowords.

Table 24. *L2 Time Course Analysis per time window for the fixed factors Vocabulary Size and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Word Type		Vocabulary Size		Interaction	
		β	t	β	t	β	t
1	-200 to -0	-0.077688	-1.979	1.167e-05	1.446	-9.076e-06	-0.802
2	0 to 200	1.413e+00	2.092*	1.041e-04	1.492	-1.873e-04	-2.061*
3	200 to 400	1.543e-01	1.983*	4.445e-06	0.606	-2.139e-05	-2.062*
4	400 to 600	1.311e+01	1.072	-6.993e-04	-0.624	-1.685e-03	-1.116
5	600 to 800	2.295e+01	1.840**	-8.724e-04	-0.650	-2.807e-03	-1.821**
6	800 to 1000	2.432e+01	1.768**	-1.005e-03	-0.703	-3.062e-03	-1.802**
7	1000 to 1200	1.553e+01	1.003	-3.327e-03	-1.901**	-1.833e-03	-0.958
8	1200 to 1400	5.200e+00	2.539*	4.469e-04	1.983**	-6.564e-04	-2.381*
9	1400 to 1600	1.963e+01	0.949	-1.575e-03	-0.889	-2.639e-03	-1.052

* p<.0.05 ** p<.0.1

The interactions of word type with vocabulary size and verbal fluency are also significant in the aggregated bin from 0ms to 200ms. After a median split of participants' verbal fluency capacity (*Mdn*=25) and vocabulary size (*Mdn*=7417) they were divided into high and low groups. It was found:

a) The high verbal fluency capacity group outperformed the low capacity in the fixation proportions in the word condition (M=-1.99 vs. M=-3.47); however the low group outperformed the high group in the pseudoword condition (M=-1.98 vs. M=-3.46, respectively). There are two likely causes for the differences between the high and low groups. First, the higher capacity group may have stronger semantic representations of existing words in the mental lexicon; therefore, their processing of the semantic information of existing words is more robust when making anticipatory looks. This finding highlights that verbal fluency may be a predictor of L2 anticipatory eye-movements of existing words, which supports previous L1 findings (Rommers et al., 2015) and informs L2 predictive processing. Second, higher verbal fluency capacity does not seem to play a significant role when predicting upcoming material based on the lexical information of recently learned pseudowords. It may be the case that the emerging semantic representations of the pseudowords are not yet robust enough to form links with higher verbal fluency capacities.

Table 25. *L2 Time Course Analysis per time window for the fixed factors Verbal Fluency and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Word Type		Verbal Fluency		Interaction	
		β	t	β	t	β	t
1	-200 to -0	-0.077688	-1.979*	2.612e-02	2.073*	0.002424	1.584
2	0 to 200	6.185e-01	1.799**	2.127e-02	2.155*	-2.188e-02	-1.660**
3	200 to 400	-1.640e-02	-0.455	6.669e-04	0.671	4.452e-04	0.752
4	400 to 600	1.311e+01	1.072	-1.907e-01	-0.520	-5.752e-01	-1.163
5	600 to 800	2.295e+01	1.840	-2.588e-01	-0.589	-9.169e-01	-1.818**
6	800 to 1000	2.432e+01	1.768**	-3.298e-01	-0.705	-9.284e-01	-1.669**
7	1000 to 1200	1.553e+01	1.003	-1.048e+00	-1.829**	-6.114e-01	-0.977
8	1200 to 1400	5.200e+00	2.539*	-5.084e-02	-1.603	8.820e-02	2.289*
9	1400 to 1600	-1.764e-01	-1.942**	-1.144e-03	-0.457	7.220e-03	2.037*

* p<.0.05   ** p<.0.1

b) High and low vocabulary size groups generated the same fixation proportions towards the target in the word (M=-3.48) and pseudoword condition (M=-3.46). These results suggest that L2 learners generated more predictive looks in the pseudoword condition; however, they were not significantly mediated by their L2 vocabulary knowledge. It may be the case that higher vocabulary knowledge is not a predictor of anticipatory looks for these learners.

The time window from 200ms to 400ms[60] showed main effects of PWM and vocabulary size with type of word. After a median split of participants' vocabulary size (*Mdn*=7417) and PWM (*Mdn*=28) they were divided into high and low capacity groups with the following results:

a) The high vocabulary size group outperformed the low group in their fixation proportions in the pseudoword condition (M=-1.97 vs. M=-3.46), but it generated lower fixation proportions in the word condition (M=-3.47 vs. M=-3.45). This indicates that more vocabulary knowledge could lead to more proportion of looks towards the target in the pseudoword condition. Given that their lexical knowledge of the recently learned novel items may not be as robust as other lexical items in their mental lexicon, L2 learners may rely on their pre-existing L2 vocabulary knowledge to predict upcoming linguistic material based on their phonological and semantic knowledge of the pseudowords.

b) The high PWM capacity group generated higher fixation proportions towards the target than the low group in the pseudoword condition (M=-1.98 vs. M=-3.45); however, the low group outperformed the high group in the word condition (M=-3.45 vs. M=-3.47, respectively). This indicates that L2 learners required more PWM capacity to make anticipatory eye-movements when processing the phonological and semantic characteristics of the recently learned pseudowords.

All the individual differences showed significant interactions with type of word in the 1200ms to 1400ms[61] time window. After dividing participants into high and low capacity groups according to their median scores in every ID, it was found that the high vocabulary group outperformed the low in the pseudoword condition (M=-1.93 vs. M=-3.35), and their fixation proportions in the word condition were exactly the same (M=-3.35). It may be the case that these participants benefitted from their lexical

[60] lmerTest::lmer(DV ~ WordType *PWM*VocabS*VerbalF + (1 | Subject) + (1 | item), Data: X_200_400L2)

[61] lmerTest::lmer(DV ~ WordType *PWM*VocabS*VerbalF + (1 | Subject) + (1 | item), Data: X_1200_1400L2)

representations of known L2 words to process the recently learned pseudowords and to make anticipatory eye-movements based on their linguistic knowledge of the novel items. This finding has important implications for L2 predictive processing in that vocabulary size might be a predictor of anticipatory looks towards the target when processing the knowledge of recently learned items. In addition, the high verbal fluency capacity group presented more fixation proportions towards the target in the word condition than the low group (M=-3.33 vs. M=-3.38), but it generated less fixation proportions than the low group in the pseudoword condition (M=-3.38 vs. M=-3.34). It is likely that L2 learners have not yet developed a semantic representation of the recently learned pseudowords that is as strong as those of already established lexical items; therefore, they do not yet need more verbal fluency capacity/semantic memory to process and engage the recently learned pseudowords. However, they might need higher capacity for their anticipatory looks towards the target when processing already established words. Moreover, the low PWM capacity group produced higher fixation proportions than the high group in the word (M=-3.29 vs. M=-3.38) and pseudoword conditions (M=-3.34 vs. M=-3.37). This highlights the possible role of PWM in lexical engagement of spoken form.

In the last time window analysed, from 1400ms to 1600ms[62], the interaction between verbal fluency and type of word was significant. Once again, after dividing participants into high and low groups according to a median split of verbal fluency capacity (*Mdn*=25), it was found that the low group generated greater fixation proportions towards the target than the high group in the pseudoword condition (M=-3.35 vs. M=-3.38), and their fixation proportions in the word condition were the same (M=-3.38). This indicates that L2 learners did not use more verbal fluency capacity to make predictions of upcoming linguistic material based on their phonological and semantic knowledge of recently learned pseudowords.

6.3.5.2 Study 3 Analysis RQ3: L1 Learners

The results of each individual difference are reported in Tables 26 (PWM), 27 (vocabulary size), and 28 (verbal fluency).

[62] lmerTest::lmer(DV ~ WordType *PWM*VocabS*VerbalF + (1 | Subject) + (1 | item), Data: X_1400_1600L2)

The analysis of the anticipatory eye-movements towards the target in the aggregated bin from -200ms to 0ms[63] revealed an interaction of word type and PWM. In order to interpret the result participants were divided into high and low capacity groups after a median split of their PMW capacity (*Mdn*=18). It was found that the high capacity group generated greater fixation proportions in the word condition than the low group (M=-2.93 vs. M= -2.94), but their fixation proportions were the same in the pseudoword condition (M=-2.94). Prior to the verb's onset, participants had not processed the verbs' auditory input (either a word or a pseudoword) to generate predictions towards the target; hence, this preliminary finding suggests that higher PWM in the word condition may be related to stronger orthographic and phonological representations of existing words in the mental lexicon. The finding also highlights that a relationship between PWM and anticipatory looks in visual tasks might exist; however, more significant results in other time bins would be needed to corroborate this.

Vocabulary size and PWM showed significant effects from 0 to 200ms. In order to interpret these results, participants were divided into high and low groups according to their median splits of PWM (*Mdn*=18) and vocabulary size (*Mdn*=9078). After an overview of the groups' fixation proportions in this time window it was found that the high vocabulary group generated more fixation proportions towards the target than the low group (M=-3.47 vs. M=-3.48). This suggests that L1 learners made more use of their vocabulary knowledge to make anticipatory looks towards the target when processing the phonological and semantic knowledge of the recently learned pseudowords and existing words. Given that there was no interaction with word type, larger vocabulary size might be a predictor of anticipatory looks towards the target, not only for familiar words (Borovsky et al., 2012) but perhaps also for recently learned items. However, more research is needed to confirm this. Moreover, the high PMW group generated more fixations towards the target (M=-3.47) than the low group (M=-3.48). This result indicates that higher PWM contributes to more anticipatory looks towards the target when processing and engaging phonological and semantic representations of lexical items in visual tasks. Given that there was no interaction with word type, it is possible to suggest that there are not significant PWM differences when processing existing words and recently learned pseudowords in visual tasks. Nevertheless, more research is needed to confirm this.

[63] lmerTest::lmer(DV ~ WordType *PWM*VocabS*VerbalF + (1 | Subject) + (1 | item), Data: X_200_0L1)

There is a significant effect of verbal fluency from 200ms to 400ms[64]. It is caused by the fact that the high verbal fluency group elicited more fixation proportions towards the target (M=-3.46) than the low group (M=-3.47). L1 learners generally needed more verbal fluency capacity to make anticipatory looks towards the target, which supports previous findings (Rommers et al., 2015); however, it also confirms that this is possible when processing and engaging recently learned items. The data reported here appear to support the assumption that verbal fluency may be a predictor of anticipatory eye-movements when extracting knowledge from recently learned items. However, verbal fluency also comes up as significant from 400ms to 600ms as the low group (M=-3.44) generated more fixation proportions than the high group (M=-3.45). These results show that higher verbal fluency capacity contributed to more fixation proportion in one aggregated time bin but not on the following bin; thus the results need to be taken with caution.

Table 26. *L1 Time Course Analysis per time window for the fixed factors Phonological Working Memory and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Word Type		PWM		Interaction	
		β	t	β	t	β	t
1	-200 to -0	4.036e+00	1.762**	2.336e-03	0.025	-2.582e-01	-1.965*
2	0 to 200	-3.112e-01	-1.248	-2.345e-02	-2.289*	1.833e-02	1.374
3	200 to 400	1.754e+00	0.984	1.150e-01	1.595	-9.177e-02	-0.897
4	400 to 600	-7.795e-01	-2.051*	-7.897e-03	-1.272	8.711e-03	-1.586
5	600 to 800	6.136e+00	2.094*	2.328e-01	1.609**	-3.443e-01	-2.049*
6	800 to 1000	7.425e-02	1.462	2.721e-03	1.211	-4.473e-03	-1.647**
7	1000 to 1200	-8.893e-02	-1.283	-8.639e-02	-0.447	8.451e-03	0.205
8	1200 to 1400	9.507e-01	1.545	2.380e-01	0.898	-3.994e-01	-1.478
9	1400 to 1600	-2.611e+00	-0.518	1.069e-01	0.311	8.408e-02	0.518

*p<.0.05 ** p<.0.1

[64] lmerTest::lmer(DV ~ WordType *PWM*VocabS*VerbalF + (1 | Subject) + (1 | item), Data: X_200_400L1)

There were interactions of word type and every ID in the aggregated time bin from 600ms to 800ms[65]. After dividing participants into high and low capacity groups according to median splits of their verbal fluency (*Mdn*=29), PWM (*Mdn*=18), and vocabulary size (*Mdn*=9078) it was found that the high verbal fluency capacity group generated more predictions in the word condition (M=-3.42) than the low group (M=-3.45). However, their fixation proportions were the same in the pseudoword condition (M=-3.43). A possible explanation for this may be that L1 learners have not yet developed a strong memory trace of the recently learned items, thus more verbal fluency performance is not yet needed for their anticipatory looks towards the target in the pseudoword condition. However, this result is line with that of Rommers et al. (2015) in that verbal fluency may be a predictor of L1 anticipatory looks in visual tasks.

Table 27. *L1 Time Course Analysis from 200ms before verb onset for the fixed factors of Vocabulary Size and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Word Type		Vocabulary Size		Interactions	
		β	t	*β*	t	*β*	t
1	-200 to -0	4.036e+00	1.762	5.380e-06	0.031	-4.230e-04	1.748
2	0 to 200	-3.112e-01	-1.248	-4.439e-05	2.082*	3.328e-05	1.197
3	200 to 400	1.754e+00	0.984	2.244e-04	1.689**	-1.879e-04	0.998
4	400 to 600	-7.795e-01	-2.051*	-5.924e-05	-1.562	8.333e-05	-1.946**
5	600 to 800	6.136e+00	2.094*	4.813e-04	1.806**	-6.832e-04	-2.208*
6	800 to 1000	7.425e-02	1.462	1.801e-05	1.824 **	-2.106e-05	-1.756**
7	1000 to 1200	-8.893e-02	-1.283	1.854e-05	2.259*	3.399e-05	0.396
8	1200 to 1400	9.507e-01	1.545	4.673e-04	0.957	-8.564e-04	-1.722**
9	1400 to 1600	-2.611e+00	-0.518	2.073e-04	0.328	2.702e-04	0.507

*p<.0.05 ** p<.0.1

[65] lmerTest::lmer(DV ~ WordType *PWM*VocabS*VerbalF + (1 | Subject) + (1 | item), Data: X_600_800L1)

In addition, the high vocabulary size group outperformed the low in the pseudoword condition (M=-3.43 vs. M=-3.44) and their fixation proportions were the same in the word condition (M=-3.47). This indicates that L1 learners needed more vocabulary knowledge to make predictions towards the target when processing and engaging pseudowords than already existing words. It was also found that there was no difference between PWM high and low groups in their fixation proportion in the word (M=-3.45) and the pseudoword conditions (M=-3.43). This highlights that L1 learners do not require more PWM capacity to predict upcoming linguistic material when processing the spoken form and meaning of recently learned pseudowords and already established items.

Table 28. *L1 Time Course Analysis per time window for the fixed factors of Verbal Fluency and Word Type (word/pseudoword)*

Time Window	Milliseconds	Fixed Predictions					
		Word Type		Verbal Fluency		Interactions	
		β	t	β	t	β	t
1	-200 to -0	4.036e+00	1.762	3.890e-03	0.075	-1.392e-01	-1.887**
2	0 to 200	-3.112e-01	-1.248	1.096e-02	0.311	-3.152e-02	-0.654
3	200 to 400	1.754e+00	0.984	8.220e-02	2.026*	-6.391e-02	-1.113
4	400 to 600	-7.795e-01	-2.051*	-7.017e-03	-2.006*	2.565e-02	1.742**
5	600 to 800	6.136e+00	2.094*	1.631e-01	2.006*	-1.964e-01	-2.081*
6	800 to 1000	7.425e-02	1.462	-1.440e-03	-1.188	-1.451e-03	-0.816
7	1000 to 1200	-8.893e-02	-1.283	-2.369e-03	-1.308	3.680e-03	1.539
8	1200 to 1400	9.507e-01	1.545	0.003074	1.716**	-4.100e-02	-1.719**
9	1400 to 1600	-2.611e+00	-0.518	5.617e-02	0.291	8.408e-02	0.518

*p<.0.05 ** p<.0.1

Vocabulary size comes up as a significant predictor in the 1000ms to 1200ms[66] aggregated time window. After dividing participants into high and low vocabulary size groups according to a median split of their vocabulary size (*Mdn*=9078) it was found that the high group generated more fixation proportions towards the target (M=-3.39) than the low group (M=-3.43). This result is in agreement with that obtained by Borovsky et al. (2012) in that vocabulary knowledge is a predictor of anticipatory eye-movements. However, this finding also raises the possibility that higher vocabulary knowledge assists anticipatory eye-movements based on the phonological and semantic information extracted from recently learned novel items.

6.4 Chapter Conclusion

The purpose of the current study was to determine if lexical engagement of the spoken form of recently learned pseudowords was possible in Spanish speaking learners of English and in English native speakers. The extent of incidental learning and possible effects of individual differences in lexical engagement of spoken form were also of interest.

The following conclusions can be drawn from the present study:

a) L1 and L2 learners predicted upcoming linguistic material based on their knowledge of the spoken form and meaning of recently learned pseudowords. This is a novel finding that affirms that lexical engagement of spoken form with other lexical levels (e.g. semantic) and lexical items (e.g. the ones to be predicted) is possible after a high number of repetitions. L1 and L2 learners engaged the spoken form of recently learned items to an extent to be able to predict upcoming linguistic material based on their knowledge of the novel items. Thus, lexical engagement of spoken form is possible for both types of learners.

b) Incidental vocabulary learning produces robust enough memory traces to generate lexical engagement of spoken form in recently learned lexical items. L1 and L2 learners predicted upcoming linguistic material based on linguistic knowledge gained through incidental reading. L2 incidental vocabulary learning, through reading, reaches lexical engagement of spoken form in high advanced adult learners of English after a high number of repetitions of the target word.

[66] lmerTest::lmer(DV ~ WordType *PWM*VocabS*VerbalF + (1 | Subject) + (1 | item), Data: X_1000_1220L1)

c) Verbal fluency is a predictor of L1 and L2 anticipatory eye-movements based on the spoken form and meaning of familiar items. However, its effect on L1 and L2 lexical engagement of spoken form in recently learned items was not confirmed.

d) PWM is a predictor of L2 anticipatory eye-movements and of lexical engagement of the spoken form of recently learned pseudowords. This confirms that PWM plays a role in L2 vocabulary learning (Baddeley, 2012), but it also furthers our knowledge of its relevance in L2 lexical engagement of the spoken form in recently learned words. It was not a significant predictor for L1 learners.

e) Vocabulary size is a verbal predictor of anticipatory eye-movements for both L1 and L2 learners. More vocabulary knowledge aids lexical engagement of the spoken form of recently learned pseudowords and generates more anticipatory looks towards a target when predicting upcoming linguistic material.

The following chapter refers to the Lexical Decision Task designed to account for L2 lexical engagement of meaning in recently learned pseudowords.

CHAPTER 7 L2 LEXICAL ENGAGEMENT OF MEANING

7.1 Study 4: Introduction

This chapter presents the results of a study carried out to investigate online lexical engagement of meaning, through lexical decision tasks (LDT) using recently learned pseudowords as primes. The aim was to find whether or not L2 learners detect semantically related and unrelated targets and thus if the recently learned pseudowords lexically engaged with other lexical items in the mental lexicon. For instance, if the pseudoword *gwap* would activate a semantically related target (e.g. eat) or a semantically unrelated target (e.g. run).

The extent of incidental learning in L2 lexical engagement of meaning was tested through its comparison with other types of exposure (explicit only and incidental and explicit combined). It was also of interest to determine whether or not the individual differences of phonological working memory, verbal fluency, and vocabulary size have an effect on LDT using recently learned pseudowords as primes.

7.2 Study 4: Methodology

The methodology in this study is similar to that adopted by Batterink and Neville (2011). A semantic priming LDT was employed to find, at a semantic level, whether the recently learned pseudowords[67] acting as primes would activate lexical related items (Rodd, Cutrin, Kirsch, Millar & Davis, 2013). If the novel items have been integrated in established lexical-semantic networks, they would act as effective primes (Tamminen & Gaskell, 2013). In addition, given that semantic priming is one of the most established examples of lexical engagement (Leach & Samuel, 2007), it will shed light on lexical engagement of meaning.

Each pseudoword was matched with a semantically related English word, a semantically unrelated English word, and two English-like nonwords. To illustrate, for the prime pseudoword "gwap" (to eat in a fast manner) the semantically related English word was "eat," the English nonrelated was "run," nonword1 was "guzz," and

[67] The pseudowords' learning phase has been described in Chapter 5 of this thesis.

nonword2 “yiss” (Appendix 8 shows the target words in each condition). All English-like nonwords were four letters long and the English words varied between three to six letters. Seven pseudowords acting as filler nouns were used in the experiment and matched with filler targets for a total of twenty-eight fillers.

7.2.1 Study 4: Research Question 1

Are Spanish speaking learners of English and English learners able to engage the meaning of recently learned pseudowords with other lexical items? If so,

Is there a difference between Spanish speaking learners of English and English native speakers in their lexical decisions when primed with recently learned pseudowords?

Hypothesis 1: There is a difference between both types of learners. L1 learners will produce quicker reaction times than L2 learners given that L2 comprehension is more time and resource-consuming than L1comprehension (Dijkgraaf et al., 2017).

7.2.2 Study 4: Research Question 2

Is there an effect of type of exposure in lexical decisions, when primed with recently learned pseudowords, for Spanish speaking learners of English and English native speakers?

Hypothesis 1: There is an effect of exposure. Given that explicit instruction can speed language acquisition (Ellis, 2015), the explicit condition elicits faster reaction times than the other types of exposure.

Hypothesis 2: Given that learning requires incidental and explicit aspects (Sun et al., 2009), a combination of incidental and explicit exposures elicits shorter reaction times than the incidental only exposure.

7.2.3 Study 4: Research Question 3

Is there an effect of the individual differences of phonological working memory, verbal fluency, and vocabulary size in lexical decisions, when primed with recently learned pseudowords, for Spanish speaking learners of English and English native speakers?

Hypothesis 1: There is an effect of the individual differences. Given that PWM is a learning device in both L1 and L2 vocabulary learning (Baddeley, 2012), higher PWM contributes to faster reaction times in the semantically related and unrelated targets.

Hypothesis 2: Given that verbal fluency taps into semantic memory (Troyer et al., 1997) it has an effect on online lexical engagement of meaning of newly learned words. Higher verbal fluency capacity elicits faster reaction times in the semantically related and unrelated targets.

Hypothesis 3: Given that vocabulary knowledge is associated with faster and more accurate word recognition (Yap et al., 2012), higher vocabulary sizes elicit faster reaction times in the semantically related and unrelated targets.

7.2.4 Study 4: Participants

The same participants described in chapter six of this thesis took part in this study. The descriptive statistics on participants' individual differences are displayed in Table 29.

Table 29. *Descriptive Statics of L1 and L2 Individual Differences for Lexical Engagement of Meaning*

	L1		L2	
	Mean	SD	Mean	SD
Vocabulary Size	8762	1118	7424	1080
PWM	18.43	4.99	25.83	2.24
Verbal Fluency	27.50	6.84	25.31	6.10

7.2.5 Study 4: Stimuli

The stimulus for this study consisted of fourteen pseudowords, described in chapter five, matched with a semantically related English word, a non-semantically related English word, and two English-like nonwords. The target English words were verbs and corresponded with the 3000 most frequent words of the British National Corpus (BNC); hence, they were known to the L2 learners. The targets did not appear during the training session in sentences containing the pseudoword used as prime; therefore, learners were not exposed to semantic associations with the target items and the primes before testing. Hence, an associative semantic link could have not been formed during training (Tamminen & Gaskell, 2013). Half of the English word targets were semantically related to the prime and the other half were semantically unrelated. Each prime was presented in a block four times: once before a related word, once before an unrelated word, and twice with English-like nonwords, for a total of 84 trials per block. Trial order was randomised per block.

7.2.6 Study 4: Procedure

Each participant was seen individually in a quiet room and they were seated in front of a 17" display screen with their eyes 20cm away from the display screen. The experiment started with a welcoming screen with instructions for the experiment and participants were to proceed to the experiment by clicking the right-hand side mouse button. They were asked to read a prime and a target word in each trial and to respond as quickly and as accurately as possible to the target by pressing a button labelled "Word" if the target was an English word and a button labelled "Nonword" if the target was not an English word. The "Word" button corresponded to the left arrow key and "Nonword" to the right arrow key on the keyboard.

Every trial started with a fixation cross that lasted 1200 milliseconds, then the prime was presented for 200ms, and the target word was presented for 300ms. The following trial started 300ms after the participant's answer (Batterink & Neville, 2011) (Figure 9). The session started with two blocks of 16 practice trials followed by 21 blocks for a total of 56 experimental trials and 28 filler trails.

Measures of lexical configuration (offline recognition and recall vocabulary post-tests) were taken prior to the LDT to ensure that participants had configuration knowledge of the recently learned pseudowords; thus, they would understand them in the LDT. An in-depth discussion on the results of the offline vocabulary post-tests can be seen in the second study in Chapter 5 of this thesis.

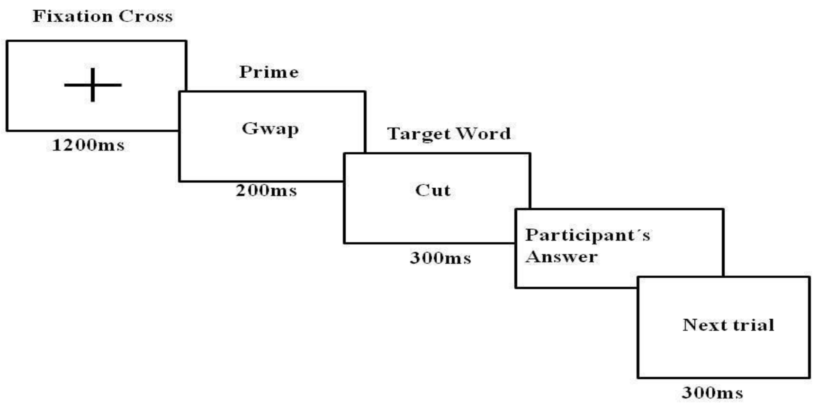

Figure 9 Trial Sequence in the Lexical Decision Task

7.3 Study 4: Results

First, a quick overview of the recognition scores in the vocabulary post-test is presented to determine if all the pseudowords could be used for further statistical analyses. Then, a brief examination of the LDT accuracy responses follows. The section finishes with the analysis of the reaction times (RTs) which was performed only on those items that participants recognised in the receptive vocabulary post-test and that were correctly answered in the LDT (Bordag et al., 2017).

7.3.1 Overview of the Vocabulary Recognition Scores

The mean scores of the recognition tests demonstrated that L1 and L2 learners recognised all the recently learned pseudowords (Table 30). Given that there were learning gains in each recently learned pseudoword, all of them were used for further analysis.

7.3.2 Overview of LDT Accuracy Responses

The mean accuracy scores were looked in order to determine if every pseudoword, used as a prime, was correctly answered, and thus, could be used for further analysis.

All the recently learned pseudowords, when acting as primes, generated a high percentage of correct responses in both types of learners (Table 30).

Table 30. *L1 and L2 Recognition Mean Scores of Every Pseudoword*

	L1		L2	
	M	SD	M	SD
Bazz	0.79	0.42	0.74	0.45
Ench	0.68	0.48	0.81	0.40
Feam	0.61	0.50	0.59	0.50
Flel	0.71	0.46	0.59	0.50
Gope	0.96	0.19	0.93	0.27
Grod	0.71	0.46	0.48	0.51
Gwap	0.89	0.31	0.81	0.40
Hirp	0.61	0.50	0.30	0.47
Nush	0.79	0.42	0.56	0.51
Pisk	0.75	0.44	0.70	0.47
Spoc	0.50	0.51	0.67	0.48
Thoy	0.86	0.36	0.67	0.48
Tirl	0.86	0.36	0.63	0.49
Woft	0.71	0.46	0.48	0.51

Table 30 illustrates that L1 and L2 participants recognised every pseudoword in the offline recognition vocabulary post-test[68].

[68] For in depth results on the vocabulary post-tests please refer to chapter 5 of this thesis.

Table 31. *Mean Scores of Semantic Related and Unrelated Responses per Item and Learner*

	Semantic Related		Semantic Unrelated	
	L1	L2	L1	L2
Bazz	0.92	0.96	0.92	0.96
Ench	0.84	0.96	0.88	0.92
Feam	0.84	0.96	0.92	0.92
Flel	0.84	0.96	0.88	0.92
Gope	0.88	0.92	0.92	0.92
Grod	0.88	0.96	0.92	0.96
Gwap	0.88	0.92	0.80	0.96
Hirp	0.84	0.92	0.84	0.92
Nush	0.92	0.96	0.92	0.96
Pisk	0.88	0.92	0.92	0.96
Spoc	0.48	0.92	0.88	0.96
Thoy	0.88	0.96	0.88	0.92
Tirl	0.92	0.96	0.92	0.96
Woft	0.88	0.96	0.88	0.92

As displayed in Table 31, L1 and L2 learners correctly recognised semantic related and unrelated targets when primed with the recently learned pseudowords. This in turn indicates that the emerging lexical entries are robust enough to act as effective primes which highlights that they have been integrated in established lexical-semantic networks (Tamminen & Gaskell, 2013). Given that all pseudowords used as primes generated correct semantically related and unrelated lexical decisions, one can infer that L1 and L2 learners have engaged the meaning of the recently learned pseudowords with other lexical items.

Due to the responses' accuracy, all the pseudowords will be used for further analyses.

7.3.3 Study 4 Data Analysis

The data analysis was performed only on items that each participant recognised in the receptive vocabulary test and that were correctly answered in the LDT (Bordag et al., 2017). In order to avoid extreme outliers, RTs faster than 200ms or slower than 3000ms were removed (Yap et al., 2012). This affected 1.3% of the L2 data and 2.1% of the L1 data.

The remaining data were analysed through a linear mixed-effect model using the package "lmertest" (Kuznetsova et al., 2017) in the R studio environment (R Studio Development Core Team, 2015). They were run to analyse RTs and their possible interaction with L1 and L2 learners, word type, exposure, and IDs. The linear mixed-effects model had subjects and primes as random factors and language background, exposure, word type, and IDs as predictors. The language predictor also had two levels: L1 and L2; the exposure predictor had three levels: explicit only, incidental only, and the combination of incidental and explicit exposure; word type had four levels: semantically related, semantically unrelated, nonword1 and nonword2; the ID predictors had only one level.

7.3.3.1 Study 4: Research Question 1

For research question 1, the mixed model included RTs as the outcome variable with the predictors of language: L1 and L2, and word type: English semantically related, English semantically nonrelated, nonword1, and nonword2.

It was expected that the main effects of first language where L1 learners would outperform Spanish speaking learners of English would be found. An effect of L1 and word type was found[69] (β=140.11, SE=42.89, t= 3.267, $p<0.05$) because:

[69] lmerTest::lmer(RT~WordType*Lang+(1|Subject)+(1|prime),data=LDT)

a) L1 learners were 173ms quicker than L2 learners when reacting to lexical decision tasks using recently learned pseudowords as primes (M=594.7ms vs. M=767.27ms, respectively). Faster RTs demonstrate quicker recognition and processing of the novel items with already established lexical entries.

b) Spanish speaking learners responded approximately 16ms quicker to semantically related words (M=679.23, SD= 281.39) than to semantically unrelated words (M= 695.70, SD= 259.12), and slower to nonwords: nonword 1 (M=876.28, SD=523.67) and nonword 2 (M=830.49, SD=438.63) (Figure 10).

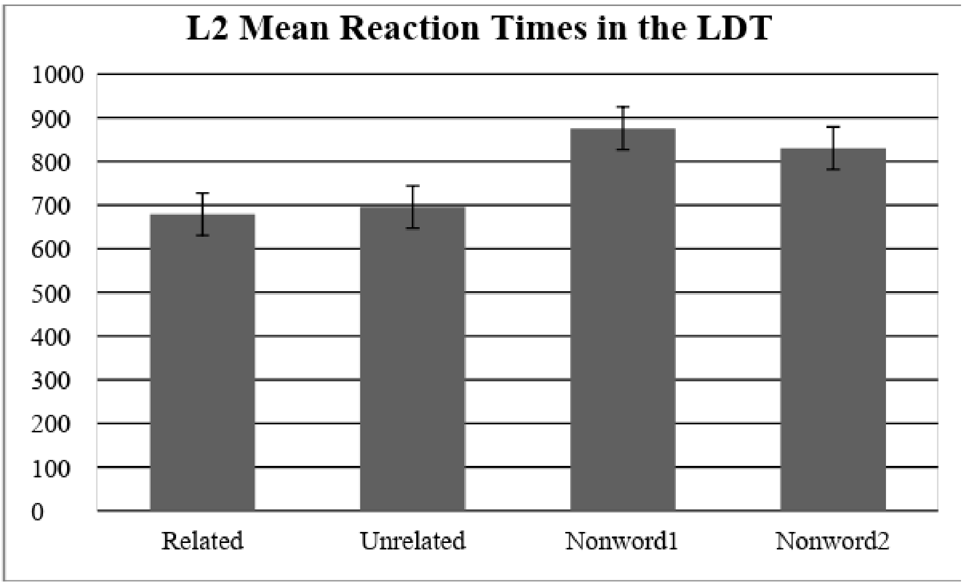

Figure 10 L2 Mean Reaction Times in Every Condition

Figure 10 exemplifies that the recently learned pseudowords acting as primes sped up the recognition of semantically related words, which taps into already established semantic lexical items (Tamminen & Gaskell, 2013). It can thus be suggested that the recently learned pseudowords have created a memory trace that semantically engages the already established items in the L2 mental lexicon. This finding supports the work of Bordag et al. (2017) in that semantic representations of L2 novel items can create lexical representations in already established semantic networks and interact with their meanings. In addition, given that lexical decisions are known to be faster when primed with a semantically related word (Francis, 2005), it can be said that Spanish speaking learners have been semantically primed, and thus that lexical engagement with the meaning of recently learned pseudowords has taken place. Longer RTs in the nonword conditions reveals that participants take longer to process words that do not have lexical representations in their mental lexicon. Given that the prime is a pseudoword, Spanish speaking learners might have taken longer to react to nonwords because they were processing two English-like pseudowords at the same time and establishing if there was a semantic relationship between them.

c) English learners responded approximately 32.68ms quicker to English related words (M=550.98, SD=168.28) than to English nonrelated (M= 583.66, SD= 169.33). Their nonwords' RTs were higher than those of English words: nonword 1 (M= 648.99, SD= 253.01) and nonword 2 (M= 592.44, SD= 154.13) (Figure 11).

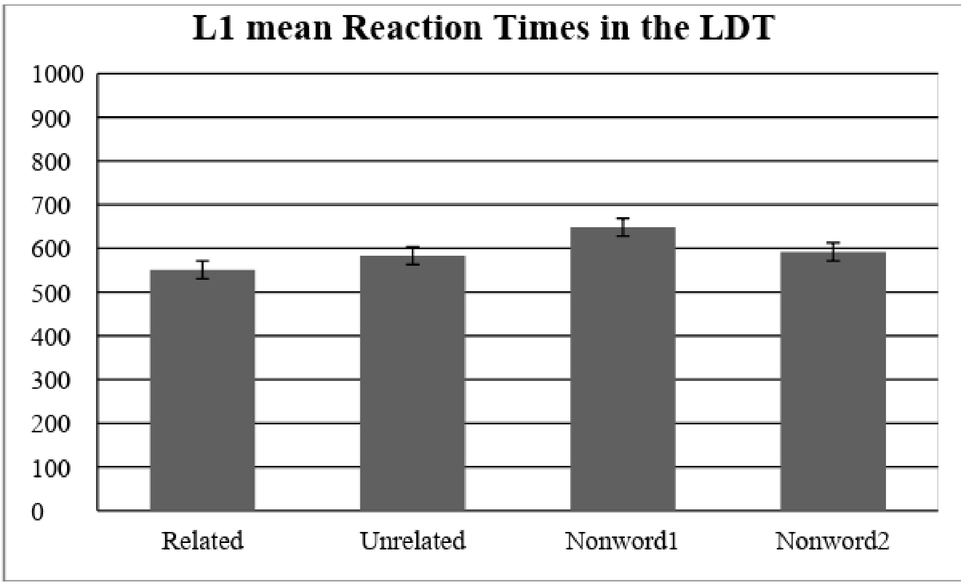

Figure 11 Mean Scores of Reaction Times in Every Condition for English Learners

As shown in Figure 11, English semantically related words sped up RTs. It may be the case, therefore, that the primes tapped into already established semantic lexical items (Tamminen & Gaskell, 2013) and thus that English learners have engaged the semantic characteristics of the recently learned pseudowords with other lexical items. It is possible to hypothesise then that the memory traces left by the recently learned pseudowords, in the learning phase, were robust enough to show lexical engagement of meaning with other lexical items. English learners took longer to process and react to English-like nonwords because those words are not stored in their semantic memory; hence, they have to process the meaning of the prime and the meaning of a nonword at the same time and this seems to slow down their RTs.

7.3.3.2 Study 4: Research Question 2

For research question 2, subjects and primes were specified as random factors with the predictors of exposure and word type. The exposure predictor had three levels: incidental only, explicit only, and incidental and explicit combined, and word type had four levels: English related, English nonrelated, nonword1, and nonword2.

In order to deeply examine the effects of exposure in each type of learner, Spanish speaking learners were analysed separately from English learners. L2 results will be presented first, followed by L1 results.

7.3.3.2.1 Study 4 RQ2: L2 Learners

It was predicted that the explicit exposure would elicit faster RTs in the English related and nonrelated categories. A main effect of exposure and word type was found[70] (β= -149.702, SE=67.66, t= -2.212, $p<0.05$). This is caused because overall L2 RTs in the explicit condition (M=715ms) were faster than in the incidental (M=744ms) and incidental and explicit combined (M=843ms), and almost in every word type (Table 32).

Table 32. *L2 Mean RTs per type of Exposure and Word Type*

	Incidental Only	Explicit Only	Incidental & Explicit
Semantic Related	654	599	778
Semantic Unrelated	660	661	758
Nonword1	894	852	883
Nonword2	767	762	996

It can be seen from the data in Table 32 that in the semantic related condition, the explicit exposure sped up RTs by 55ms in comparison to the incidental exposure, and by 179ms when compared to the incidental and explicit combined. The observed decrease in RTs could be attributed to the fact that the memory traces left by the explicit exposure facilitated their meaning consolidation to such an extent to activate already established semantic representations. It can thus be suggested that the emerging pseudowords are faster activated in existing semantic networks when learned explicitly, which confirms the association between explicit instruction and speed in language acquisition (Ellis, 2015). This not only suggests that the recently learned pseudowords have engaged with other lexical items, but that they have integrated into existing semantic networks as they primed semantic unrelated items.

[70] lmerTest::lmer(RT~WordType*Exposure+(1|Subject)+(1|prime),data=LDTL2)

From the data reported in Table 32, one can also see a marginal difference of 1ms in the semantic unrelated condition of the incidental exposure when compared to the explicit exposure. Given such minimal difference, more research is needed to confirm if the incidental condition actually speeds RTs in lexical decisions when compared to explicit learning. Nevertheless, a possible explanation for this might be that learners' advanced proficiency levels helped them understand the context where the pseudowords were embedded and thus they generated incidental memory traces while reading. It is important to bear in mind that the context where the pseudowords were embedded was highly controlled and this could have facilitated robust memory traces from incidental reading, given that each contextual encounter with a word leaves a memory trace of the word and its context (Bordag et al., 2017). This result therefore needs to be interpreted with extreme caution and more research is needed to confirm it with other L2 populations and throughout different contexts.

Contrary to expectation, the incidental exposure sped up RTs in almost every condition, except nonword1, when compared to the incidental and explicit exposure.

In general, therefore, it seems that the memory traces of the recently learned pseudowords, in every type of exposure, are robust enough to reach lexical engagement with other lexical items. Nevertheless, the memory traces gained in the incidental exposure do not to speed lexical decisions when compared to explicit exposures. This is an important issue for future research on lexical engagement with the meaning of recently learned pseudowords and thus more research is needed to extrapolate this to other L2 populations.

7.3.3.2.2 Study 4 RQ2: L1 Learners

It was predicted that the explicit exposure would elicit faster RTs in the English related and English nonrelated categories. It is somewhat surprising that no main effects or significant interactions were found[71]. To illustrate, word type and exposure: (β=-7.705, SE= 27.595, t=-0.279, p<0.78). There are two likely causes for this result. First L1 learners integrated the meaning of the recently learned pseudowords regardless of the type of input received during training. They may have created an emerging lexical entry of the pseudowords, despite the type of exposure, due to the high number of repetitions during the learning phase. Recall that participants encountered each target item 24 times; hence, it is very likely that this high number of repetitions assisted their

[71] lmerTest::lmer(RT~WordType*Lang+(1|Subject)+(1|prime),data=LDTL1)

vocabulary learning process. Second, the highly controlled conditions of the learning phase contributed to understand the context in which the pseudowords were embedded. Each pseudoword was embedded in sentences whose context belonged to the 3000 most frequent words in the English language; hence, for L1 speakers, this context may have facilitated learning the meaning of the novel items to such an extent that providing participants with a short definition of the novel items did not speed meaning recognition in online tasks.

7.3.3.3 Study 4: Research Question 3

For research question 3 subjects and primes were specified as random factors with the predictors of word type, phonological working memory, verbal fluency, and vocabulary size. The word type predictor had four levels: English related, English nonrelated, nonword1, and nonword2. The other predictors only had one level.

In order to deeply analyse the effects of RTs and exposure in each type of learner, Spanish speaking learners were analysed separately from English learners. L2 results will be presented first, followed by L1 results.

7.3.3.3.1 Study 4 RQ3: L2 Learners

An effect of every ID was expected where higher cognitive capacities would elicit faster RTs. The analysis showed significant effects[72] of PWM (β=60.085, SE= 20.825, t=2.885, $p<0.05$). In order to best interpret this result participants were divided into low and high PWM groups following a median split from their overall PWM median score (*Mdn*=27). It was found that the high capacity group elicited slower RTs than the low capacity (M=965.28 vs. M=674.56 respectively) in every condition (Table 33).

This result supports previous findings indicating that PWM capacity may not account for bilingual advantages in novel word learning (Kaushanskaya, 2012), and it suggests that higher PWM capacity does not speed up L2 RTs in semantic lexical decision tasks with recently learned pseudowords as primes.

As it can be seen in Table 33, clearly, L2 learners did not make use of higher PWM capacity to react quicker to LDT when semantically primed with recently learned pseudowords.

[72] lmerTest::lmer(RT~WordType*PWM*VocabSize*VerbalF+(1|Subject)+(1|prime),data=LDTL2)

Table 33. *Mean RTs for Low and High PWM L2 Groups*

	Low Group		High Group	
	Mean	SD	Mean	SD
Semantic Related	586.97	199.60	881.31	330.47
Semantic Unrelated	617.06	206.43	872.62	282.64
Nonword1	796.63	558.25	1043.54	405.53
Nonword 2	711.80	381.50	881.31	457.98

7.3.3.3.2 Study 4 RQ3: L1 Learners

An effect of every ID was expected where higher cognitive capacities would elicit faster RTs. However, no significant main effects or interactions were found[73]. To illustrate, PWM (β=1.62453, SE= 12.69673, t=0.128, p<0.89); vocabulary Size (β=-0.04881, SE= 0.05472, t=0.892, p<0.38); verbal fluency (β=-14.70407, SE= 8.36310, t=-1.758, p<0.09).

Surprisingly, L1 RTs are not mediated by higher cognitive capacities. A possible explanation for this might be that L1 learners have a robust lexical knowledge of the English targets, thus they do not require higher cognitive capacities to access them. Again, the learning context of the pseudowords may have facilitated their memory traces and engagement with other lexical items; hence, higher cognitive capacities are not significantly required to make the lexical decisions.

7.4 Chapter Conclusion

This chapter presented the results of a study carried out to investigate L1 and L2 lexical engagement of meaning in recently learned pseudowords. The main findings are summarised in four main points:

[73] lmerTest::lmer(RT~WordType*PWM*VocabSize*VerbalF+(1|Subject)+(1|prime),data=LDTL1)

a) Lexical engagement of meaning of recently learned pseudowords can be accounted for through semantic prime LDTs. L1 and L2 participants engaged the meaning of the novel items with already established lexical items. These results are in line with Tamminen and Gaskell (2013) in that novel items can prime lexical decisions in L1 adult learners; however, this finding also contributes to new perspectives in L2 adult word learning and lexical engagement.

b) L1 Lexical engagement of meaning of recently learned pseudowords is not hindered or facilitated by type of exposure. For L2 learners, their RTs in LDT using recently learned pseudowords as primes are sped up by explicit exposure.

c) L2 incidental vocabulary learning can reach lexical engagement of meaning after a high number of repetitions with the target items.

d) For the L1 and L2 participants in this study, the individual differences in phonological working memory, vocabulary size, and verbal fluency do not have a significant effect on their lexical engagement of meaning of recently learned pseudowords.

The following chapter refers to an eye-tracking study designed to account for L2 lexical engagement of use in recently learned pseudowords.

CHAPTER 8 L2 LEXICAL ENGAGEMENT OF USE

8.1 Study 5: Introduction

This chapter presents the results of a study carried out to investigate online lexical engagement through L2 semantic and syntactic ambiguities of newly learned words. The extent of incidental learning and the effect of individual differences were also taken into account.

The study was designed to investigate how L2 adult learners of English resolve subject-object ambiguities in plausible and implausible garden-path sentences, using pseudowords as targets, such as, *While the woman grodded the baby fell in the bath.* The aim of the experiment was to find whether L2 learners were able to detect subject-object ambiguities, and thus if the recently learned pseudowords showed lexical engagement of grammatical use with other lexical items. It was also of interest to determine the extent of incidental learning by comparing it to two other types of exposures (explicit only, and incidental and explicit), and if the individual differences of phonological working memory, verbal fluency, and vocabulary size affect lexical engagement of grammatical use.

8.2 Study 5: Methodology

The methodology of the study is similar to that adopted by Roberts and Felser (2011). An eye-tracking during reading study was used to investigate the real-time processing and comprehension of temporarily ambiguous sentences containing newly learned pseudowords. Each pseudoword was paired in a plausible and implausible semantic condition, such as in (1) and (2) below,

(1) While the woman grodded [washed] the baby fell in the bath.

(2) As the girl grodded [washed] the dough felt very soft indeed.

The direct object *the baby* in sentence (1) is semantically plausible given the pseudo-verb *grod (*wash) whereas the direct object *the dough* in sentence (2) is not. When the disambiguating material *the dough felt* in (2) is not compatible with the learner's initial analysis (e.g. *the dough* as the direct object of *grodded* [washed]), the sentence is predicted to be more difficult to process than when the initial analysis matches the disambiguating material like *the baby fell* in (1) (Roberts & Felser, 2011) Given that in garden path sentences the reader relies on syntactic information only unless the upcoming material is ambiguous, and thus a second reading becomes necessary to revise the structural parse tree and the first initial structural attachment (Harley, 2014), longer reading times are expected in the processing of the ambiguous determiner phrase (DP) (e.g. *the dough* in 2 above) given its semantic and syntactic implausibility. Thus, reading times of the ambiguous DP in the plausible and the implausible condition may differ since plausible sentences carry out more semantic processing and because parsers find it difficult to abandon initial analyses if they require more semantic processing (Pickering & Traxler, 1998). The ambiguous DP is the region where lexical engagement of use is more likely to be determined as learners have to engage the semantic and syntactic characteristics of the recently learned pseudowords with those of the ambiguous DP in order to detect and comprehend the subject-object ambiguity.

Eye movements and fixation times will reveal the learner's initial and later stages of semantic and syntactic processing of both the pseudowords and the plausible and implausible sentences' conditions. First fixation and first pass fixation times may be indicators of early processing whereas regressions and total fixation times may be indicators of later processing (Conklin et al., 2018)

None of the sentences, either experimental or fillers, had internal punctuation to avoid providing participants with cues that could hinder their linguistic processing (Frazier & Rayner, 1982). Most of the sentences were nine or ten words long. Every target sentence was followed by a comprehension question to check whether or not participants understood the sentences. All questions targeted the subject of the main clause in the sentence (e.g. Did the woman fall in the bath?) and did not include the pseudoword. Likewise, some of the fillers were followed by a comprehension question.

8.2.1 Study 5: Research Question 1

Are Spanish speaking learners of English and English native speakers able to engage the use of recently learned pseudowords with other lexical items through online comprehension of temporary subject-object ambiguous sentences? If so,

> Is there a difference between Spanish speaking learners of English and English native speakers in their online comprehension of newly learned pseudowords in temporary subject-object ambiguous sentences?
>
> *Hypothesis 1*: There is a difference between both types of learners. L2 learners are more affected by semantic plausibility than L1 learners, thus they will elicit

longer reading times on the ambiguous determiner phrase (Clahsen & Felser, 2006).

Hypothesis 2: There is an effect of plausibility due to the semantic integration of the newly learned words. Both types of learners would commit to their first initial semantic analysis (Pickering & Traxler, 1998) before encountering the subject-object ambiguity.

8.2.2 Study 5: Research Question 2

Is there an effect of type of exposure in lexical engagement of use of recently learned pseudowords for Spanish speaking learners of English and English native speakers?

Hypothesis 1: There is an effect of exposure for L1 and L2 learners. Given that explicit instruction can speed language acquisition (Ellis, 2015), the explicit exposure elicits less overall reading times in the ambiguous DP in both plausible and implausible sentences.

Hypothesis 2: Given that learning requires incidental and explicit aspects (Sun et al., 2009), a combination of incidental and explicit exposures elicits less overall reading times in the ambiguous DP than the incidental only condition.

8.2.3 Study 5: Research Question 3

Is there an effect of the individual differences of phonological working memory, verbal fluency, and vocabulary size on lexical engagement of use of recently learned pseudowords for Spanish speaking learners of English and English native speakers?

Hypothesis 1: There is an effect of the individual differences. Given that PWM is a learning device in both L1 and L2 vocabulary learning (Baddeley, 2012) it has an effect on online lexical engagement of use of newly learned words. Higher PWM contributes to faster processing of the ambiguous DP in plausible and implausible sentences.

Hypothesis 2: Given that verbal fluency taps into semantic memory (Troyer et al., 1997), it has an effect on online lexical engagement of use of newly learned words. Higher verbal fluency capacity elicits faster processing of the ambiguous DP in plausible and implausible sentences.

Hypothesis 3: Given that vocabulary knowledge contributes to both L1 and L2 reading processes (Lervag & Aukrust, 2010) and that it aids word consolidation (James et al., 2017), it has an effect on lexical engagement of use of newly learned words. Higher vocabulary knowledge elicits less reading times of the ambiguous DP in both plausible and implausible sentences.

8.2.4 Study 5: Participants

The same participants described in the previous chapter, twenty-seven L2 learners and twenty-seven English monolinguals, took part in this study. All participants had normal or corrected to normal vision. Descriptive statistics on participants' individual differences are displayed in Table 34.

Table 34. *Descriptive statistics on participants' individual differences*

	L1		L2	
	Mean	SD	Mean	SD
Vocabulary Size	8672	1152	7472	831.78
PWM	18.06	5.15	28.08	1.85
Verbal Fluency	29.82	7.46	24.11	5.16

8.2.5 Study 5: Stimuli

The stimulus for this study consisted of a subset from the stimuli used in Chapters 6 and 7. The following seven optionally transitive pseudo-verbs were selected to create plausible and implausible garden-path sentences with subject-object ambiguities: grod, woft, ench, gwap, hirp, flel, and nush. The stimuli consisted of twenty-eight sentences containing preposed adjunct clauses such as (1) and (2) above. Target verbs appeared twice in a plausible condition and twice in an implausible condition (Appendix 9) and they were not located either at the beginning or end of the sentence to avoid return sweeps (Rayner & Pollatsek, 2006). Target sentences were randomised together with 72 sentences functioning as fillers, which did not have similar semantic or syntactic ambiguities as the target sentences in order to avoid overload [74]. Comprehension questions followed only two-thirds of the fillers.

All experimental garden-path sentences were piloted with high proficient adult L2 learners of English (n=5) with a mean age of 30.8 (SD=3.34, min=26, max=34) and adult L1 English monolinguals (n=5)[75] as a control with a mean age of 31.8 (SD=4.91, min=24, max=36). The offline piloting aim was to find whether or not the materials were suitable for the study. Participants were asked if the garden-path sentences were plausible or implausible. If the sentence was plausible they had to score it as correct, if it was implausible as incorrect. Accuracy mean scores for the plausible (M=4) and implausible condition (M=4) revealed that all participants (n=10) interpret them correctly. Hence, no modifications were made to the experimental garden-path sentences.

Three different types of exposure were taken into account in this study: incidental only, explicit only, and incidental and explicit combined. The experimental manipulation across participants was explained in Chapter 5 of this thesis.

8.2.6 Study 5: Procedure

The procedure of this study is similar to that of Chapter 7. Each participant was seen individually in a quiet room and they were seated in front of a 17” display screen with their chins and forehead supported on an Eye Link 1000 plus desktop mount. Participants were seated with their eyes 20cm away from the display screen.

The session started with calibration and validation procedures. Then, participants were instructed to read carefully the upcoming sentences, which were presented separately in a blank screen. They were informed that comprehension questions will appear after reading some of the sentences and that they had to answer either “yes” or “no” by clicking the right-hand side mouse-button. A drift correct, in the form of a black centrally-located circle, appeared between each trial, and participants were asked to look at it and press the space bar in the keyboard while doing so. The drift correct was shown in order to allow re-calibration of the eye-tracker before each trial.

The experiment started with a welcoming screen with the experiment’s instructions and participants were to proceed to the experiment by clicking the right-hand side mouse

[74] Experimental items were not matched on syllable length and/or frequency. Future work should take it into consideration.
[75] A higher number of participants, for the experimental piloting, would have enriched this work.

button. Soon after that, the experimental screen was displayed followed by the screen with the comprehension question. The following screen started after participants responded. Three practice trials preceded the experimental.

8.3 Study 5: Results

First, results of the comprehension questions are briefly analysed in order to establish whether or not participants understood the sentences in which the target verbs were embedded. Then, results on plausibility are examined, followed by the results of exposure, and then the section ends with the analysis of the individual differences.

8.3.1 Comprehension Questions

Table 35 presents the accuracy scores of the comprehension questions.

Table 35. *Accuracy Mean Scores of the Comprehension Questions*

	Mean	Minimum	Maximum	St. Deviation
L1 Learners	90.1	80.88	95.59	4.22
L2 Learners	86.11	67.65	97.06	7.64

Table 35 provides the summary statistics of the comprehension questions. As expected, L1 speakers (90%) obtained higher scores than L2 speakers (83%). Lower accuracy scores in the L2s reveal that they found the garden-path sentences more difficult to understand than L1 speakers (Roberts & Felser, 2011). Nevertheless, L2 speakers correctly scored 83% of the target sentences, which demonstrates their understanding of the sentences and the context where the pseudowords appeared.

Overall, these results indicate that L1 and L2 speakers comprehended the target sentences and the context where the newly learned pseudowords were inserted. Thus, they were used for further analyses.

8.3.2 Study 5: Data Analysis

Participants' first fixations times, first pass times, total reading times, and regressions into and out of the region of interest were analysed through a series of linear mixed-effects models, using the "lmerTest" package (Kuznetsova et al., 2017) in the R environment (R Studio Development Core Team, 2015). Reading times on six different critical segments were taken into account.

The first region of interest corresponded to the determiner phrase (DP) as shown in [1] below in Figure 12, the second region to the pseudoword [2], the third to the ambiguous DP [3], the fourth to the disambiguating verb [4], the fifth to the spillover words [5], and the sixth to the end of the sentence. In order to avoid extreme outliers reading times over 5000ms or less than 100ms were removed. This affected 0.5% of the L1 data and 4% of the L2 data.

While	the teacher	enched	the essay	started	an important	debate.
	1	2	3	4	5	6

Figure 12 Sentences' critical regions of analysis

Longer reading times in the implausible sentences up to the third critical region and in the plausible sentences from the fourth region onwards were expected, given that the subject-object ambiguity is likely to slow down online processing. Thus, plausible sentences would be read faster up to the third critical region, but the reading times will increase from the fourth region onwards.

8.3.3 Study 5: Analysis Research Question 1

For research question 1, the linear mixed-effects model had subjects as random factors and first language (L1) and plausibility as predictors. The L1 predictor had two levels: L1 and L2; and the plausibility predictor also had two levels: plausible and implausible.

On the pseudowords, L2 learners would elicit longer total reading times overall and in the implausible condition, given that L1 and L2 semantic and syntactic comprehension differ (Clahsen & Felser, 2006). The analysis of first fixation times[76]showed significant main effects of first language (β =51.36, SE=20.31, t=2.529, $p<0.05$). This is mainly because L2 learners elicited longer first fixation times (M=331.78ms) than L1 learners (M=276.12ms). Given that first fixation times indicate word recognition and retrieval from the mental lexicon (Conklin et al., 2018), it is possible, therefore, that L2 learners took longer to recognise and retrieve the meaning and form of the recently learned pseudowords because they are just emerging on their mental lexicons. From these results one can also infer that in their first online reading of the novel words, L2 learners take longer to engage and relate their meaning with their grammatical use.

[76] (lmerTest::lmer(FirstFix ~ L1 * plaus + (1 | subject) + (1 | item), data = pseudoFirstFix)

On the ambiguous determiner phrase: a) longer total reading times for L2 learners and b) longer L1 and L2 overall reading times in the implausible versus the plausible condition were expected. The analysis of total reading timesshowed a significant main effect of plausibility (β =47.21, SE= 20.82, t= 2.268, p<0.05) and no interaction with the L1 group. This result is due to the fact that plausible sentences elicited approximately 48ms longer total reading times (M=483ms) than implausible sentences (M=435ms), irrespective of language group. It can thus be suggested that L1 and L2 learners integrated the ambiguous DP into the current parse and this caused more difficulty when it led to a plausible analysis. This result may be explained by the fact that learners were committed to their first semantic analysis of the ambiguous DP and abandoning that first plausible semantic interpretation produces more processing costs than implausible analyses (Pickering & Traxler, 1998). This in turn suggests that learners noticed the subject-object ambiguity (as evidenced in their total reading times); hence, it could conceivably be hypothesised that they have engaged the grammatical use of the target pseudowords with their semantic characteristics and this gave rise to processing difficulties when abandoning their first semantic analysis of the ambiguous DP.

If readers were affected by plausibility in the disambiguating region, L2 longer total reading times and L1 and L2 longer total reading times in the plausible condition were expected. The analyses of first fixations[77] (β = 31.85, SE= 14.17, t= 2.247, p<0.05), first pass times[78] (β = 45.89, SE= 20.04, t=2.289, p<0.05), and regressions into the region[79] (β = -0.18875, SE=0.06559 t= -2.878, p<0.05) revealed main effects of language background but not on plausibility. L2 learners took longer to read this segment for the first time (M=253.54ms) than English learners (M=213.26ms) and their first pass times were also longer (M=303.70ms) than those of L1 learners (M=252.59ms) (Figure 13). For the regressions into the critical region the patterns were reversed: L2 learners were faster (M=0.26ms) than English learners (M=0.45ms). For the other reading time measures, there were no other significant main effects or interactions.

[77] lmerTest::lmer (FirstFix ~ L1* plaus + (1 | subject) + (1 | item, data= disambFirstFix
[78] lmerTest::lmer (FirstP ~ L1* plaus + (1 | subject) + (1 | item, data= disambFirstPass)
[79] lmerTest::lmer (RegIn ~ L1*plaus + (1 | subject) + (1 | item, data= disambRegin)

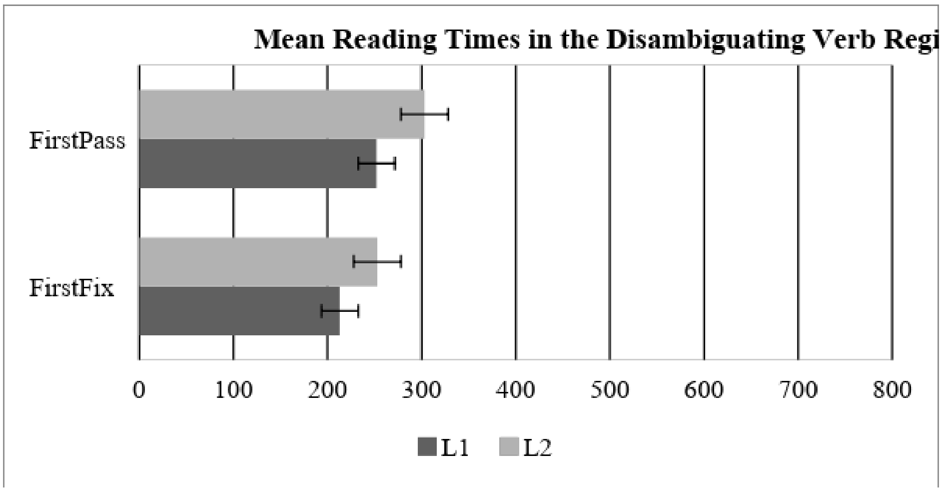

Figure 13 L1 and L2 Mean First Fixation and First Pass Times in the Disambiguating Verb Region.

From the data in Figure 13, L1 and L2 reading time differences can be clearly seen. This finding is consistent with that of Roberts and Felser (2011) who found that L2 learners take longer than L1 speakers to process this region.

On the spillover regions it was expected: L2 slower reading times as L2 learners would have taken longer to process the previous disambiguating region, and longer L1 and L2 reading times for the plausible condition, given that the region following the syntactic disambiguation requires more processing difficulty in the plausible condition (Roberts & Felser, 2011). In the analysis of regressions out of the region[80], there was a significant effect of first language (β = SE=-0.10543, t= -2.057, $p<0.05$) regardless of plausibility. It is mainly because L2 learners (M=0.23ms) elicited less reading time than L1 learners (M=0.34ms). Given that L2 learners took longer to process the disambiguating verb, processing the spillover sections is less demanding and, therefore, their regressions are quicker than those of L1 learners.

For the other reading time measures, there were no other significant main effects or interactions. There were no effects either at the determiner phrases (DPs) or at the sentences' final region (for a complete list of all codes used and their results see Appendix 10).

8.3.4 Study 5: Analysis Research Question 2

Subjects were specified as random factors with the predictors of plausibility and exposure. The plausibility predictor had two levels: plausible and implausible; and the exposure predictor had three levels: incidental only, explicit only, and incidental and

[80] lmerTest::lmer (Regout ~ L1*plaus + (1 | subject) + (1 | item), data= spills)

explicit combined. In order to deeply analyse the effects of plausibility and exposure, L2 learners were analysed separately from L1 learners.

L2 results will be presented first followed by L1 results.

8.3.4.1.1 Study 5 Analysis RQ2: L2 Learners

In the determiner phrase, it was expected overall longer reading times in the incidental only condition and longer reading times in the implausible condition in every type of exposure would be found. The analysis of regressions out of the region[81] showed a significant effect on incidental exposure and plausibility (β= 0.13188, SE= 0.05527, t= 2.386, p<0.05). This result is caused mainly because the plausible condition (M=0.13ms) generated less regression out times than the implausible condition (M=0.21ms) in the incidental exposure. This result highlights that learners regress out of the determiner phrase faster in plausible sentences when the recently learned pseudowords were encountered incidentally in the training phase. Given that this region precedes the recently learned pseudowords, learners may need to reanalyse it after parsing the subject-object ambiguity as it is linked to the target pseudoword.

When parsing the pseudowords, slower reading times overall in the incidental only exposure were expected. In terms of plausibility, shorter reading times for the implausible conditions in every type of exposure were predicted. The analysis of first fixations[82] (β= 43.73, SE= 18.29, t= 2.39, p<0.05) and first pass times[83](β= 96.37, SE= 24.93, t= 3.865, p<0.001) revealed main effects with the incidental condition. These results can be explained by the following facts:

a) First fixation times in the incidental (M=276.33ms) and in the incidental and explicit condition (M=277.10ms) were longer than in the explicit condition (M=227.20ms).

b) First pass reading times in the incidental (M=374.02ms) and incidental and explicit condition (M=357.28ms) were slower than in the explicit (M=269.89ms) (Figure 14).

It can thus be suggested that an explicit learning condition of the pseudowords contributed to faster online processing in garden-path sentences containing subject-object ambiguities. Given that there was no interaction with plausibility, it is possible to hypothesise that longer first fixation times may not be linked to the sentences' temporary ambiguities and lexical engagement of use, but to the pseudowords' lexical

[81] lmerTest::lmer(regout~plaus*Exposure+ (1|subject)+ (1|item), data = dpsL2)
[82] lmerTest::lmer(ffix~plaus*Exposure+ (1|subject)+ (1|item), data = pseudoL2)
[83] lmerTest::lmer(firstP~plaus*Exposure+ (1|subject)+ (1|item), data = pseudoL2)

characteristics (as previously discussed in the results of the first research question of this chapter).

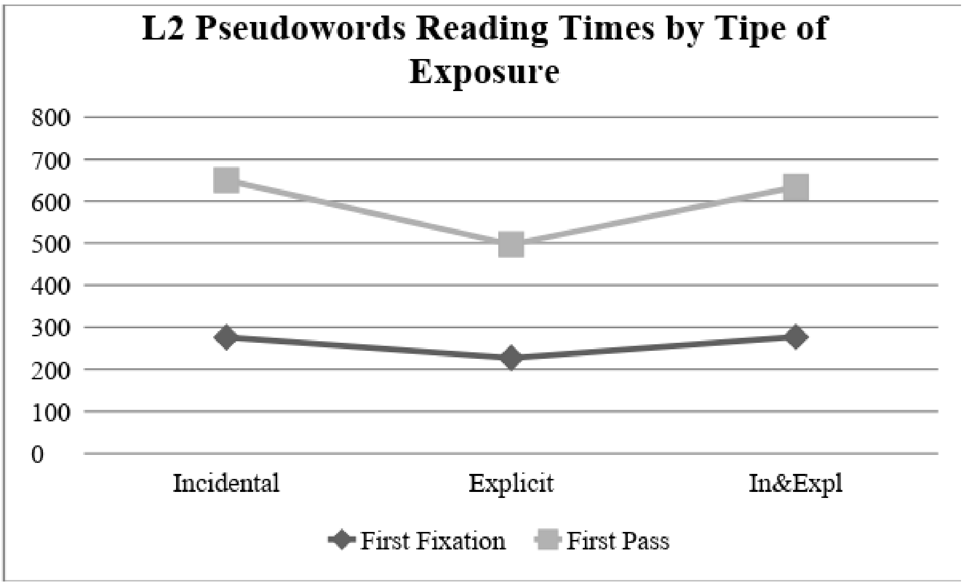

Figure 14 L2 Pseudowords Mean First Fixation and First Pass times in every exposure condition.

It is apparent from Figure 14 that the incidental condition generated longer first fixation and first pass reading times than the other exposures.

If readers were affected by exposure in the ambiguous DP, overall longer reading times in the incidental condition were expected. In terms of plausibility, the plausible condition would elicit longer reading times than the implausible in every type of exposure. The analysis of total reading times[84] showed an effect of incidental exposure and plausibility (β= -137.61, SE=60.79, t= -2.264, p<0.05). This interaction can be explained by one main factor: the plausible condition (M=493.60ms) generated longer reading times than the implausible condition (M=434.32ms) in the incidental exposure. This finding confirms that L2 implausible analyses are easier to abandon on the basis of the semantic implausibility (Pickering & Traxler, 1998), but it highlights that it was significant in the incidental condition.

Given that the region following the syntactic disambiguation requires more processing difficulty in the plausible condition (Roberts & Felser, 2011), an effect of plausibility in every exposure was expected in the spillover region. Longer overall reading times in the incidental only exposure were also predicted. The analysis of first fixations[85] revealed a significant effect of plausibility and incidental and explicit exposure (β= 51.582,

[84] lmerTest::lmer(total~plaus*Exposure+ (1|subject)+ (1|item), data = ambdpL2)
[85] lmerTest::lmer(ffix~plaus*Exposure+ (1|subject)+ (1|item), data = spillsL2)

SE=21.478, t= 2.402, p<0.01). These results are explained by the fact that in the incidental and explicit exposure the plausible condition elicited approximately 35ms longer reading times (M=252.97ms) than the implausible (M=217.89ms), as expected. A possible explanation for this is that when reading for the first time this region (e.g. *hot and*) in plausible sentences, such as 3 below, L2 learners take longer to process it for the first time due to the sentences' plausibility up to encountering the disambiguating verb (e.g. got).

(3) While the boy hirpped [walked] the dog got hot and smelly.

This result not only confirms that learning requires incidental and explicit aspects (Sun et al., 2009), but also that L2 learners engaged the meaning of the recently learned pseudowords with their grammatical use since they showed online plausibility processing effects (Roberts & Felser, 2011). Nevertheless, the plausibility effect is significant when the novel words were learned in a combination of incidental and explicit exposures. This in turn suggests that L2 incidental word learning might not produce similar results to the ones just discussed; however, more research with other L2 populations and lexical items is needed to confirm it.

There were no significant effects at the sentences' final region (for a complete list of all codes used and their results see Appendix 10.

8.3.4.1.2 Study 5 Analysis RQ2: L1 Learners

Faster reading times in the explicit condition were expected when reading the recently learned pseudowords in plausible and implausible sentences. The analysis of regressions out of the region[86] showed a significant effect for the incidental and explicit condition (β= 0.09527, SE= 0.03578, t= 2.662, p<0.05) and no plausibility effects. This result was because the incidental and explicit condition elicited slower reading times (M=0.14ms) than the explicit (M=0.04ms) and incidental (M=0.09ms) conditions. Given that regressions give the reader the opportunity to re-examine a previous part in the text (Winke, Godfroid & Gass, 2013), it can be assumed that English learners re-examined the pseudowords slower in the incidental and explicit exposure. A possible explanation for this might be that learning the pseudowords through incidental and explicit exposures generated more robust lexical representations in the mental lexicon; hence, learners regress out of them slower in this condition as they are reprocessing their semantic and syntactic elements. Even though this finding suggests that L1 learners may

[86] lmerTest::lmer(regout~plaus*Exposure+ (1|subject)+ (1|item), data = pseudoL1)

have benefited from incidental and explicit aspects (Sun et al., 2009), it does not highlight lexical engagement of use, as there is no interaction with plausibility.

Effects of exposure were expected in the disambiguating region where the incidental exposure and the plausible condition would elicit longer reading times. The analysis of a) first fixations[87], b) total reading times[88], c) regressions into[89] and d) out of the region[90] showed significant effects of plausibility and the incidental and explicit condition. This can be explained by the fact that the plausible condition elicited faster reading times than the implausible. To illustrate:

a) For first fixation times (β= -51.097, SE= 21.078, t= -2.424, p<0.05), the implausible condition elicited slower reading times (M=220.02ms) than the plausible (M=187.64ms). This indicates that when L1 learners read the disambiguating region for the first time they took longer to process it in the implausible condition. Given that in the implausible condition the region preceding the disambiguating verb is an implausible ambiguous DP, the first fixation of the disambiguating verb may take longer because it resolves or increases the previous ambiguity. For instance, once the learner parses the disambiguating verb the ambiguous DP (e.g. *the dough* in 4 below) can potentially be the subject of the disambiguating verb (e.g. fell) and this may slow down their first fixation times.

(4) As the girl grodded [washed] the dough felt very soft indeed.

b) In total reading times (β= 128.68, SE= 64.30, t= 2.001, p<0.05) the plausible condition generated shorter reading times (M=546.82ms) than the implausible (M=584.75ms) (Figure 15). Similarly with first fixation times, longer total reading times in the implausible condition may have been due to the semantic and syntactic ambiguity in the sentence. L1 learners spend more time reading the disambiguating verb because it potentially clarifies the ambiguity, and this takes longer when the sentence carried the subject-object ambiguity before parsing the disambiguating region.

c) For the regressions into the region (β= 0.24222, SE= 0.11466, t= 2.112, p<0.01) L1 learners regressed faster in the plausible condition (M=0.48) than the implausible (M=0.59). The reason for this is that it took L1 learners longer to re-examine and re-

[87] lmerTest::lmer(firstF~plaus*Exposure+ (1|subject)+ (1|item), data = disambVL1)
[88] lmerTest::lmer(total~plaus*Exposure+ (1|subject)+ (1|item), data = disambVL1)
[89] lmerTest::lmer(regin~plaus*Exposure+ (1|subject)+ (1|item), data = disambVL1)
[90] lmerTest::lmer(regout~plaus*Exposure+ (1|subject)+ (1|item), data = disambVL1)

process the disambiguating verb in the implausible condition due to the sentences' implausibility, as highlighted above.

d) Regressions out of the region (β= -0.18359, SE= 0.09211, t= -1.993, p<0.01) elicited shorter reading times in the plausible (M=0.07ms) than the implausible (M=0.18ms) condition. This can be explained in part by the fact that learners re-read this region more quickly in the plausible condition; hence, they regress approximately 11ms faster out of it.

In general, the results just shown clearly demonstrate that the incidental and explicit exposures contributed to faster processing of the plausible condition when parsing the disambiguating verb.

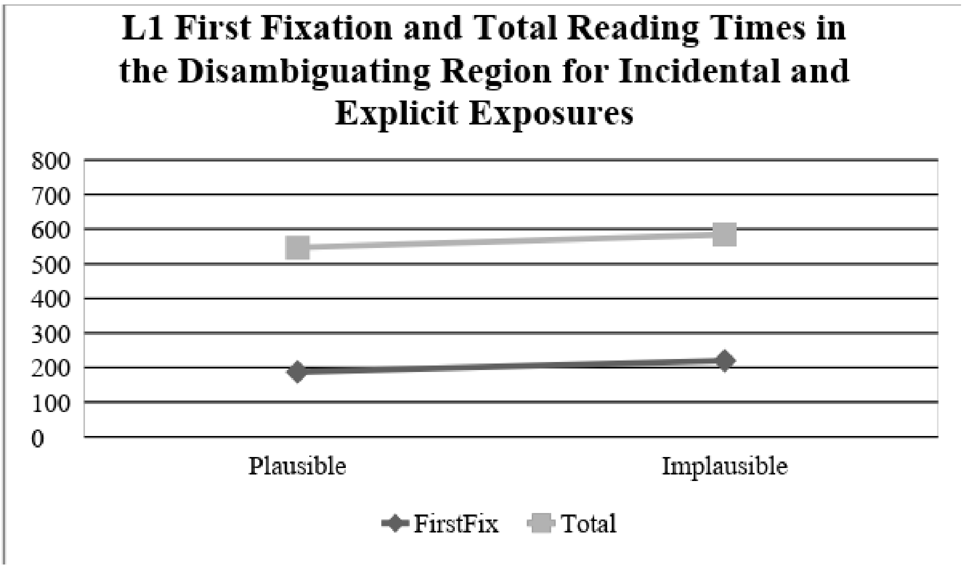

Figure 15 L1 First Fixation and Total Reading Times in the Disambiguating Region for Incidental and Explicit exposures.

For the spillover region an effect of exposure was expected: the incidental exposure would generate longer reading times. An effect of plausibility was also predicted: where the plausible condition would elicit shorter reading times. The analysis of first pass times[91] revealed a significant effect in the incidental only exposure (β= 65.801, SE=31.729, t= 2.074, p<0.05), but no effect of plausibility. The incidental exposures (M=310ms) elicited longer reading times than the explicit (M=258ms) and the incidental and explicit exposures (M=252ms) (Figure 22). The observed increase in first pass times in the incidental condition could be attributed to the robustness of the pseudowords' emerging lexical representations. It is possible that learners take longer to

[91] lmerTest::lmer(FirstP~plaus*Exposure+ (1|subject)+ (1|item), data = spillsL1)

read the spillover region, when the pseudowords were learned incidentally, because this type of exposure did not produce memory traces as robust as those in other types of exposures.

Given that first pass reading times take into account all fixations that were made on a region before the eye exited it (Conklin et al., 2018), this result suggests not only that a combination of incidental and explicit exposures aids learning (Sun et al., 2009), but also that it may contribute to faster parsing of spillover regions in temporary ambiguous subject-object sentences. This could be an important issue for L1 novel word learning, future studies on the current topic are therefore recommended.

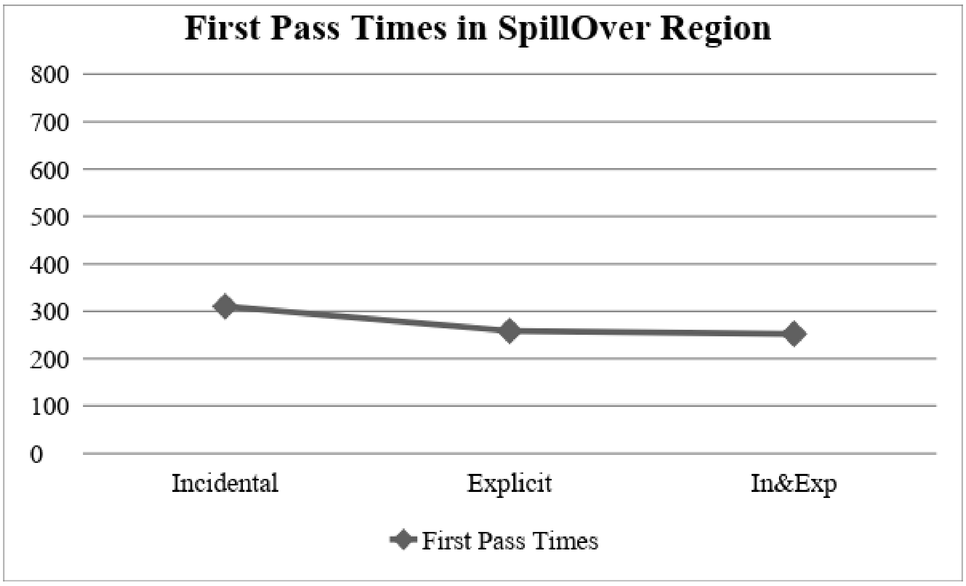

Figure 16 L1 First Pass times in the spillover region and types of Exposure.

The figure above illustrates that learners' first pass times in the spillover region were faster in the incidental and explicit condition.

When analysing the regressions out[92] of the spillover region, a significant effect of plausibility was found (β= 0.16410, SE= 0.07158, t= 2.293, p<0.01) because the plausible condition (M=0.43ms) was 16ms slower than the implausible condition (M=0.27ms). This was expected as the region following the syntactic disambiguation requires more processing difficulty in the plausible condition (Roberts & Felser, 2011).

There were no effects in the other sentence's regions (for a complete list of all codes used and their results see Appendix 10).

[92] lmerTest::lmer(regout~plaus*Exposure+ (1|subject)+ (1|item), data = spillsL1)

8.3.5 Study 5: Data Analysis Research Question 3

Subjects were determined as random factors with the predictors of plausibility, phonological working memory, verbal fluency, and vocabulary size. The plausibility predictor had two levels: plausible and implausible; the other predictors only had one level. In order to deeply analyse the effects of plausibility and the individual differences, L2 learners were analysed separately from L1 learners. L2 results will be presented first.

8.3.5.1.1 Study 5 Analysis RQ3: L2 Learners

An effect of every individual difference was expected for the ambiguous DP in both the plausible and implausible conditions in every reading measure. The analysis of first fixations[93] (β= 4.664, SE= 1.727, t= 2.700, $p<0.01$) and first pass times[94] (β= 6.374, SE= 2.060, t= 3.094, $p<0.01$) showed significant effects of plausibility and verbal fluency. In order to better interpret this result participants were divided into high and low verbal fluency groups according to a median split[95] on their verbal fluency scores in this region (*Mdn*=25). It was found that the high verbal fluency capacity group:

a) Elicited longer first fixation times (M=235.76ms) and first pass times (M=269.24ms) than the lower capacity group (M=228.72ms and M=264.85ms respectively).

b) It was 31.5ms slower in their first fixation times in the plausible condition than the lower group (M=253.34ms vs. M=221.76ms), and 20ms slower when processing the implausible condition (M=216.81ms vs. M=236.41ms) (Figure 23).

c) It elicited longer first pass times than the lower group in the plausible (M=295.72ms vs. M=256.98ms) and implausible (M=240.71ms vs. M=273.55ms) conditions.

Taken together these results point out that having more verbal fluency capacity slows down the online processing of the ambiguous DP for Spanish speaking learners of English. A possible explanation for this may be that those learners with higher verbal fluency capacity strongly integrated the meaning and grammatical functions of the pseudowords during training. Therefore, when parsing the ambiguous DP, their reading times slow down as they identify and engage the semantic characteristics of the recently

[93] lmerTest::lmer (FirstF ~ PWM*vocab*verbalF* plaus + (1 | subject) + (1 | item), data= ambdpL2)

[94] lmerTest::lmer (FirstP ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= ambdpL2)

[95] The median splits performed for the analyses of the third research question are for illustrative purposes only; hence, they are not use for further testing.

learned pseudowords with the semantic and syntactic elements of the ambiguous DP. According to this, one can infer that those L2 participants with higher verbal fluency capacity might have developed stronger emerging lexical representations of the pseudowords.

Regression times into[96] the ambiguous DP (β=- 0.008332, SE= 0.003928, t=-2.121, p<0.05) showed significant effects of plausibility and PWM. Participants were divided into high and low capacity groups according to a median split of their PWM (*Mdn*=28).

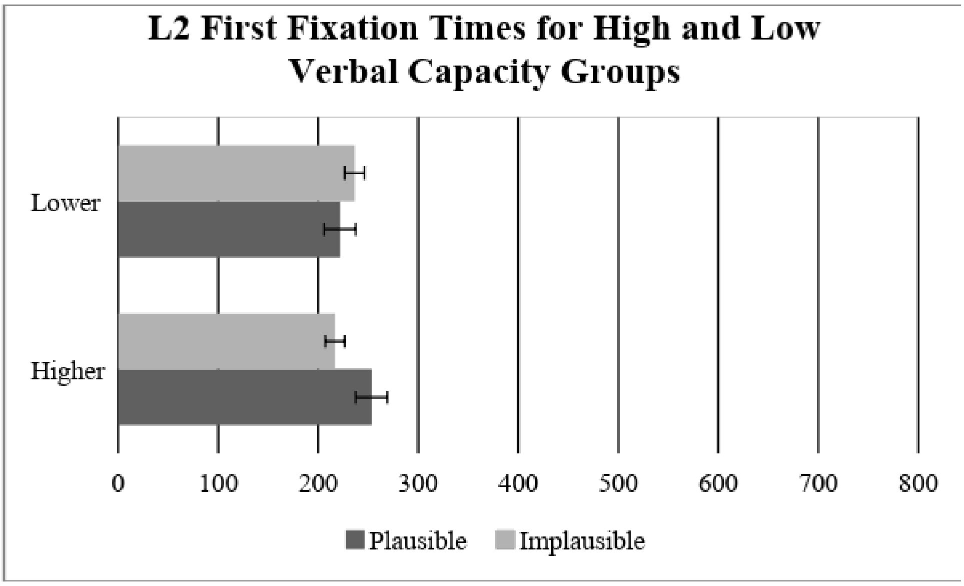

Figure 17 L2 First Fixation Times in the Ambiguous DP for the High and Low Verbal Fluency capacity Groups.

As can be seen in Figure 17, when fixating this ambiguous region for the first time participants with higher verbal fluency capacity took longer to read it in both plausible and implausible conditions.

After dividing participants into high and low PWM capacity groups, results highlighted that the higher PWM capacity group regressed into the region 4ms faster (M=0.30ms) than the lower group (M=0.34ms); it was 13ms faster in the implausible condition (M=0.24ms) than in the plausible (M=0.37ms), and its regression times were 6ms slower in the plausible condition (M=0.36ms) when compared to the plausible (M=0.30ms) (Figure 24).

A possible explanation for this may be that participants' higher PWM assisted their learning of the pseudowords during the training phase. For instance, given that PWM is an L2 vocabulary learning device (Baddeley, 2012), it is possible, therefore, that higher

[96] lmerTest::lmer (RegIn ~ PWM*vocab*verbalF* plaus + (1 | subject) + (1 | item), data= ambdpL2)

PWM capacity aids learning the semantic and syntactic characteristics of the pseudowords during the learning phase. Thus, when encountering a semantically implausible subject for the recently learned pseudowords, they reanalysed it faster on the basis of the knowledge they acquired during training.

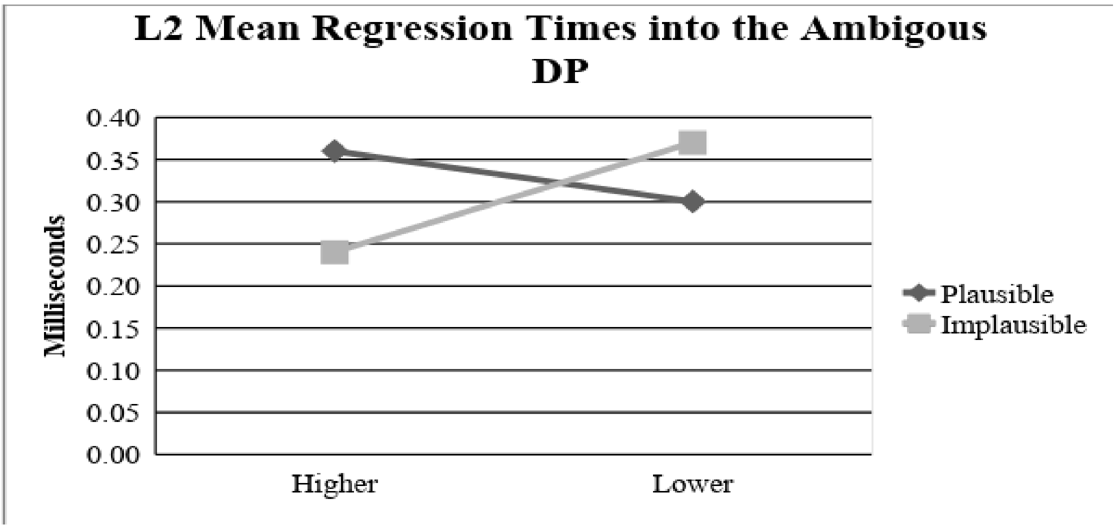

Figure 18 L2 Mean Regression Times into the ambiguous DP.

Figure 18 illustrates that L2 learners with higher PWM regressed into the ambiguous DP significantly faster in the implausible condition. This result highlights that higher PWM capacity may have an effect on lexical engagement of use of novel items as the higher capacity group elicited faster regression times. In addition, these learners were 6ms slower when reanalysing the ambiguous DP in the plausible sentences because, as already mentioned, implausible analyses are easier to abandon on the basis of the semantic implausibility (Pickering & Traxler, 1998). This combination of findings provides support for the conceptual premise that lexical engagement of use has taken place and that higher PWM capacity may have an effect on it.

In the disambiguating verb effects of every individual difference were predicted. The analysis of the regressions into[97] the region showed a significant effect of verbal fluency, phonological working memory, and vocabulary size (β= 2.359e-05, SE= 9.777e-06, t= 2.413, p<0.05). In order to interpret this result, a median split of participants' individual differences in this region was performed: PWM (*Mdn*=28), verbal fluency (*Mdn*=25), and vocabulary size (*Mdn*=7302). From this data, participants

[97] lmerTest::lmer (RegIn ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL2)

were divided into low and higher individual difference groups. Table 36 displays the descriptive statistics on each group in each individual difference.

High PWM and verbal fluency groups regressed into the disambiguating region exactly as the same speed and faster (M=0.12) than the low group (M=0.09); however, the contrary effect was found for vocabulary size as the lower group (M=0.06) outperformed the high group (M=0.16).

Table 36 *L2 High and Low Groups' Individual Differences*

	PWM		Verbal Fluency		Vocabulary Size	
	M	SD	M	SD	M	SD
Low Group	27.20	1.50	20.76	3.16	6783	336.94
High Group	29.80	0.68	29.21	2.95	8155	523.50

These results suggest that higher PWM and verbal fluency aided faster reanalysis and processing of the disambiguating region, but higher L2 vocabulary knowledge does not significantly contribute to faster processing of the disambiguating verb. As there was no interaction with plausibility, these findings are likely to be caused by online processing individual differences and perhaps not by lexical engagement of use. For instance, it is not possible to know if the individual differences just mentioned had an effect on the reanalysis of the disambiguating verb due to the sentences' semantic and syntactic implausibility. It can thus be suggested that these findings are likely to be caused by online processing individual differences and perhaps not by lexical engagement of use of the recently learned pseudowords.

For the pseudowords it was predicted that every individual difference would have an effect in both plausible and implausible conditions in every reading measure. However, contrary to expectation, there was only a significant effect of vocabulary size in first pass reading times[98] (β= -0.06650, SE= 0.01953, t= -3.405, $p<0.05$). Once again, participants were categorised into high and low vocabulary knowledge according to a median split of their vocabulary size (*Mdn*= 7417). It was found that the high vocabulary knowledge group were 79.77ms faster than the low group (M=290.39ms vs. M=370.16ms). This finding highlights that L2 learners with more L2 vocabulary

[98] lmerTest::lmer(FirstP~plaus*PWM*VocabSize*VerbalF+ (1|subject)+ (1|item), data = pseudoL2)

knowledge were faster when processing the recently learned pseudowords. This suggests that learners' previous vocabulary knowledge sped up their online first pass reading times of recently learned pseudowords.

8.3.5.1.2 Study 5 Analysis RQ3: L1 Learners

An effect of every individual difference was expected for the ambiguous DP in plausible and implausible conditions in every reading measure. The analysis of the regressions into[99] the region showed significant effects of plausibility and vocabulary size (β= 3.645e-04, SE= 1.657e-04, t= 2.200, p<0.05). In order to interpret this result participants were categorised into high and low vocabulary knowledge groups according to a median split of their vocabulary size (*Mdn*= 7417). It was found that the high vocabulary knowledge group regressed into this region 4ms faster (M=0.35ms) than the lower group (M=0.39ms); it was 10ms faster (M=0.31ms) than the low group (M=0.41ms) when processing the implausible condition, and it was 3ms slower in the plausible condition (M=0.40ms vs. M=0.37ms) (Figure 19).

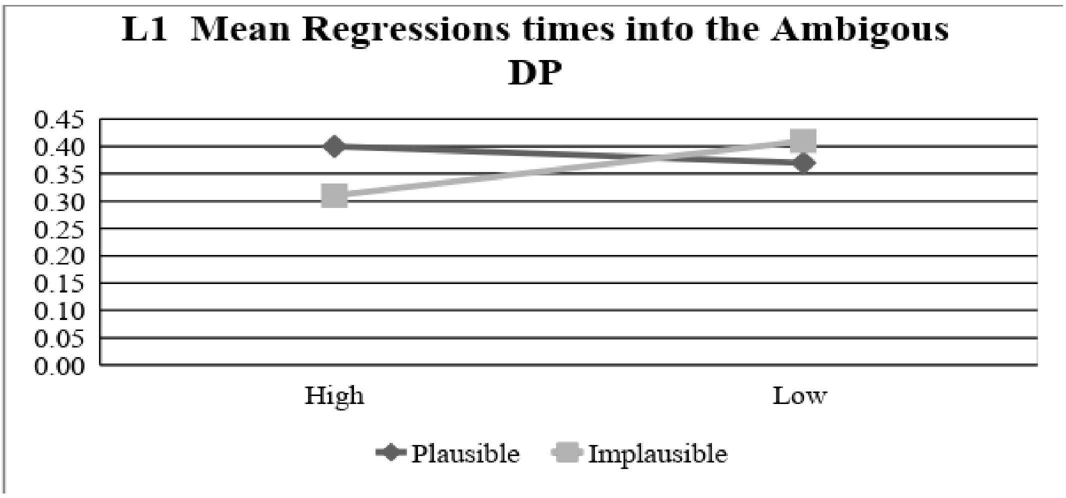

Figure 19 L1 Mean Regression times into the ambiguous DP.

As Figure 19 shows, the high vocabulary knowledge group outperformed the low group in the implausible condition. This suggests that pre-existing vocabulary knowledge aids their reanalysis of the ambiguous DP as an implausible object of the recently learned pseudowords. The higher group may have taken less time to reanalyse the syntactic and semantic characteristics of the ambiguous DP in the implausible condition because they

[99] lmerTest::lmer (RegIn ~ PWM*vocab*verbalF* plaus + (1 | subject) + (1 | item), data= ambdpL1)

are more sensitive and aware of the implausibility of the ambiguous DP (e.g. the toy) as a direct object of the recently learned pseudoword (e.g. gwap) in 5 below.

(5) As the boy gwapped [ate] the toy rolled off the table.

It is possible to hypothesise that the higher vocabulary group is more sensitive to the ambiguity and thus slower in the implausible condition because their pre-existing vocabulary knowledge aided their learning of the semantic and syntactic characteristics of the pseudowords during the training phase.

For the pseudowords, effects of every individual difference were expected in the plausible and implausible conditions in every reading measure. The analysis of total reading times [100] showed significant effects of plausibility with every individual difference (β= 5.569e-03, SE= 2.642e-03, t=2.108, $p<0.05$), and regressions into[101] the region revealed an interaction of plausibility and verbal fluency (β=0.020778, SE= 0.009639, t=2.156, $p<0.05$). Participants once again were divided into high and low groups according to the individual differences' median splits. It was found that:

a) The higher PWM group were 25.82ms faster in their total reading times than the low group (M=782.04ms vs. 807.86ms). In terms of plausibility, the higher PWM group outperformed the lower in both the plausible (M=780.84ms vs. M=824.82) and implausible condition (M=783.20ms vs. M=791.27ms). These total reading time differences can be explained by the fact that having more PWM contributed to participants' vocabulary learning of the pseudowords during the training phase.

b) The higher vocabulary size group was 42.46ms faster in their total reading times than the lower group (M=821.76ms vs. M=779.30ms). They were also faster in the plausible (M=860.25ms vs. M=763.62ms) and implausible (M=782.43ms vs. M=793.95ms) conditions. These results indicate that higher lexical knowledge sped up total reading times of the recently learned pseudowords.

c) The lower verbal fluency group was 42.46ms faster in their total reading times than the higher group (M=779.30ms vs. M=821.76ms) and 96.63ms faster in the plausible condition (M=763.62ms vs. M=860.25ms). However, they were slower when processing the pseudowords in the implausible condition (M=782.43ms vs. M=793.95). Total reading times measure word integration and since they can be influenced by context and discourse (Conklin et al., 2018), it may be the case, therefore, that the

[100] lmerTest::lmer (Total ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= pseudoL1)
[101] lmerTest::lmer (RegIn ~ PWM*vocab*verbalF* plaus + (1 | subject) + (1 | item), data= pseudoL1)

higher capacity group outperformed the lower in the implausible condition due to the context's implausibility.

Generally, the findings on the pseudoword region suggest that the individual differences had an effect on L1 online processing and lexical engagement of use in recently learned pseudowords. Higher PWM and vocabulary size sped up total reading times of the novel items in plausible and implausible subject-object ambiguous sentences. These findings raise intriguing questions regarding the nature and extent of individual differences in L1 lexical engagement of use and sentence processing of temporary ambiguous sentences. Thus, research on this topic is suggested. In the disambiguating verb effects of every individual difference were expected in plausible and implausible conditions in every reading measure. The analysis of regressions into the region, showed significant effects of PWM (β= -0.089805, SE=0.041624, t= -2.158, $p<0.01$). After a median split of participants' PWM it was found that the higher PWM capacity group slightly outperformed the lower group (M=0.46ms vs. M=0.44ms). L1 learners with higher PWM reanalysed the disambiguating verb 2ms faster, perhaps due to faster processing during training; however, given that the time difference is not great and that there were no effects on plausibility, this result has to be interpreted with caution. More research on L1 novel word lexical engagement and possible effects of PWM should be undertaken to better understand this result.

For the other reading time measures, there were no other significant main effects or interactions.

8.4 Chapter Conclusion

The main goal of this study was to investigate online lexical engagement of use through semantic and syntactic ambiguities of newly learned words. The extent of incidental learning and the effect of individual differences were also taken into account.

From the results of this study, the following three main conclusions are drawn:1)L1 and L2 learners' semantic and syntactic knowledge of the recently learned pseudowords is robust enough to show lexical engagement of grammatical use in temporary subject-object ambiguous sentences. L2 learners were similarly affected as L1 learners by the sentences' plausibility, and both types of learners committed to their first initial semantic analysis (Pickering & Traxler, 1998) before encountering the subject-object ambiguity.

2) L2 incidental word learning can reach lexical engagement of use within the parameters of this study. However, for L1 learners a combination of incidental and explicit exposures is more efficient in order to achieve lexical engagement of use.

3) Higher PWM capacity assists L1 and L2 lexical engagement of use of novel items, in particular by faster L2 processing of the ambiguous DP.A link exists between L1 and L2 higher vocabulary knowledge and faster online processing of recently learned novel items embedded in temporary ambiguous sentences. Higher vocabulary knowledge influences L1 lexical engagement of use. Higher verbal fluency capacity has an effect on L2 lexical engagement of use.

CHAPTER 9 FINDINGS AND DISCUSSION

The discussion on this thesis will refer to the key findings of the experimental studies previously reported. It will address the research questions of each study. Then, the chapter finishes by examining the limitations of this work.

9.1 Findings and Discussion on Lexical Configuration

9.1.1 Findings and Discussion Study 1

The findings of this study suggest that L2 learners recognised and recalled the form, meaning, and use of recently learned pseudowords from incidental reading, which supports previous findings in that L2 incidental vocabulary learning from reading is possible in adult learners (Waring & Takaki, 2003; Webb, 2007, 2008; Pellicer-Sánchez & Schmitt, 2010; Pellicer-Sánchez, 2015). The hypothesis that Spanish speaking learners of English would recognise and recall the meaning, form, and use of recently learned pseudowords is confirmed. The study also corroborates that L2 incidental vocabulary learning from reading depends on modality given that recognition scores were higher than those of recall which has been well established in previous research (Webb, 2007, 2008; Pellicer-Sánchez & Schmitt, 2010; Pellicer-Sánchez, 2015). However, there were no significant differences between recognition and recall knowledge of form, meaning, and use with word type; thus, the hypothesis that nouns will present more significant results in both recognition and recall tasks is rejected. These results are likely to be related to four main learning conditions. First, the number of items per word type and frequency of exposure was not balanced. The target words included three nouns, two adjectives, and one verb. Thus, participants had 36 encounters with words functioning as nouns, 24 encounters of words functioning as adjectives, and 12 exposures to words functioning as verbs. This distribution does not take into account the frequency of occurrence of nouns and verbs in language use (Kucera & Francis, 1967), and it fails to provide equal exposures for developing memory traces in the mental lexicon. Given that every encounter with a word strengthens permanent or emerging semantic memory codes (Salasoo et al., 1985) and that frequency of exposures with a target influences L2 word learning (Waring & Takaki, 2003; Webb, 2007, 2008; Pellicer-Sánchez & Smichtt, 2010; Pellicer-Sánchez, 2015), it is likely that the lack of balance in the lexical items may have affected the results obtained. For instance, even though participants had more encounters of words functioning as nouns, there were only three target words functioning as nouns which may not be sufficient to yield significant results. Further research controlling the number of target items per word type should be undertaken.

Second,the contexts' informativeness was not controlled and this may not have provided adequate learning conditions for participants to infer the words' meanings (Nation & Webb, 2011; Bordag et al., 2015). This study used authentic texts to offer a naturalistic learning context (see Godfroid, Choi, Ballard, Cui & Yoon, 2017 for a study on incidental vocabulary learning in naturalistic contexts using online methodologies); however, the texts' vocabulary complexity was overlooked. Therefore, the target items may have been embedded in natural texts containing vocabulary that hindered participants' understanding. To illustrate, the newspaper articles were related to the topics of finance and economy, and their vocabulary frequency was not accounted for; thus, participants may have not understood the context well enough and this undoubtedly could have hindered their vocabulary learning (Nation & Webb, 2011; Elgort & Warren, 2014; Elgort et al., 2018). One possible way to control the vocabulary in the context is to ensure that only one in every 20 running words is unknown to the learners. This would have guaranteed 95% text coverage (Hu & Nation, 2000); however, it was not the aim of this study to manipulate the authentic texts.

Third, the position of the target items in the sentences was not controlled. To illustrate, some target items (e.g. pib) were embedded in the title, at the beginning of the sentence, or in the middle of it and this could have affected participants learning process and understanding of the target. Fourth, the order in which the vocabulary post-tests were administered. For instance, the recognition tests were administered prior to the productive and this could have caused learning and test effects since participants' receptive knowledge may have activated their linguistic productive knowledge. In addition, some recognition tests may have influenced the results of other receptive tests. To illustrate, given that the recognition test of meaning-association was the last taken (recognition of orthographic forms, grammatical functions, and meaning-association) participants may have already activated their semantic knowledge of the target words while processing their knowledge of form and grammatical functions in the previous tests. Considering the potential test effects mentioned above, the receptive scores of form and grammatical functions may reveal a clearer and a more accurate picture of the learners’ vocabulary gains given that they were the first to be administered and form processing may not highly affect knowledge of grammatical functions. In terms of the productive scores, they have to be taken with caution given the potential learning effects provided by the receptive tests. These factors may explain the no significant differences found between recognition and recall knowledge of form, meaning, and use with word type.

Overall, the findings on receptive and productive knowledge of form, meaning, and grammatical use are somewhat limited by the learning and test effects just mentioned. However, the tests of receptive knowledge of form and grammatical use bring an accurate reflection of learners’ vocabulary gains.

In terms of the effects of individual differences on recognition and recall scores **(RQ2)**, results corroborated the findings of previous work in that PWM has an effect on L2 vocabulary learning (Speciale et al., 2004; French, 2006; de Abreu & Gathercole, 2012; Baddeley, 2012). However, they add to current literature in that higher PWM capacity elicits higher recognition of grammatical use, thus it may facilitate grammar acquisition (Baddeley et al., 2015), and higher recall of the meaning and use of recently learned items. This finding could have important implications for L2 incidental vocabulary learning from reading in that higher PWM assists recall of the meaning and use of novel items; however, due to the small sample size, the learning conditions, and the ceiling effects previously reported in the fifth chapter of this thesis, this should be taken with caution. To develop a full picture of the possible effects of PWM on L2 incidental vocabulary learning of novel items, additional studies with offline and online methodologies are needed and highly recommended. The hypothesis that participants with higher aptitude scores will score higher on the recognition and recall tests is confirmed only for recognition and recall of grammatical use and meaning recall of recently learned pseudowords.

Surprisingly, there were no significant effects of L2 vocabulary learning and vocabulary size. This outcome is contrary to that of previous studies suggesting that there is a link between word learning and vocabulary knowledge (Perfetti et al., 2005; Henderson et al., 2015; James et al., 2017). A possible explanation for this may be that the offline vocabulary post-tests used facilitated participants’ recognition and recall scores; therefore, there are not significant effects on vocabulary knowledge given the ceiling effects elicited by the instruments used. In addition, participants’ advanced L2 proficiency level and the context’s informativeness could have influenced the results

The hypothesis that more vocabulary knowledge will result in higher scores in the recognition and recall tests is not confirmed.

9.1.2 Findings and Discussion Study 2

Results showed that L1 and L2 learners acquired lexical configuration knowledge of the meaning of the pseudowords in line with previous studies (Tamminen & Gaskell, 2013; Pellicer-Sánchez, 2015). However, English native speakers outperformed Spanish speaking learners in both recognition and recall post-tests and this confirms the hypothesis that L1 learners would elicit higher recognition and recall scores. The L1 and L2 differences found can be explained in part by the fact that L1 learners have been exposed more to the English language than L2 learners (Kaan, 2014); hence, the learning context may have facilitated their recognition and recall processes (Perfetti et al., 2005; Nation & Webb, 2011). For instance, while reading, a word's relevant information has to be accessed and recognised in order to understand the sentence where it is embedded (Gaskell & Brown, 2005); thus, the sentence context can facilitate recognition as most words within any given sentence are related in meaning (Eysenck & Kane, 2015). In addition, L2 speakers may have activated the meaning and form of L1 and L2 words while reading the texts (Dijkstra, 2005), and thus, their comprehension may have been more effortful and resource-consuming than that of L1 learners (Dijkgraaf, Hartsuiker & Duyck, 2017). Another possible explanation for the results obtained is that L1 lower-level processing (e.g. recognition) is automatic (Dronjic & Bitan, 2016); therefore, it may be less costly for L1 learners. The parallel activation in the bilingual mental lexicon could have also influenced the results as it slows L2 language tasks for bilinguals (de Groot, 2011).

Regarding the effects of type of exposure **(RQ2)**, it was found that incidental learning reaches L1 and L2 recognition and recall of novel items (Webb, 2007, 2008; Pellicer-Sanchez & Smichtt, 2010; Batterink & Neville, 2011; Tamminen & Gaskell, 2013; Pellicer-Sánchez, 2015) but to a lesser extent. To illustrate, the explicit condition generated higher L1 and L2 recognition and recall scores, followed by the incidental and explicit combination, and lastly the incidental condition (Table 37).

Table 37. *Summary of the Recognition and Recall Scores per type of Learner and Exposure*

	Recognition		Recall	
	L1	L2	L1	L2
Explicit	0.82	0.79	0.51	0.47
Incidental & Explicit	0.80	0.68	0.33	0.27
Incidental	0.65	0.49	0.26	0.20

Given that explicit learning can speed lexical production (Ellis, 2015), it was expected that the explicit condition would contribute to higher recognition and recall than the other conditions and the results confirmed this. A combination of incidental and explicit exposures also aided L1 and L2 recognition and recall processing, but to a lesser extent, and incidental exposure even less. This result highly contributes to the understanding of explicit instruction in language learning since it points out that the short definitions of the meanings of novel items during learning boost the acquisition of lexical configuration knowledge. It also suggests that L2 incidental word learning from reading does not generate as many learning gains as the combination of incidental and explicit exposure. Driving learners' attention to the meaning of the novel items generated more learning gains in line with previous studies in that more attention may lead to more learning (Schmidt, 2001; Robinson, 2003; Godfroid et al., 2013; Ellis, 2015). These results also support previous studies on the limits and extent of the incidental learning of novel items (Webb, 2007, 2008; Batterink & Neville, 2011; Pellicer-Sánchez, 2015).

On the effects of individual differences **(RQ3)**, it was found that L1 and L2 recognition and recall processes are mediated by vocabulary knowledge. Given that vocabulary knowledge is relevant in word learning and processing (Borovsky et al., 2012; Yap et al., 2012; Weighall & Gaskell, 2015; Henderson et al., 2015; James et al., 2017; Mainz et al., 2017) it is not surprising that vocabulary size is a predictor of word recognition and recall for the adult learners in this study. A possible explanation for the results is that learners' previously existing knowledge helped them to consolidate the new information faster (Wilhem et al., 2008, 2013) than those learners whose previous knowledge was not as vast. In addition, having more lexical knowledge may have sped up learning the novel items, since learners had more lexical resources to interpret and understand the context where the pseudowords were embedded (Perfetti, et al., 2005). These results are in line with previous studies on the relevance of vocabulary knowledge in word processing (Borovsky et al., 2012; Yap et al., 2012; Henderson et al., 2015; Weighall & Gaskell, 2015; James et al., 2017), and they also confirm the hypothesis that higher vocabulary knowledge will result in higher scores on the recognition and recall tests.

It was hypothesised that participants with higher PWM would score higher on the vocabulary post-tests. Nevertheless, this was not confirmed for the L1 and L2 participants in this study. This supports Baddeley's (2015) assertion that PWM contributes to vocabulary learning but that it is not strictly crucial when learning new words. Recognition and recall processes require the activation of different features of the word including its phonological aspects (Levelt et al., 1999; Coltheart et al., 2001), however, higher PWM capacity does not seem to significantly contribute to higher recognition and recall of recently learned novel words for the participants in this study. This result may be explained by the fact that the learning context where the pseudowords were embedded was highly controlled; therefore participants may have not needed higher PWM to learn the new items. The possible interference of the type of PWM test used cannot be ruled out. For instance, Spanish NWR may have not been adequate for L1 and L2 learners; however, it has been proven to be effective (Speciale et al., 2004). Even though no significant effects were found, the relationship between PWM and adult novel word learning still is an important issue for future research (Baddeley, 2015). Thus, studies on the effect of PWM in lexical configuration knowledge of meaning, form, and use of novel words are recommended.

With respect to the effects of verbal fluency on meaning recognition and recall, the results highlighted that it only facilitated L1 word learning. This result further supports the idea of Luo et al. (2010) and Rommers et al. (2015) in that verbal fluency aids word processing, and confirms the hypothesis that participants with higher verbal fluency will score higher on the recognition and recall tests. Given that verbal fluency taps into semantic memory (Troyer et al., 1997), it may be the case that L1 learners retrieved information from their semantic memory storage to process the learning context and to recognise and recall the novel words' meanings in the post-tests. An implication of this is the possibility that, given that L2 learners were tested on their L2, they do not significantly require higher verbal fluency because their semantic storage of English lexical items is not as robust as that of L1 learners.

Another possible explanation for not finding significant effects of verbal fluency capacity in L2 recognition and recall processes is the bilingual disadvantage in verbal fluency tests (Bialystok, Craik and Luk, 2008; Sandoval, Gollan, Ferreira & Salmon, 2010). To illustrate, when retrieving information in a verbal fluency task, L2 learners need to retrieve a semantic category in the target language and control interference from the non-target language (Sandoval et al., 2010). This dual process may slow down their verbal fluency capacity and interfere in their verbal fluency tests and this might have influenced the results obtained.

It is relevant to mention that the type of test used could have also influenced the results, as participants' verbal fluency was only tested in one semantic category. To develop a full picture of the effects of verbal fluency in L1 and L2 recognition and recall processes of novel items, additional studies are needed.

9.2 Findings and Discussion on Lexical Engagement of Form

The results indicated that L1 and L2 lexical engagement of spoken form is possible in recently learned pseudowords through sentence reading. To illustrate, L1 and L2 learners made anticipatory looks towards the target on the word and pseudoword condition. This finding is consistent with previous studies in that speakers use and integrate semantic and syntactic information to make linguistic predictions while auditory material unfolds (Altman & Kamide, 1999, 1997; Kaan et al., 2010; Kukona et al., 2011; Borovsky et al., 2012; Grüter et al., 2012; Hopp, 2013; Dijkgraaf et al., 2017), however, it is novel in that it also occurs when engaging and integrating lexical information of recently learned words. This shows that learners predicted upcoming linguistic material based on their knowledge of the spoken form and the meaning of recently learned pseudowords. It can therefore be assumed that they comprehended the novel items to such an extent as to unconsciously engage their spoken form and semantic information with other lexical items in the visual-world task.

The findings further support previous research in that L1 and L2 learners use their lexical, syntactical, and semantic knowledge about a word to predict upcoming material (Kaan et al., 2010) and that they activated, comprehended, and immediately used their lexical knowledge of the auditory context to make linguistic predictions (Huettig et al., 2011). Moreover, given that semantic, morpho-syntactic and lexical aspects of the words yet to appear are pre-activated (Federmeier, 2007) in predictive processing, L1 and L2 learners activated and engaged different lexical aspects of the upcoming words in order to make anticipatory eye-movements towards the target in both the word and pseudoword condition. However, the findings also add to current literature by demonstrating that the linguistic predictive mechanisms just mentioned occur when using lexical knowledge of recently learned items. For instance, learners engaged the phonological and semantic knowledge of the recently learned pseudowords with other lexical items in the auditory input to pre-activate the linguistic characteristics of the words yet to come and to make anticipatory eye-movements. This suggests that recently learned items can be robust enough to engage, and thus pre-activate, lexical aspects of the words yet to appear, and that L2 vocabulary learning from reading can reach lexical engagement of spoken form and meaning of recently learned pseudowords.

In general, therefore, it seems that the lexical knowledge of the recently learned pseudowords is robust enough to generate lexical engagement of the spoken form with already established lexical items to predict upcoming linguistic material. This remarkable linguistic process emphasises that newly learned novel items can unconsciously engage with pre-existing lexical items to make predictions of upcoming linguistic material. It also suggests that L2 participants learned and engaged the phonological representations of the recently learned items through their orthographic representations while reading. Given that participants have not been trained on the spoken form of the novel items, it is remarkable that they can process and engage it with the semantic characteristics of the recently learned pseudowords. This also point outs that orthographic input is not only robust enough to create phonological representations of the recently learned pseudowords, but also to activate those representations when accessing their meaning in auditory tasks. This finding is consistent with that of Juhasz and Pollatsek (2011) in that phonological representations are activated when accessing word meanings in reading, which may also be the case when retrieving pseudoword meanings. The hypotheses that both learner groups would produce anticipatory eye-movements in the word and pseudoword conditions; that learners would generate more anticipatory looks in the pseudoword condition; and that L1 learners' fixation proportions in the word condition would be higher than those of L2 learners are corroborated.

9.2.1 Lexical Engagement of Form and Type of Exposure

In regard to the effects of type of exposure in lexical engagement of form **(RQ2)**, findings confirmed that incidental vocabulary learning generated similar predictive processing to explicit vocabulary learning for both L1 and L2 learners. Not finding L1 and L2 effects of exposure emphasizes not only that every exposure condition contributed to prediction of upcoming material, but that the incidental vocabulary learning also leaves robust enough memory traces to generate lexical engagement of spoken form and meaning in recently learned items. L2 learners cannot only learn factual knowledge of novel words incidentally from reading (Waring & Takaki, 2003; Webb, 2007, 2008; Pellicer-Sánchez & Smichtt, 2010; Pellicer-Sánchez, 2015), but they can also engage them with other lexical levels and items. This is a novel finding that informs L2 incidental learning theories and practices. An implication of this is the possibility that incidental vocabulary learning may facilitate underlying processes of language prediction based on phonological and semantic knowledge of recently learned pseudowords. However, more research is needed in order to confirm this with other L2 populations.

A possible explanation for the result obtained is that a vast number of repetitions (n=24) in incidental reading contributed to lexical engagement of the spoken form of novel words given that phonological representations are activated when accessing word meanings in reading (Juhasz & Pollatsek, 2011). Hence, even without explicit learning of the phonology of the novel words encountered in incidental reading, L2 learners are able to engage their spoken form with other lexical levels (e.g. semantic) and lexical items from the auditory input. Hence, it could conceivably be hypothesised that vocabulary learning through incidental reading can leave robust enough memory traces to reach lexical engagement of spoken form in adult learners of English. Another possible explanation for the incidental exposure generating similar predictive processing to explicit vocabulary learning is the combination of the high number of repetitions in the incidental condition and the highly controlled context where the pseudowords were embedded. This combination of factors may have made the lexical items in the incidental condition more salient, thus, similar results than the other conditions. In addition, these processing similarities may be explained in part by the fact that the pseudowords may have not been learned faster in the explicit condition (Ellis, 2015) because participants were not explicitly instructed to learn the meaning of the target items. Therefore, they may show similar predictive processing.

The hypotheses that the explicit condition would elicit more anticipatory looks than the other types of exposure, and that a combination of incidental and explicit exposures would generate more anticipatory looks than the incidental only condition are rejected for both L1 and L2 learners. They are rejected because they did not generate more anticipatory looks and they showed similar predictive processing as mentioned above. These results are likely to be related to the fact that in the explicit condition the meaning of the pseudowords was shown deliberately however participants were not explicitly instructed to learn the meaning of the pseudowords, Thus, the lexical items in the explicit condition and in the combination of incidental and explicit exposures might have not elicited faster learning (Ellis, 2015) than in the incidental condition

However, as previously mentioned, the L2 learners had a high-advanced level of English and this could have influenced the results; therefore these findings cannot be extrapolated to other proficiency levels. Further work is required to establish the viability of lexical engagement of spoken form of recently learned items at various L2 proficiency levels and with varied numbers of encounters with the novel items in the learning phase.

9.2.2 Lexical Engagement of Form and Individual Differences

The results of the effects of individual differences **(RQ3)** highlighted that vocabulary size is a predictor of L1 and L2 anticipatory eye-movements based on the spoken form and on semantic knowledge of recently learned pseudowords and familiar words. This finding broadly supports the work of other studies in that vocabulary knowledge predicts lexical processing (Mainz et al., 2017) and anticipatory eye-movements towards a target (Borovsky et al., 2012); however, to the researcher's knowledge this has not yet been confirmed in L2 predictive processing of recently learned novel words and in lexical engagement of spoken form. It may be the case, therefore, that L2 learners rely on their pre-existing L2 lexical representations to predict upcoming linguistic material based on their knowledge of the spoken form and meaning of the recently learned items.

The current finding raises the possibility that pre-existing lexical representations are associated with anticipatory eye-movements (Borovsky et al., 2012) since larger vocabularies generated more predictive looks when processing the phonological and semantic information of recently learned items. Given that the novel words are not as established as existing lexical representations in the mental lexicon, learners with higher vocabularies rely on their pre-existing vocabulary knowledge to make anticipatory eye-movements. Possible reasons for this may be that larger vocabulary repertoires aid the pre-activation of the semantic, morpho-syntactic, and lexical aspects of the words yet to appear (Federmeier, 2007) because learners established more links between those words yet to come and the words in the unfolding auditory material. In addition, they contribute to understanding the auditory context as learners have a greater vocabulary repertoire to process it. Moreover, the pseudowords were learned through sentence reading, thus more vocabulary knowledge may have contributed to understanding the context where the pseudowords were embedded (Perfetti et al., 2005).

This not only confirms that learners have engaged the spoken form of the pseudowords with their semantic level and other lexical items, but also that they required more vocabulary knowledge to do so. It is possible, therefore, that vocabulary knowledge aids predictive processing based on phonological and semantic knowledge of recently learned pseudowords from sentence reading. The hypothesis that more vocabulary knowledge generates more predictive looks towards the target is confirmed for both groups of learners.

In terms of verbal fluency capacity, the results further support that it may be a predictor of L1 (Rommers et al., 2015) and L2 anticipatory looks for familiar word. However, learners processed and engaged the spoken form of the recently learned pseudowords with its semantic level without significantly requiring more verbal fluency capacity to do so. One of the reasons for this may be that engaging the spoken form of the pseudowords with other lexical levels (e.g. semantic) does not place a greater cognitive demand on verbal fluency as the emerging semantic representations are not yet robustly established in the mental lexicon. Therefore, participants do not yet have well-established semantic representations of the target words to retrieve semantic related items from their semantic memory stores (Troyer et al., 1997). The possible interference of the type of verbal fluency test on these results cannot be ruled out, as already mentioned in the previous section. Given that previous studies (Luo et al., 2010; Rommers et al., 2015) have used more than one semantic category and this study did not, it is necessary to conduct further research to develop a full picture of the effects, if any, of verbal fluency on lexical engagement of the spoken form of recently learned items. Nevertheless, the results confirmed that verbal fluency capacity is a verbal predictor of L2 anticipatory eye-movements in familiar words. The hypothesis that higher verbal fluency capacity generates more predictive looks towards the target is rejected.

PWM was a significant predictor of anticipatory looks towards the target for Spanish speaking learners of English. L2 learners with higher PWM capacity generated more looks towards the target than those with lower PWM capacity. There are three main possible explanations for PWM being a significant predictor of L2 anticipatory looks towards the target. First, L2 learners are processing, decoding, engaging, and predicting auditory input, and these tasks place a great demand on their PWM capacity; hence, higher PWM capacity contributes to performance on these tasks. Second, given that the phonological loop draws attention to information that comes from speech (Eysenck & Keane, 2015), learners with more PMW capacity are likely to make more predictions towards the target, as they may process the auditory input faster than other learners. Third, due to the existing relationship between L2 word learning and PWM (Speciale et al., 2004; French, 2006; de Abreu & Gathercole, 2012; Baddeley, 2012; Baddeley, 2015), learners with higher PWM may have created stronger emerging lexical representations of the recently learned pseudowords in the learning phase.

Overall, the findings showed that PWM capacity may be a predictor of L2 anticipatory eye-movements and of lexical engagement of the spoken form of recently learned items. To the researcher's knowledge, no previous studies have tested the relationship between PWM and L2 lexical engagement of form in recently learned words; thus, this is a novel finding that sheds light on the importance PWM has in L2 vocabulary learning (Baddeley, 2012; Baddeley, 2015) and in L2 lexical engagement of form. This is an important issue for future research in L2 vocabulary learning and engagement; thus, more research is needed to corroborate this finding with other proficiency levels and frequencies of exposure.

9.3 Findings and Discussion: Lexical Engagement of Meaning

Results highlighted that L1 and L2 learners engaged the meaning of recently learned pseudowords with other lexical items and that participants developed a meaningful lexical entry of the recently learned pseudowords since they can quickly and accurately access lexical information that is semantically related or unrelated to them (Batterink & Neville, 2011; Rod et al., 2012; Tamminen & Gaskell, 2013; Bordag et al., 2017). The findings are in line with those of Tamminen and Gaskell (2013) who found that recently learned words can prime L1 semantic lexical decisions in adult learners; however, they also confirm that this also occurs in L2 adult learners (Bordag et al., 2015; Bordag et al., 2017). This result can inform theories on L2 lexical engagement of meaning by asserting that recently learned items may be robust enough to lexically engage with other lexical items in the L2 mental lexicon. This is a relevant topic for future research on L2 vocabulary learning; thus, more studies on L2 lexical engagement of novel words are recommended.

The findings also revealed L1 and L2 differences in lexical engagement of meaning as L1 elicited faster RTs than L2 learners. A possible explanation for this may be that L1 learners have had more qualitative and quantitative input of the English language (Kaan, 2014); thus, their existing semantic representations are more robust than those of L2 learners. In addition, given that L2 comprehension might be less accurate, more effortful, and more time and resource-consuming (Dijkgraaf et al., 2017) than L1 comprehension, this may have generated longer L2 RTs in the lexical decision task.

The combination of L1 and L2 findings provides further support for the hypotheses that learners engaged the meaning of the recently learned pseudowords with other lexical items, and that L1 learners will produce quicker RTs than L2 learners.

9.3.1 Lexical Engagement of Meaning and Type of Exposure

Results on type of exposure **(RQ2)** demonstrated that L1 lexical engagement of meaning of recently learned pseudowords occurs independently of type of exposure. For instance L1 speed of access in lexical decisions is not significantly facilitated or inhibited by how the lexical entry was learned (incidentally, explicitly, or in a combination of incidental and explicit exposures). A possible explanation for this may be that given that every encounter with a word strengthens permanent or emerging semantic memory codes (Salasoo et al., 1985), the number of repetitions (n=24) of each target pseudoword in the training phase created robust memory traces regardless of type of exposure. This in turn indicates that lexical engagement of meaning may be possible through incidental learning after a high number of encounters with the target word. These results can be strong evidence to support the claim that adult learners of English can lexically engage the meaning of novel items through incidental learning from reading. However, one has to bear in mind that the highly controlled context where the pseudowords were embedded might have hindered possible effects of exposure, since contextual cues aid word learning (Nation & Webb, 2011; Elgort et al., 2018).

With regard to L2 RTs, they are sped up by explicit exposure. These participants benefitted from having an explicit definition of the pseudowords in the learning phase as explicit learning results in input processing with the conscious intention to work it out (Hulstijn, 2005). Therefore, they directed their attention not only to the context where the pseudowords were embedded but also to their explicit meaning and this developed robust memory traces that engaged faster with existing lexical items. It can therefore be assumed that the explicit learning condition in this study facilitated lexical engagement of meaning of recently learned pseudowords to such an extent to elicit faster RTs. Hence, it could conceivably be hypothesised that explicit instruction facilitates L2 lexical engagement of meaning of recently learned pseudowords; however, further work is required to establish the possible effect of explicit input in L2 lexical engagement of meaning of recently learned words.

The hypothesis that the explicit condition elicits lower RTs than the other types of exposure, given that explicit instruction can speed language acquisition (Ellis, 2015), is confirmed for L2 learners. However, the hypothesis that a combination of incidental and explicit exposures elicits lower RTs than the incidental only exposure is not confirmed for L2 learners as the incidental condition actually generated faster RTs. This result may have been caused by a combination of three factors. First, the context where the pseudowords were embedded was highly controlled and could have facilitated incidental memory traces of the pseudowords' meanings (Bordag et al., 2017), as previously mentioned. Those two factors may have made the lexical items more salient in the incidental condition and thus their faster processing when compared to the incidental and explicit exposure. Another possible explanation may be that in the explicit condition participants were not explicitly instructed to learn the meaning of the target items; thus, the potential benefits of explicit instruction speeding language acquisition (Ellis, 2015), may not have taken place. Second, the high number of repetitions of the pseudowords (n=24) is very likely to have facilitated incidental vocabulary learning given that 10 or more exposures of a target word contribute to incidental vocabulary learning from reading (Webb, 2007, 2008; Pellicer-Sánchez & Schmitt, 2010; see Pellicer-Sánchez 2015 for word learning gains after only eight exposures). Third, participants' advanced proficiency levels were high enough to comprehend the context where the pseudowords were embedded. Thus, providing participants with a definition of the target items did not bring significant results as their proficiency level and the context contributed to their learning.

The finding asserting that the incidental condition generated faster RTs than the incidental and explicit exposure raises the possibility that L2 incidental word learning achieves lexical engagement of meaning after a high number of exposures with the target words in a context with high frequent lexical items. Future studies on L2 lexical engagement of the meaning of novel items should be undertaken to confirm this result with other L2 populations and frequencies of exposure.

9.3.2 Lexical Engagement of Meaning and Individual Differences

In regard to the effects of IDs **(RQ3)**, Spanish speaking learners of English and English native speakers do not require higher PWM capacity to make faster lexical decisions. These findings raise intriguing questions regarding the nature and extent of PWM in lexical engagement of meaning of novel lexical items, given that PWM contributes to both L1 and L2 vocabulary learning (Baddeley, 2012; Baddeley, 2015). It may be the case that PWM does not have a significant effect on lexical engagement of meaning, as tested in this study, given that the prime lexical decisions were based on written input and not auditory; therefore, the task may not have placed a significant demand on participants' phonological processing. Thus, recognising and accessing pre-existing words from the mental lexicon may not place a high demand on learners' PWM, as there is no auditory input in the task.

Another possible explanation for the PWM result obtained is that given that L2 learners were semantically primed, but not phonologically, with the recently learned pseudowords and that the LDT task does not require phonological input processing, they may have not required higher PWM capacity to react faster when making lexical decisions. This result does not rule out the influence of other factors such as the participants' proficiency levels and the highly controlled learning conditions for the recently learned pseudowords. Hence, more research is highly recommended to develop a better understanding of the role, if any, of PWM in lexical engagement of meaning in recently learned items. It was hypothesised that participants with higher PWM capacity would elicit faster RTs in the prime lexical decision task given that it assists L1 and L2 vocabulary learning (Baddeley, 2012) and thus higher PWM would contribute to lexical engagement with the meaning of the recently learned pseudowords; however, this was not confirmed for the L2 participants in this study.

In the case of verbal fluency and vocabulary size, they do not seem to have significant effects on L1 and L2 lexical decisions. It was hypothesised that higher vocabulary sizes would elicit faster responses, given that vocabulary knowledge is associated with faster and more accurate word recognition (Yap et al., 2012); however, this was not confirmed for the participants in this study. Moreover, the data did not show any significant results of vocabulary knowledge in word recognition through lexical decisions, probably due to the participants' proficiency levels and the learning context, as previously explained.

Undoubtedly, participants made lexical decisions based on their semantic knowledge of the recently learned pseudowords and they used their previously existing vocabulary knowledge to do so; however, their high proficiency level may be robust enough to account for lexical engagement and word recognition. Similarly, they may not require higher verbal fluency capacity to recognise semantically related and unrelated targets, when primed with the recently learned pseudowords, because their existing semantic networks are robust enough given their high proficiency levels. Therefore, these findings may be somewhat limited by the highly controlled context in which the pseudowords were learned and the high L2 proficiency levels. It is possible to hypothesise that these individual differences are less likely to have an effect on lexical engagement of meaning of recently learned pseudowords. However, further research should be undertaken to confirm this in other L2 populations.

9.4 Findings and Discussion: Lexical Engagement of Use

Results suggest that L1 and L2 learners engaged their grammatical knowledge of the recently learned pseudowords with other lexical items and levels. To illustrate, L1 and L2 learners were sensitive to subject-object ambiguities in plausible sentences given their total reading times of the ambiguous DP. As total reading times are a measure of word integration that can be influenced by context and discourse (Conklin et al., 2018), one can infer that L1 and L2 longer reading times in the plausible condition were affected by the subject-object ambiguities. Therefore, it can be assumed that learners have engaged the semantic characteristics of the recently learned pseudowords with their grammatical use as it took them longer to process the ambiguous DP in the plausible condition. To illustrate:

a) L1 and L2 learners strongly committed to their initial semantic and syntactic analysis of the ambiguous DP; thus, they spend more time reading it in the plausible condition, because implausible analyses are easier to abandon on the basis of the semantic implausibility (Pickering & Traxler, 1998). For instance, in plausible sentences, such as 1a below, the ambiguous DP (e.g. the baby) is plausible before encountering the disambiguating verb; however, once it has been parsed learners have to reanalyse the sentence's semantic and syntactic structures because the noun phrase *the baby* is a plausible direct object for the verb *grodded* and a plausible subject for *fell*. This analysis is not as costly in the implausible sentences, such as 1b below, as prior to encountering the disambiguating verb the sentence already carries an implausibility as *the dough* is not a plausible direct object for *grodded*.

(1a) While the woman grodded [washed] the baby fell in the bath.

(1b) While the woman grodded [washed] the dough fell in the bath.

These results confirm that lexical engagement of use has taken place but the hypothesis that L2 learners are more affected by semantic plausibility than L1 learners is not corroborated, as there was no interaction with L1 group.

The findings of this research question also highlighted L1 and L2 online processing differences when parsing temporarily ambiguous sentences. For example:

b) L2 learners differed from L1 learners in their first online parsing of the recently learned pseudowords as they elicited longer first fixation times. Given that the pseudowords were parsed before the subject-object ambiguity and the disambiguating verb, longer first fixation times may not be linked to the sentences' temporary ambiguities, but to their lexical characteristics. As mentioned in the second chapter of this thesis, when exposed to new words in L2 reading, learners develop and establish orthographic, phonological, and semantic representations (Elgort et al., 2018) that can be later recognised and retrieved. Thus, these results on first fixation times may be indicators of online recognition of the recently learned pseudowords and L1 and L2 online processing differences. Given that both types of learners had the same qualitative and quantitative input in the learning phase, it seems possible that L2 longer fixation times are due to intrinsic L1 and L2 learning and processing differences and not strictly related to the pseudowords' lexical engagement of use. This finding may have important implications for theories on L1 word learning processing mechanisms; hence, a further study with more focus on L1 populations is suggested.

c) L2 learners took longer to read for the first time the disambiguating verb and this shows online processing difficulties in comparison to the L1 learners. Effects of first fixations in the disambiguating region have been related to syntactic processing difficulty (Frazier & Rayner, 1982; Pickering & Traxler, 1998; Staub, 2007; Clifton & Staub, 2011) and this was evidenced in the L2 learners. A possible explanation for this is that their first analysis of the sentence does not match the semantic and syntactic characteristics of the disambiguating verb. For instance, when a new lexical item is added to the parse it is integrated in the current processing (Juffs & Rodriguez, 2015), thus L2 learners semantically and syntactically processed the ambiguous DP as a direct object in their first parse. Thus, they find it hard to abandon their first initial analysis of the noun phrase as the direct object of the preceding verb to reanalyse it as the subject of the disambiguating verb. According to this, one can infer that L2 learners present more online processing costs as they may be more committed to their initial semantic analysis than L1 learners; however the possible interference of L2 learners being usually slower than L1 readers (Duncan et al., 2014) cannot be ruled out. Nevertheless, undoubtedly, L1 and L2 learners used semantic and syntactic cues but, when doing so, L2 processing is more effortful and slower. In general, these findings provide further support for the hypothesis that both types of learners would commit to their first initial semantic analysis (Pickering & Traxler, 1998) before encountering the subject-object ambiguity.

d) Findings on the disambiguating region also revealed L1 longer regression times into the disambiguating verb than L2 learners, which highlights processing difficulties as learners need to go back to the verb and reanalyse it. Given that the eyes return to a previous location when an analysis is incorrect (Harley, 2014), it can thus be suggested that L1 learners experienced processing difficulties in this region. There are two likely causes for this L1 and L2 processing difference:. First, L1 learners spend less time reading the disambiguating verb for the first time than L2 learners; hence, they may take longer when regressing into the region as they have not processed it for as long as L2 learners. Second, given that L2 first pass times were longer than those of L1 speakers (M=303.70ms vs. M=252.59ms), L2 learners may reanalyse and reinterpret the disambiguating verb faster as their previous online processing took longer. It is important to bear in mind that L1 and L2 intrinsic processing differences (Proverbio et al., 2002; Segalowitz, 2010; Duncan et al., 2014) could have also influenced the results.

9.4.1 Lexical Engagement of Use and Type of Exposure

There is an effect of exposure on L1 and L2 lexical engagement of use and processing of recently learned pseudowords **(RQ2).** To illustrate, L2 learners elicited longer first fixation and first pass times when online reading the pseudowords incidentally learned. For instance, they took approximately 49.13ms longer to read for the first time the pseudowords and they spend more time in their overall online reading times. When learning new lexical items, incidentally, learners have to process them as input and infer their meanings (Barcroft, 2015); hence, it is possible that these processes slowed down the parsing of the pseudowords as indicated by their reading times. Given that incidental learning of new lexical items requires less conscious involvement than explicit learning (Hulstijn, 2005; Ellis, 2011; Ender, 2016), L2 learners may have taken longer to process the pseudowords incidentally learned as their meanings and grammatical functions were not consciously specified during training. It is therefore likely that L2 learners' emerging representations of the pseudowords are not as robust as those learned explicitly, thus they generated longer reading times in the incidental condition. As there was no effect of plausibility, these findings must be interpreted with caution as they can be due to lexical processing differences and may not be strictly linked to lexical engagement of use. In addition, L2 findings on the ambiguous DP demonstrated that lexical engagement of the grammatical use of the recently learned pseudowords can occur through incidental learning as L2 learners showed longer total reading times in the plausible condition in the incidental exposure. A possible explanation for this may be that the memory traces left by the incidental exposure are robust enough to elicit plausibility effects that have been previously found (Pickering & Traxler, 1998). It can therefore be assumed that L2 learners' semantic and syntactic knowledge of the incidentally learned pseudowords is sensitive to subject-object ambiguities, as their total reading times revealed. This, in turn, suggests that the memory traces left by the incidental condition can be robust enough to reach lexical engagement of grammatical use of recently learned pseudowords. One can hypothesise then that L2 incidental word learning is not restricted to factual knowledge of grammatical use as it may also reach lexical engagement. Moreover, findings on the spillover region pointed out that incidental exposure may be limited in lexical engagement of use. For instance, a combination of incidental and explicit input may create stronger emerging lexical representations for faster processing of spillovers in subject-object ambiguous sentences. Given that learning requires incidental and explicit aspects (Sun et al., 2009), L2 learners may benefit from them when online parsing the spillover region, which does not contradict the idea that incidentally learned novel items can show lexical engagement of use.

The combination of findings above provides support for the conceptual premise that L2 incidental word learning can reach lexical engagement of use within the parameters of this study. As to the researcher's knowledge, this is a novel finding in the L2 incidental vocabulary learning field that can be useful in understanding how adult learners process and engage new lexical items. It is important to bear in mind that the high proficiency level of the L2 participants and the conditions in the highly controlled learning phase (as previously mentioned) may have influenced these results. Further work is required to establish the viability of lexical engagement of use from incidental word learning with other L2 populations and in other learning conditions.

L2 learners regressed out of the determine phrase, in plausible sentences, faster in the incidental learning condition. The observed increase in DP regression out times in the implausible sentences could be attributed to the implausible subject-object ambiguity. For instance, when re-analysing the DP in the implausible condition, learners need to verify if it is a plausible subject for the pseudoword and thus if its semantic and syntactic characteristics match the implausible ambiguous DP. Regressing out of this region is faster in the plausible sentences as learners may take less time parsing plausible analysis, which in turn suggests that L2 learners may have integrated the semantic and syntactic characteristics of the temporarily ambiguous sentences. It may be the case, therefore, that these learners benefited from incidental reading of the pseudowords during training as they re-processed and regressed out of the DP faster in the plausible condition. This finding suggests that L2 incidental learning may provide robust memory traces for learners to regress out quicker of determiner phrases in plausible temporary subject-object ambiguous sentences. These data must be interpreted with caution because, to the researcher's knowledge, these results have not been previously found in L2 incidental word learning and engagement of grammatical use.

In the case of the L1 learners, a combination of incidental and explicit input in novel word learning contributes to their lexical engagement of grammatical use. The findings on the regression out times in the pseudoword region, and those of plausibility with first fixations, total reading times, regressions into and out of the disambiguating region clearly revealed that L1 learners benefitted from both incidental and explicit aspects. These findings raise intriguing questions regarding the nature and extent of lexical engagement of use in L1 novel word learning. It may be the case that for L1 learners, conscious and unconscious word learning processes contribute to reach lexical engagement of use of novel items.

9.4.2 Lexical Engagement of Use and Individual Differences

There is an effect of L1 and L2 learners' individual differences in lexical engagement of use **(RQ3).** To illustrate:

a) L2 learners with higher PWM capacity regressed into the ambiguous DP and the disambiguating region faster than those with lower capacity. Likewise, effects of PWM were found for L1 learners as the higher capacity group spent less total reading time in the pseudoword region than the lower group in both the plausible and implausible conditions. These are novel findings that not only corroborate that PWM is associated with L1 and L2 vocabulary learning (Baddeley, 2012), but also highlight that it can assist lexical engagement of use of novel items, and provide support for the hypothesis that higher PWM contributes to L2 faster processing of the ambiguous DP. A possible explanation for these results may be that higher PWM capacities provided more efficient cognitive resources to learn the semantic and syntactic characteristics of the novel items, and thus, to faster processing. It is therefore likely that such connections exist between higher PWM capacity and faster processing of recently learned items embedded in temporarily ambiguous sentences. As, to the researcher's knowledge, the processing time differences just mentioned have not been found elsewhere; thus, they should be taken with caution. Further research should be undertaken to investigate the possible effects of PWM on L1 novel word learning and lexical engagement of use. Overall, this combination of findings provides support for the premise that PWM has an effect on lexical engagement of use of novel items. This is an important issue for future research on L1 and L2 lexical engagement of grammatical use, therefore more studies on this topic are highly recommended.

b) In terms of the possible effects of vocabulary knowledge, the results pointed out that L2 learners with higher lexical knowledge elicited lower first pass reading times in the pseudowords. Similarly, higher L1 vocabulary knowledge produced faster total reading times. Given that existing vocabulary knowledge is linked to more efficient word learning (Henderson et al., 2015; James et al., 2017), and that it may speed up novel word learning (Perfetti et al., 2005), more vocabulary knowledge may have facilitated the understanding of the contexts where the pseudowords were embedded during training and in the online garden-path experiment. For instance, learners' pre-existing vocabulary knowledge may have aided the emergence of new lexical representations of the pseudowords in the mental lexicon and to interpret the context in which they were embedded; hence, those with higher vocabulary knowledge may have processed the pseudowords faster in the online reading. The results do not explain whether vocabulary knowledge contributed to L2 lexical engagement of the grammatical use of the pseudowords, as there is no effect on plausibility. Nevertheless, these findings suggest that a link may exist between L1 and L2 vocabulary knowledge and faster online processing of recently learned novel items embedded in temporarily ambiguous sentences. Moreover, L1 learners with higher lexical knowledge regressed into the ambiguous DP faster in the implausible condition but slower in the plausible. This is likely to be caused by the fact that the higher vocabulary knowledge group was more efficient when learning the meaning and grammatical use of the pseudowords; thus, they reanalyse them faster. It can be assumed, therefore, that higher lexical knowledge may contribute to faster reanalysis of the ambiguous DP, which is the sentence's region that clearly evidences possible semantic and syntactic knowledge of the recently learned pseudowords. Taking L1 and L2 results together, the hypothesis that higher vocabulary knowledge elicits lower reading times of the ambiguous DP in both plausible and implausible sentences is not confirmed.

c) Higher verbal fluency capacity elicited longer first fixations and first pass times in the ambiguous DP for L2 learners of English. This result may be explained by the fact that given that verbal fluency taps into semantic memory (Sun et al., 2009), the high capacity group may be more sensitive to the semantic ambiguity of the DP and this slows their online reading. For instance, this group may be more sensitive to the semantic and syntactic ambiguity within the DP because they have higher semantic capacity to process the meaning of the recently learned pseudowords within the sentence and during training, and the semantic characteristics of the disambiguating region. Hence, when they encounter the ambiguous DP in the plausible and implausible conditions, their reading times increase because the semantic characteristics of the lexical representations in their mental lexicon do not match those of the ambiguous DP. In addition, higher verbal fluency capacity generated faster L2 regression times into the disambiguating verb. A possible explanation for this may be that L2 learners with more verbal fluency capacity are faster, when reinterpreting and reanalysing the disambiguating verb, since they might have quicker access to their semantic memory traces. However, more research is needed to explore this further.

For L1 learners, higher verbal fluency elicited slower total reading times in the pseudoword region and faster total reading times in the implausible condition. A possible explanation for this may be that processing the recent pseudowords in the implausible condition requires sensitivity towards the ambiguous DP as an implausible object of the pseudowords, which in turn involves knowing and engaging the semantic characteristics of the pseudowords with their grammatical use. Those learners with higher verbal fluency capacity elicited lower total reading times because their higher semantic memory has very likely contributed to their understanding of the semantic characteristics of the recently learned pseudowords. Therefore, when processing the semantic implausibility they take less time than those with lower capacity. Surprisingly, the higher group read the pseudowords slower in the plausible condition. It is difficult to explain this result, but it might be related to the sentence context in the training phase. For instance, these native speakers may have not needed higher verbal fluency capacity to process the semantic characteristics of the pseudowords and their context because they belonged to the 3000 most frequent words in the English language. Hence, they only seem to require higher verbal fluency when the context presents an ambiguity. The hypothesis that higher verbal fluency capacity would elicit faster processing of the ambiguous DP is not confirmed for the learners of this study.

9.5 Limitations

9.5.1 Limitation 1: Lexical Items

The lexical items acting as target words for the first study of this thesis were unbalanced: three nouns, one verb, and two adjectives. Certainly, more encounters with words functioning as nouns could have influence participants' performance on the vocabulary post-tests; however, even in natural contexts, the number of nouns is higher compared with adjectives and verbs (Atchison, 2004).

The use of pseudowords instead of existing English words may not simulate natural reading context as low-frequency words do (Pellicer-Sánchez, 2015); thus, participants may have behaved differently than when reading authentic texts. In addition, the use of pseudowords with regular English spelling may not carry the same learning burden of real English words (Elgort et al., 2018). Hence, participants may have behaved differently here than when learning real unknown English words. Moreover, testing only pseudowords acting as verbs does not give a full picture of lexical engagement, as verbs are cognitively more complex than nouns (Slavakova, 2016). Thus, it is suggested that future investigations use different lexical items (e.g. nouns and verbs) to develop a full picture of lexical engagement of form, meaning, and use of novel items.

The high number of repetitions (n=24) of the pseudowords for the studies on lexical configuration could have influenced the results obtained. The number of encounters with the target items was higher than previous studies on vocabulary learning (Pellicer-Sánchez & Schmitt, 2010; Batterink & Neville, 2011; Bisson et al., 2014; Elgort et al., 2018) and this could have facilitated lexical configuration knowledge.

On terms of lexical engagement, the studies in this thesis took into consideration findings from previous studies in that in order to reach lexical engagement between 24 to 30 exposures are needed (Gaskell & Dumay, 2003; Leach & Samuel, 2007). However, more repetitions with the target items could have provided more significant results of lexical engagement. Thus, lexical engagement studies on the form, meaning, and use of novel items controlling varying the number of repetitions are highly recommended.

9.5.2 Limitation 2: Piloting

Lack of thorough piloting of the instruments used for the first study is certainly a limitation. For instance, it led to ceiling effects in the vocabulary post-tests, which undoubtedly may have affected the results obtained. In addition, a higher number of participants in the piloting of the studies on lexical engagement could have enriched this work.

Future studies on lexical configuration and lexical engagement of recently learned words should guarantee more satisfactory piloting conditions than the ones in this work.

9.5.3 Limitations 3: Learning Contexts

The lexical variability among the texts in the first study of this thesis is a limitation. Not controlling the context where the pseudowords appeared may have limited or facilitated the learning process. Moreover, the learning context, where the pseudowords were embedded, was highly controlled in the studies tapping into lexical engagement. To illustrate, the lexical items were chosen from the 3000 most frequent words of the English language (Pellicer-Sánchez, 2015; Pellicer-Sánchez & Schmitt, 2010) and this may have facilitated the learning of the pseudowords. Even though such controlling was used to guarantee meaningful contexts for the pseudowords, it may have facilitated the understanding of the learning context given the high proficiency level of L2 learners. In future investigations different learning conditions, for instance more naturalistic contexts (Godfroid et al., 2017; Hulme, Barsky & Rodd, 2018) or less controlled input, should be considered to fully assess the extent of L2 word incidental learning and lexical engagement.

9.5.4 Limitations 4: Participants

The scope of the first study of this thesis was limited in terms of the number of participants (n=17). In order to improve the ecological validity, a higher number of participants is needed. A monolingual control group would have also enriched and validated the results of this study.

The high proficiency level of the L2 participants may have permeated the results obtained. In order to generalize the findings of this work, future research with other L2 proficiency levels is highly encouraged.

9.5.5 Limitations 5: Online and Offline Tasks

The first study of this thesis did not evaluate the use of online methods and this limits it, since offline methods do not provide a full account of the on-going lexical processes in word learning (Borovsky et al., 2012).

In terms of the visual-world eye-tracking paradigm, in the visual display the agent always appeared in the same position. Thus, participants could have visually learned that the target's position would be either on the right or left hand side of the screen and this might have influenced their gaze direction. However, the target and the distractor positions were randomized.

The verbal fluency task used for the studies of this thesis only asked for one semantic category, while previous studies have tested it using two categories (Luo et al., 2010; Rommers et al., 2015). Further studies on verbal fluency performance and its effects on lexical configuration and lexical engagement of recently learned items should include more than one semantic category in the task.

Laboratory-trained conditions may not reflect more naturalistic learning conditions and this could have influenced the results in this study. Therefore, studies on lexical engagement of form, meaning, and use in more naturalistic contexts could enrich our understanding of lexical engagement of novel items.

CHAPTER 10 GENERAL DISCUSSION AND FINAL CONCLUSIONS

10.1 General Discussion

The general discussion on this thesis will refer to the main findings in terms of lexical development, learning condition, and individual differences. It will address the theoretical and empirical accounts of this work. Then, the chapter finishes with general and specific conclusions and directions for future work.

10.2 General Discussion of Lexical Development

The empirical findings in this thesis provide a new understanding of L2 vocabulary development in that L2 vocabulary learning, through reading, not only contributes to offline receptive and productive learning gains (Webb, 2007, 2008; Pellicer-Sánchez & Schmitt, 2010), but also to lexical engagement gains (Bordag et al., 2015, 2017). This is a novel finding that informs current L2 vocabulary learning literature in that it confirms that L2 advanced learners' lexical development of novel items is robust enough to reach lexical engagement. This new understanding should help to improve and to take a new approach on what it is to know a word and the potential benefits of incidental reading for lexical development beyond factual knowledge.

In order to investigate lexical development through lexical engagement this thesis applied Leach and Samuel's (2007) framework of lexical configuration and lexical engagement. This lexical approach is novel in the L2 vocabulary field given that, to the best of the researcher's knowledge, only two empirical studies have done so (Bordag et al., 2015, 2017), and lexical engagement has been conceptualised differently in the SLA literature. For instance, Schmitt (2008) mentioned that more engagement with a novel word leads to more learning gains, and he relates lexical engagement to Craik and Lockhart's (1972) Depth of Processing hypothesis and with Hulstijn and Laufer's (2001) Involvement Load hypothesis. The notion of engagement as a construct that provides deeper learning gains through lexical involvement relates to Leach and Samuel's (2007) approach in that learners need deep/robust knowledge of a lexical item for it to lexically engage in the mental lexicon. However, Schmitt (2008) conceptualises engagement in terms of learners' engagement with target words and external factors associated to it like students' motivation and attitudes, learning materials, and type of assessment. The key difference with Schmitt's (2008) approach towards engagement is that it does not account for online internal processing factors in the mental lexicon such as how a word semantically activates or primes another lexical item. Meara's (2006) Lexical Networks' idea is also in a way related to Leach and Samuel's (2007) lexical engagement perspective. To illustrate, he employs Boolean's Networks to exemplify how words are interconnected in the mental lexicon. He mentions that lexical networks may be made out of words, randomly connected which each other through a series of nodes. Words are activated when external input is received, and it stimulates and triggers specific words in the network causing spread of activation throughout the entire network. Even though Meara (2006) does not use the term engagement, his lexical network approach highlights that lexical items are related in the mental lexicon and that they can activate and react to external stimuli. Similarly, Leach and Samuel's (2007) lexical engagement considers that lexical items in the mental lexicon are interconnected, can activate each other, and they respond to external input. Hence, this thesis has contributed to the study of L2 lexical development by applying a novel lexical engagement framework in the SLA field. This thesis also lays the groundwork for future research into L2 lexical engagement of novel items and their development in the mental lexicon.

Leach and Samuel's (2007) lexical engagement conceptualization is related, but yet different, to the distinction of breadth and depth of vocabulary knowledge (Anderson & Freebody, 1981). In terms of breadth of vocabulary knowledge which has been traditionally defined in the SLA literature as how many words the learners knows (Schmitt, 2014), Leach and Samuel's (2007) constructs do not account for it. To illustrate, their conceptualisation of lexical configuration refers to the factual/static knowledge of the word, such as how the word sounds, what it looks like, what it means, and how it fits into sentences (Leach & Samuel, 2007), and not on how many words the learner knows. Nevertheless, their approach on lexical engagement – how a word interacts with other lexical entries and lexical levels in the mental lexicon– is similar to that of depth of knowledge (Read, 2004). Read (2004) mentioned that depth of knowledge is related to the learners' ability to link individual words with others. He proposes a network building perspective of depth of knowledge in which lexical development and growth "entails the building of more extensive linkages between items in the mental lexicon" (Read, 2004, p.221), which complements Leach and Samuel's (2007) concept of lexical engagement. Those links in the mental lexicon were, to a certain extent, explored in this thesis through Leach and Samuel's (2007) lexical engagement perspective. Thus, this thesis has provided a deeper insight into depth of vocabulary knowledge via Leach and Samuel's (2007) measures of lexical engagement which have been useful in expanding our understanding of how a recently learned word lexically develops and interacts in the mental lexicon.

It is worth mentioning that other authors have highlighted that depth of knowledge can also refer to what learners can do with the lexical items receptively and productively (Schmitt, 2014) based on Nation's (2001) framework of what it is to know a word. However, Nation's (2001) framework, as already discussed in the second chapter of this thesis, only accounts for factual receptive and productive word knowledge. Hence, depth of receptive and productive knowledge has been traditionally researched via offline measures (Waring and Takaki, 2003; Webb, 2007, 2008; Pellicer-Sánchez & Schmitt, 2010), and this is not associated with Leach and Samuel's (2007) lexical engagement. The experimental studies of this thesis on lexical configuration are more related to this perspective of depth of knowledge than the experimental studies on lexical engagement. Another perspective of depth of knowledge on terms of what learners can do with a word is how automatically they can be used in reading, writing, listening, and speaking skills (Schmitt, 2014). This automaticity is related to psycholinguistic methodologies such as speed of retrieval and lexical judgment (Schmitt, 2014); hence, it can complement Leach and Samuel's (2007) lexical engagement construct. This work explored lexical development through written (e.g. sentence processing) and auditory (e.g. prediction of upcoming linguistic material) modalities; hence, experimental studies on lexical engagement via speaking and writing skills are recommended.

This thesis has theoretically contributed to the field of L2 vocabulary learning by applying a new perspective on lexical development and by establishing that it can expand our knowledge of what it is to know a word beyond factual knowledge. Even though Leach and Samuel's (2007) approach do not seem to consider breadth of vocabulary knowledge, it clearly taps into depth of knowledge and complements Read's (2004) network building perspective and Schmitt's (2014) automaticity approach on reading, writing, listening, and speaking skills.

10.3 General Discussion of Learning Conditions

The experimental studies of this thesis confirmed that incidental, explicit, and a combination of incidental and explicit exposures contributed to lexical configuration and lexical engagement of the form, meaning, and use of novel lexical items. These are novel findings in the field of L2 vocabulary learning given that, to the best of the researcher's knowledge, only two empirical studies have investigated L2 lexical engagement (Bordag et al., 2015, 2017) and they have not compared different learning conditions and explored engagement of form and use. To illustrate, Bordag et al. (2015) researched lexical engagement of meaning in incidental vocabulary learning, and Bordag et al. (2017) in intentional learning. Hence, this thesis explored lexical engagement through three different types of exposures and found out that learning conditions do play a role in lexical engagement.

Explicit learning conditions, as conceptualised in this thesis, generated L1 and L2 lexical engagement gains of form, meaning, and use. However, it brought more L2 lexical engagement gains of meaning and use than the other type of exposures, as discussed in Chapter 9 of this thesis. Overall, this thesis strengthens the idea that explicit exposures elicit faster learning (Ellis, 2015); however, it adds to current L2 learning theories in that this also occurs in lexical engagement of meaning and use of novel lexical items. To the best of the researcher's knowledge, this is the first time that explicit exposures have been compared to other exposures in L2 lexical engagement of meaning and use. The main theoretical implication of these findings is clear: explicit exposure, as conceptualised in this thesis[102], contributes to faster lexical engagement of the meaning and use of novel lexical items than incidental exposure and a combination of incidental and explicit exposures. Therefore, L2 vocabulary learning scholars should take into consideration that for a lexical item to elicit faster lexical engagement gains of meaning and use an explicit learning condition is needed. In terms of lexical engagement of spoken form, the explicit condition did not generate any significant L1 or L2 learning gains in comparison to the other types of exposure. This finding suggests that explicit learning conditions are not more beneficial, in terms of higher prediction of upcoming linguistic material, than incidental and a combination of incidental and explicit exposures. These results add to the rapidly expanding field of L1 and L2 language processing and learning in that for novel lexical items to develop lexical engagement gains of spoken form, an explicit exposure does not elicit more

[102] See Chapter 5 for an explanation on how the explicit learning condition was created.

predictive processing. To the best of the researcher's knowledge, this is the first time empirical research suggests that for L1 and L2 lexical engagement of spoken form, an explicit exposure does not bring more learning gains, contrary to expected (Ellis, 2015). One of the reasons for this finding may be due to how the explicit learning condition was conceptualised in this thesis as previously highlighted. It is recommended therefore, to carry out more empirical research on L1 and L2 lexical engagement of form with a clearer and more specific explicit learning condition (e.g. explicitly telling participants to try to learn the meaning and form of the novel lexical items) to simulate explicit learning that considers a conscious effort to learn a specific linguistic aspect (Roehr-Brackin, 2015).

In terms of incidental learning, the findings of this thesis showed that it contributes to L1 and L2 lexical engagement of form, meaning, and use. Nevertheless, it elicits lexical engagement learning gains of form that are not significantly different than those obtained in explicit conditions and a combination of incidental and explicit learning. As pointed out in Chapter 9 of this thesis, a possible reason for this finding is the high number of repetitions with the target items (n=24), participants' high linguistic proficiency and the high frequency level of the words in the written input. Notwithstanding these factors, this thesis suggests that incidental vocabulary learning reaches L1 and L2 lexical engagement of spoken form of novel lexical items to a similar extent than explicit learning and a combination of incidental and explicit learning conditions. This finding informs L1 and L2 incidental vocabulary learning research in that after a high number of repetitions with the target items emerging lexical representations develop lexical engagement gains of spoken form. This complements previous research in that lexical engagement gains can be seen after 24 repetitions with the target (Leach & Samuel, 2007), and adds to it by asserting that this is also the case for lexical engagement of spoken form. Another relevant finding of this thesis is that L2 incidental learning generates faster overall L2 reaction times (M=744ms) in primed lexical decisions tasks than incidental and explicit exposures (M=843ms). This indicates that for L2 lexical engagement of meaning, incidental learning conditions generate faster recognition and reaction times than a combination of incidental and explicit exposures. This corroborates previous findings in that L2 incidental learning reaches lexical engagement of meaning (Bordag et al., 2015); however, it also sheds new light on the possibility of this learning generating faster lexical engagement than a combination of incidental and explicit exposures. The main theoretical implication of this finding is that after a high number of repetitions with the target item (n=24) incidental vocabulary learning develops strong memory traces that engage their meaning with other lexical items in the mental lexicon. This is contrary to Bordag et al. (2015) who found lexical engagement gains of meaning only after three repetitions with the target; however, they did not compare incidental learning with other types of learning conditions. Therefore, it cannot be known if three incidental exposures with a target are enough to develop stronger lexical engagement of meaning than that of other learning conditions. Another theoretical implication of the finding is that L2 vocabulary learning through reading, as formulated in this thesis and in high advanced L2 learners, leads to more successful vocabulary learning gains than those of a combination of incidental and explicit exposures. This contributes to existing knowledge of L2 incidental vocabulary learning by providing empirical evidence of the extents of L2 incidental vocabulary learning and lexical engagement of meaning in adulthood (Bordag et al., 2015). This new understanding should help to improve predictions of the impact of L2 incidental learning in adults and on the relevance of L2 incidental vocabulary learning through reading. It also demonstrates that in L2 incidental reading processes learners develop and establish semantic representations (Elgort et al., 2018) that reach lexical engagement of meaning. In the case of L1 learners, the incidental learning condition also showed similar lexical engagement gains of meaning that those of the other types of exposures. This broadly corroborates previous findings in that L1 adult learners can develop lexical engagement gains of the meaning of novel lexical items (Tamminen & Gaskell, 2013). Nevertheless, this thesis has also shown that lexical engagement of meaning is not significantly different in incidental learning conditions than those of explicit or a combination of incidental and explicit exposures. This finding adds to current literature on L1 lexical engagement of meaning and broadly supports the work of Leach and Samuel (2007) in that 24 repetitions are needed for a lexical item to show lexical engagement gains.

In terms of the combination of incidental and explicit exposures, it generated L1 and L2 lexical engagement gains of form, meaning, and use, and it was particular beneficial in L1 lexical engagement of use. To illustrate, it elicited faster processing of the disambiguating region, of temporary ambiguous garden-path sentences, and the spillover. These empirical findings not only corroborate that learning requires incidental and explicit aspects (Sun et al., 2009), but it also suggest that a combination of incidental and explicit exposures aids L1 faster processing of the grammatical functions of recently learned words. This finding sheds light on the relevance of combining incidental and explicit-declarative meanings of recently learned words to assist their grammatical knowledge. Given that the explicit exposure in this thesis did not clearly asked participants to learn the use of the novel lexical items, it may not have made a significant difference in the processing of the regions mentioned above. Thus, when providing participants with a learning condition that combines explicit and incidental learning (Sun et al., 2009) it generates faster processing than the explicit learning condition. In the case of L2 learners, the combination of incidental and explicit exposures, as conceptualised in this thesis, contributed to faster processing of the grammatical functions of the novel words when compared to the incidental condition. This finding demonstrates the limitations of incidental learning in lexical engagement of grammatical use, and it highlights that combining incidental and explicit learning is beneficial for L2 learners. This is a novel finding as, to the best of the researcher's knowledge, no other empirical research has investigated the effects of exposure in L2 lexical engagement of the grammatical use of novel lexical items. This finding has theoretical implications in that a learning condition that combines incidental learning through reading with definitions of the meaning of the target items strengthens L2 lexical engagement of grammatical use. The findings will be of interest to L2 vocabulary learning scholars; thus further experimental research on L2 lexical engagement of use through incidental and explicit learning is recommended.

The combination of incidental and explicit learning did not generate faster L2 lexical engagement of meaning than the incidental condition as predicted. This finding confirms that in specific experimental circumstances incidental and explicit learning does not elicit faster L2 lexical engagement of meaning. As previously mentioned, the explicit condition in the experimental studies did not ask participants to consciously learn the meaning of the novel lexical items; therefore, combining this type of explicit learning with incidental learning through reading does not generate faster L2 lexical engagement of meaning. In addition, the possible saliency of the incidental condition, due to participants' advanced L2 language proficiency and the high frequent context where the pseudowords were embedded, may have influenced the incidental learning conditions. Notwithstanding these limitations, the findings contribute to the field of L2 vocabulary learning as it confirms that incidental and explicit vocabulary learning through reading aids L2 lexical engagement of meaning to a lesser extent than incidental learning. This new understanding should help to improve predictions of the impact of L2 incidental vocabulary learning through reading on L2 lexical engagement of meaning.

This thesis is one of the first attempts to thoroughly examine how different learning conditions affect L1 and L2 lexical engagement of the form, meaning, and use of novel words as, to the best of the researcher's knowledge, no other experimental research has done so. The experimental findings confirm that explicit, incidental, and a combination of incidental and explicit learning elicits L1 and L2 lexical engagement of form, meaning, and use of novel lexical items. However, the different learning conditions do not similarly contribute to L1 and L2 lexical engagement as discussed above.

Overall, this thesis has provided a deeper insight into how different learning conditions have an effect on L1 and L2 lexical engagement of form, meaning, and use of novel lexical items.

10.4 General Discussion of Individual Differences

The empirical findings in this thesis confirmed that learners' individual differences on phonological working memory (PWM), verbal fluency, and vocabulary size have an effect of lexical configuration and lexical engagement of form, meaning, and use of novel items. These findings provide a new understanding of the role individual differences have on lexical engagement of recently learned words given that, to the best of the researcher's knowledge, this is the only empirical investigation on the effects of individual differences in L2 lexical engagement of novel items. Hence, a general discussion on the findings of every individual difference is necessary.

PWM is a predictor of L2 offline recognition and recall of the grammatical functions of novel items. This finding further supports Baddeley's (2012) assertion that the phonological loop, and thus PWM, contributes to L2 vocabulary learning, and that it may also be linked to grammatical processing (Baddeley, 2015). This finding is consistent with that of Speciale et al. (2004) who found that PWM was a predictor of L2 recognition of novel words, and it suggests that it contributes to L2 recognition of the grammatical functions of recently learned words. In terms of lexical engagement of the use of the words, the empirical findings of this thesis pointed out that PWM aids L1 and L2 lexical engagement of grammatical use. This novel finding has significant implications for the understanding of Baddeley's (2000) working memory model and how it may have an effect on L2 lexical engagement of use. To illustrate, the phonological loop, one of the model's component, assists L1 (Gathercole & Baddeley, 1990; Baddeley, 2012; Eysenck & Keane, 2015) and L2 word learning (Baddeley et al., 1998; Speciale et al., 2004; Baddeley, 2012). Nevertheless, Baddeley et al. (2015) have mentioned that it may also facilitate grammar acquisition and the empirical findings of this thesis confirmed it. Thus, these findings contribute to current literature on the functions of one of the components of Baddeley's (2000) working memory model in L2 grammatical acquisition and engagement. Further work has to be done to research the extent of the PWM in L2 lexical engagement of grammatical use.

PWM is also a predictor of L1 and L2 lexical engagement of the spoken form of novel items. This finding contributes to existing knowledge of the role of the phonological loop, in processing auditory linguistic material, by providing evidence of it effects in L1 and L2 lexical engagement of spoken form. Given that the phonological loop stores speech and auditory information (Baddeley et al., 2015), it is not surprising that it assist L1 and L2 lexical engagement of the spoken form. However, this finding raises the possibility that the phonological loop not only contributes to online processing of auditory information, but also to its lexical engagement with its semantic properties. This finding sheds light on the role of PWM in L1 and L2 lexical engagement of spoken form, and this can be of interest to L1 and L2 researchers investigating the role of the phonological loop in novel word learning and processing. In terms of L1 and L2 lexical engagement of meaning, the empirical findings of this thesis suggest that PWM does not have a significant effect on it. This highlights that even though the phonological loop process verbal information (Juffs & Harrinton, 2011), it does not significantly assists online processing and engagement of the semantic characteristic of recently learned words. Prior to this thesis it was difficult to make predictions about how or if PWM has an effect on L1 and L2 lexical engagement of form, meaning, and use of novel words. The overall findings of this thesis revealed that it has a significant role on L1 and L2 lexical engagement of form and use. Thus, this research lays the groundwork for future research into the effects of PWM in L1 and L2 lexical engagement of form and use.

The empirical findings of this thesis also demonstrated that verbal fluency capacity does not significantly assist L1 and L2 lexical engagement of form, meaning, and use. This finding was unexpected and it may have been caused by the type of verbal fluency test used as highlighted in the limitations' section in Chapter 9. Further experimental investigations are needed then to establish whether or not verbal fluency capacity has an effect on L1 and L2 lexical engagement of recently learned words. Given that L2 lexical engagement is an emergent field (Bordag et al., 2015, 2017), and that verbal fluency aids word processing (Luo et al., 2010; Rommers et al., 2015), it is relevant to examine more closely its possible effects in L1 and L2 lexical engagement of recently learned words. Notwithstanding the limitations of the type of test used to account for verbal fluency capacity, the empirical findings also showed that it aided L1 offline meaning recognition of novel items. This finding suggests that those with more capacity to access verbal information from their semantic memories (Troyer et al., 1997), show more recognition of the meaning of novel items. This finding contributes to current literature on the effects of verbal fluency in L1 word processing (Luo et al., 2010; Rommers et al., 2015), and it informs it in that it also has an effect on meaning recognition of novel words. Overall, the findings on this investigation highlight that verbal fluency capacity does not have a significant effect on L1 and L2 lexical engagement of form, meaning, and use; however, it contributes to L1 offline recognition of the meaning of recently learned words.

In terms of the effects of vocabulary knowledge, the empirical findings revealed that it has an effect on L1 and L2 lexical engagement of spoken form, and L1 lexical engagement of use. These findings shed new light on the relevance of vocabulary knowledge not only for word learning and processing (Borovsky et al., 2012; Elman & Fernald, 2012; Yap et al., 2012; Henderson et al., 2015; Borovsky et al., 2016; James et al., 2017; Mainz et al., 2017), but also for its L1 and L2 engagement of form and grammatical use in the mental lexicon. These are novel findings that provide a new understanding of the effects previous vocabulary knowledge can have on novel word learning through sentence reading. The theoretical implications of these findings are clear: higher vocabulary knowledge assists L1 and L2 novel word learning to such an extent that the emerging lexical representations engage their spoken form and grammatical functions with other lexical items in the mental lexicon. This new information can be used to develop L1 and L2 reading practices to boost vocabulary learning. It can also inform L2 vocabulary teaching practices given that knowing more L2 words leads to L2 lexical engagement of form and use of novel items. The empirical findings also demonstrated that vocabulary knowledge generated more L1 and L2 offline meaning recognition of the novel words. This finding should help to improve predictions of the impact and benefits of targeting L1 and L2 vocabulary knowledge and growth in adult learners. Given that adults keep on learning new words throughout their lifespan (Tamminen and Gaskell, 2013), these findings are of relevance not only to researchers on the fields of L1 and L2 word learning and processing, but also to L1 and L2 teachers and practitioners and text developers. Overall, the findings on the effects of vocabulary knowledge on L1 and L2 lexical engagement of form, L1 lexical engagement of use, and L1 and L2 offline meaning recognition, provide empirical evidence on the relevance vocabulary knowledge has in L1 and L2 word learning. Thus, more research into the effects of vocabulary knowledge on L1 and L2 lexical engagement is strongly recommended.

One of the main contributions of this thesis has been to confirm that the individual differences of PWM, verbal fluency, and vocabulary knowledge have an effect on L1 and L2 lexical configuration and lexical engagement of form, meaning, and use of novel items.

10.5 General Conclusions

The present thesis explored one of the most relevant aspects of L2 language learning, namely vocabulary learning. It discussed theoretical grounds underlying L2 incidental word learning measured by lexical configuration and engagement of meaning, form, and use.

The studies in this thesis demonstrated that L2 incidental vocabulary learning from reading can lead to lexical engagement of form, meaning, and use in novel words, and that explicit learning and a combination of incidental and explicit learning also generate L2 lexical engagement of form, meaning, and use.

This thesis also demonstrates that theories on L2 word learning can move forward towards a more comprehensive and dynamic framework of what it is to know a word beyond factual knowledge. In addition, it has pointed out that learners' individual differences of PWM, verbal fluency, and vocabulary size cannot be overlooked as they have an effect on lexical configuration and lexical engagement of novel words.

10.6 Specific Conclusions

Study 1 demonstrated that L2 adult Spanish speaking learners of English acquired lexical configuration knowledge of meaning, form, and use of novel words from incidental reading of authentic texts. Their recognition was higher than their recall and their PWM had an effect on their vocabulary learning gains.

Study 2 highlighted that L2 adult Spanish speaking learners of English and English native speakers showed lexical configuration knowledge of meaning of novel words from incidental sentence reading. Recognition is facilitated by a combination of incidental and explicit exposures and recall by explicit exposure. L2 learners' recall process is mediated by their PWM and vocabulary size, whereas every individual difference affects L1 recall. Vocabulary knowledge aids recognition of novel items for both L1 and L2 learners.

Study 3 showed that lexical engagement of form of novel items is possible through incidental vocabulary learning from reading. In the case of L2 learners, PWM and vocabulary knowledge contribute to their lexical engagement of form by being predictors of anticipatory eye-movements. For L1 learners, vocabulary knowledge facilitates their lexical engagement of form, since it is a predictor of anticipatory eye-movements.

Study 4 established that lexical engagement of meaning of novel words occurred for both L1 and L2 learners. In the case of L2 learners, encountering the target words explicitly in the learning phase sped up their RTs in the lexical decision task. Individual differences did not have an effect on lexical engagement of meaning.

Study 5 demonstrated that lexical engagement of use of novel words is possible for L1 and L2 learners. A combination of incidental and explicit exposures benefits L1 lexical engagement of use. PWM, vocabulary size, and verbal fluency have an effect on L1 and L2 lexical engagement of use of novel words.

10.7 Future Work

This thesis suggests that future research on L2 incidental word learning from reading investigate the depth of novel word learning adopting Leach and Samuel's (2007) theory of novel word learning in adulthood. In addition, the use of online methodologies to further our knowledge of what it is to know a word beyond factual knowledge is a must.

It is also recommended that methodologies with event-related potentials (ERPs) are employed to tap into deeper unconscious operations during incidental learning. The use of ERPs would undoubtedly enrich the field of L2 incidental vocabulary learning and lexical engagement.

Investigating lexical engagement of novel words with other L2 backgrounds would further our knowledge of what it is to know a word beyond factual knowledge. There is a need to find whether lexical engagement of meaning, form, and use is possible through incidental vocabulary learning for a wider population than the one investigated in this thesis.

Last, but not least, this work suggests that learners' individual differences be considered in studies on L2 incidental vocabulary learning and lexical engagement of form, meaning, and use.

Appendix 1: EXAMPLE OF WRITTEN INPUT STUDY 1

Boaf storm could throw UK into chaos, Bank of England warns

Bank of England warns that **boaf** has become "more **thafe**", as it says threat of Greek default poses "significant risks" to the UK

Mr Carney warned last month that diverging monetary policies in the US, Britain, Europe, and Japan may set off further currency turbulence and "test capital flows across the global economy, including to emerging markets." Photo: Reuters

By Szu Ping Chan

10:24AM GMT 26 Mar 2015

45 Comments

The **chuth** Bank of England has warned that a global boaf storm could endanger financial stability if pibs suddenly demanded their money back, adding that the threat of a Greek default posed "significant risks" to the UK.

The Financial Policy Committee (FPC), which is in charge of maintaining financial stability at the Bank, said **boaf** - or the degree to which investments can be easily traded - may have become "more **thafe**" in some markets.

Policymakers, including Bank Governor Mark Carney, said they would work with the Financial Conduct Authority to assess whether investment managers could cope with a rapid change in market conditions and **rird** them.

"The Committee remains concerned that investment allocations and pricing of some securities may presume that sales can be performed in an environment of continuous market **boaf**, although **boaf** in some markets may have become more **thafe** ," the FPC said following a meeting this week.

"Trading volumes in fixed income markets have fallen relative to market size and recent events in financial markets, including in US Treasury markets in October 2014, appear to suggest that sudden changes in market conditions can occur in response to modest news. This could lead to heightened volatility and undermine financial stability."

FPC members said they would work with market participants to ensure they were "alert to these risks" and would "price **boaf** appropriately and manage **boaf** prudently".

Mr Carney warned last month that diverging monetary policies in the US, Britain, Europe, and Japan may set off further currency turbulence and "test capital flows across the global economy, including to emerging markets."

The FPC also said that tensions in Greece also posed a threat to the UK. "There also remain significant risks in relation to Greece and its financing needs, including in the near term," it said. The FPC said a further slowdown in China and the eurozone also posed risks.

"Any of these risks could trigger abrupt shifts in global risk appetite that in turn might lead to a sudden rird reappraisal of underlying vulnerabilities in highly indebted economies, or sharp adjustments in financial markets."

In a letter to Chancellor George Osborne, Mr Carney said the risks to financial stability remained "elevated" and added that it would review UK bank capital rules that could result in lenders having to raise their capital buffers. Mr Carney said policymakers would pay particular attention to Britain's biggest banks.

The Bank will ask managers about their strategies for managing and rirding **boaf** of their funds. "This would inform assessment of the extent to which markets are reliant on investment funds offering redemptions at short notice," the FPC said.

The Bank said that risks to Britain from its housing market had not increased since its last report in December, but that steps it took last year to guard against overheating remained necessary.

Appendix 2: OFFLINE VOCABULARY POST-TESTS USED IN STUDY 1

Form Recognition

Instructions: Circle the words with the correct spelling.

1. (a) pibb	(b) pab	(c) pib	(d) piib
2. (a) thefa	(b) thafe	(c)thufe	(d) thifa
3. (a) rir	(b)rerd	(c)rard	(d) rird
4. (a) sheild	(b) shild	(c) shield	(d)sheld
5. (a) clutch	(b) clatch	(c) cletch	(d) cetch
6. (a) blaft	(b)bloft	(c) boaft	(d) boaf
7. (a) chuth	(b) chath	(c) choth	(d) cheth
8. (a) knus	(b)knes	(c) knesh	(d) knush

Use Recognition

Instructions: Choose the sentence that best describes the word.

1. Knush (a) It is a knush.

   (b) He knushed it.

   (c) It is slighty knuish

2. Pib (a) I like her pibs

   (b) They pibed him.

   (c) It is very pib

3. Clutch (a) We clutched each other.

   (b) They are clutchy.

   (c) I am clutched.

4. Chuth (a) It is a chuth.

   (b) He chuthed his friend.

   (c) They are chutch people.

5. Rird (a) It is rird.

   (b) He has been rird.

   (c) The boy is rird.

6. Shield (a) It is a shield.

   (b) They shielded.

   (c) The girl is shield.

7. Thafe (a) It is a thafe.

(b) She thafed.

(c) They are thafe.

8. Boaf(a) It is a boaf.

(b) The bed boafed.

(c) The bus is boafy.

Meaning Recognition

Multiple Choice

Instructions: Choose the word that best associates with the following words.

1. Rird	(a) flower	(b) car	(c) plan
2. Pib	(a) money	(b) computer	(c) doll
3. Clutch	(a) floor	(b) hand	(c) dishwasher
4. Thafe	(a) bath	(b) delicate	(c) hospital
5. Chuth	(a) symbolic	(b) drink	(c) unhappiness
7. Shield	(a) pillow	(b) soldier	(c) boot
8. Boaf	(a) bill	(b) book	(c) ceiling
9. Knush	(a) tree	(b) lost	(c) anger

Form Recall

Instructions: Listen to the following words twice and write them down. The first letter is provided.

1. C ___ ___ ___ ____

2. R ___ ___ __

3. P ___ ___

4. T ___ ___ ___ ___

5. B ___ ___ ___ ___

6. C ___ ___ ___

7. K ___ ____ ___ ___

Use Recall

Sentence Construction Test

Instructions: Write a sentence with the words given. Please leave it blank if you cannot write a sentence with the word.

1. Knush
   ____

2. Boaf
____

3. Shield
____

4. Thafe

____

5. Pib

____

6. Chuth

____

7. Rird

____

8 Clutch

____

Meaning Recall

Instructions: Write an Associate for the Following Words

1. Chuth
2. Knush
3. Shield
4. Boaf
5. Rird
6. Clutch
7. Thafe
8. Pib

Appendix 3: RESULTS RESEARCH QUESTION 2 STUDY 1

Form Recognition

	Fixed Effects		
	β	Std Error	t
LLAMA B	-3.238e+02	7.432e+04	-0.004
LLAMA D	-3.741e+02	7.911e+04	-0.005
LLAMA C	-3.199e+02	7.917e+04	-0.004
VocaSize	-1.472e+00	3.592e+02	-0.004

Meaning Recognition

	Fixed Effects		
	β	Std Error	t
LLAMA B	-1.355e+02	3.617e+05	0.000
LLAMA D	-2.087e+02	3.361e+05	-0.001
LLAMA C	-1.446e+02	3.785e+05	0.000
VocaSize	-6.495e-01	1.696e+03	0.000

Form Recall

	Fixed Effects		
	β	Std Error	t
LLAMA B	-9.064e+02	8.905e+04	-0.010
LLAMA D	-9.240e+02	8.801e+04	-0.010
LLAMA C	-9.538e+02	9.487e+04	-0.010
Vocabulary Size	-4.339e+00	4.258e+02	-0.010

Appendix 4: TARGET PSEUDOWORDS IN THE EXPLICIT CONDITION

Target Pseudowords	Short Definitions in the Explicit Condition
Bazz	To send items in a fast but precise way
Ench	To write with one’s wrist raised from the writing surface.
Feam	To play happily and slowly
Flel	To move one’s arms and legs simultaneously in a coordinated effort to do something.
Gope	To smoke quickly with one hand.
Grod	To wash quickly but thoroughly
Gwap	To eat in a fast manner
Hirp	To walk with one's toes raised and one's weight on the heels of the feet.
Nush	To teach patiently but thoroughly
Spoc	To quickly throw an object with one eye closed.
Thoy	To kick powerfully by swinging the hips.
Tirl	To paint in a quick manner.
Pisk	To drink slowly and carefully.
Woft	To buy in a quick manner

Appendix 5: OFFLINE VOCABULARY POST-TESTS FOR STUDY 2

Recognition

Multiple Choice Test

Instructions: Choose the word that best describes the meaning of the following words:

1. Clet	a) shelf	b) book	c) study	d) album	e) I don’t know
2. Spoc	a) push	b) smell	c) throw	d) cat	e) I don’t know
3. Pilb	a) bread	b) cry	c) biscuit	d) benefit	e) I don’t know
4. Thoy	a) attack	b) jug	c) kick	d) exercise	e) I don’t know
5. Zeef	a) widow	b) dream	c) computer	d) door	e) I don’t know
6. Woft	a) invest	b) buy	c) secret	d) acquire	e) I don’t know
7. Flel	a) kiss	b) attend	c) move	d) function	e) I don’t know
8. Gope	a) smoke	b) deceive	c) rain	d) moon	e) I don’t know
9. Ench	a) print	b) autograph	c) include	d) write	e) I don’t know
10. Tirl	a) money	b) payment	c) swim	d) paint	e) I don’t know
11. Nush	a) school	b) teach	c) show	d) dress up	e) I don’t know
12. Lerb	a) cake	b) mug	c) muffin	d) plant	e) I don’t know
13. Fusk	a) lipstick	b) dog	c) whale	d) bark	e) I don’t know
14. Gwap	a) feed	b) sunshine	c) eat	d) snore	e) I don’t know

15. Hirp	a) sit	b) walk	c) listen	d) dance	e) I don't know
16. Fowd	a) swallow	b) wine	c) cherry	d) shoe	e) I don't know
17. Grod	a) depurate	b) rest	c) wash	d) detergent	e) I don't know
18. Drid	a) admire	b) grass	c) garden	d) clean	e) I don't know
19. Pisk	a) drink	b) card	c) mouse	d) draw	e) I don't know
20. Feam	a) touch	b) hug	c) play	d) down	e) I don't know
21. Bazz	a) do	b) send	c) kiss	d) pain	e) I don't know

Recall

L2 learners

Translation Task

Instructions: Please provide a translation for each of the following words. Leave it blank if you do not know the translation in Spanish.

1. Clet: ________________________________
2. Zeef: ________________________________
3. Grod ________________________________
4. Fusk ________________________________
5. Ench ________________________________
6. Lerb ________________________________
7. Gwap ________________________________
8. Spoc ________________________________
9. Tirl ________________________________

10. Flel ______________________________

11. Hirp ______________________________

12. Fowd ______________________________

13. Thoy ______________________________

14. Drid ______________________________

15. Pilb ______________________________

16. Gope ______________________________

17. Woft ______________________________

18. Nush ______________________________

19. Pisk ______________________________

20. Feam ______________________________

21. Bazz ______________________________

L1 learners

Translation Task

Instructions: Please provide a synonym for each of the following words. Leave it blank if you are unsure.

1. Clet: ______________________________
2. Zeef: ______________________________
3. Grod ______________________________
4. Fusk ______________________________
5. Ench ______________________________
6. Lerb ______________________________
7. Gwap ______________________________
8. Spoc ______________________________

9. Tirl ______________________________

10. Flel ______________________________

11. Hirp ______________________________

12. Fowd ______________________________

13. Thoy ______________________________

14. Drid ______________________________

15. Pilb ______________________________

16. Gope ______________________________

17. Woft ______________________________

18. Nush ______________________________

19. Pisk ______________________________

20. Feam ______________________________

21. Bazz ______________________________

Appendix 6: NONWORD REPETITION TASK

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Speciale et al.: Determinants of L2 vocabulary acquisition

APPENDIX E

Nonwords used in the Spanish Nonword Repetition task

No. Syllables	Spanish Nonword	Spanish Nonword in IPA	Spanish Wordlikeness Rating/5
2	termar	tɛrmar	3.6
2	baldor	bældʊr	3.2
2	ardal	ardæl	4
2	orda	orðə	4.4
3	taurete	tæwretɛ	3.8
3	patanco	pætanco	3.8
3	mermallar	mermayiær	4.1
3	laderal	lædɛræl	3.9
4	movilido	mɔbIlido	3.1
4	sucursina	sʊkɔrsinə	3.1
4	antiembre	æntiɛmbrɛ	2.6
4	desboroto	ɾɛsbɔtato	3.5
5	cobrosamente	abrosæmɛntɛ	4.4
5	estancioso	ɛstænðioso	4.9
5	acrecentera	ækreðentɛrə	4
5	rabiosera	ræbiɔsɛrə	3.6
5	emitancia	ɛmItæðiə	2.6
5	oprimalmente	ɔprImælmɛnte	4
6	santificorado	sæntIkɔrædo	2.9
6	embulicioso	ɛmʊllðloso	3.5
6	eliminicio	ɛlImInIðlo	3.5
6	conespidiente	kɔnespIdienɾe	3.2
6	proseguienda	prɔsɛrIɛndə	3.2
6	abastologia	æbæsɾɔlɔχIə	3.5
7	decacuad-refecto	dɛkækwædrefekto	3.2 + 3.4
7	trasora-naderio	ɾræsɔrænædɛrio	2.4 + 3
7	curtillo-barajento	kɔrtiyobæræχɛnto	3.8 + 2.4
7	autido-desampato	awɾidodɛsapæto	2.9 + ?
8	crosar-partiferencia	krɔsarpartifɛrɛnðia	3.4 + 3.1
8	tironano-civinista	tirɔnænɔsivinIstə	3.4 + ?
8	ampato-debicario	æmpætodɛbiikarIyo	2.9 + ?
8	mangual-solteramente	mæŋgwælsɔltæramɛntɛ	2.9 + ?

Note: Underlined portions of nonwords were not included in the pretest. IPA, International Phonetic Alphabet.

Appendix 7: STATISTICAL CODES AND THEIR RESULTS FOR STUDY 3.

Research Question 1

For all the time windows, the codes above were also tested with the following results:

```
lmerTest::lmer(DV~WordType+Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_200)
lmerTest::lmer(DV~WordType+Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_200_400)
lmerTest::lmer(DV~WordType+Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_400_600)
lmerTest::lmer(DV~WordType+Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_600_800)
lmerTest::lmer(DV~WordType+Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_800_1000)
lmerTest::lmer(DV~WordType+Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_1000_1200)
lmerTest::lmer(DV~WordType+Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_1200_1400)
lmerTest::lmer(DV~WordType+Lang+(1|Subject)+(1|TRIAL_LABEL),data=X_1400_1600)
```

Time Window	Milliseconds	Fixed Predictions			
		WordType		Language	
		β	t	*β*	t
1	-200 to -0	0.011301	0.988	-0.011184	-1.065
2	0 -200	3.159e-02	3.789 *	-7.594e-03	-0.757
3	200 -400	1.242e-02	1.144	-1.119e-02	-1.178
4	400 -600	0.00543	0.482	-0.01546-	-1.204
5	600- 800	-2.788e-03	-0.240	-9.101e-03	-0.601
6	800 -1000	-1.497e-02	-1.321	-2.963e-03	-0.221
7	1000-1200	4.051e-03	-0.628	-1.293e-02	-1.587
8	1200-1400	-1.982e-03	-0.204	7.013e-04	0.060
9	1400- 1600	0.00543	0.482	-0.01546	-1.204

*p<.0.05

Research Question 2

L2 Learners

For all the time windows, the codes above were also tested with the following results:

lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_200L2)

lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_200_400L2)

lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_400_600L2)

lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_600_800L2)

lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_800_1000L2)

lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_1000_1200L2)

lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_1200_1400L2)

Time Window	Milliseconds	Fixed Effects					
		Exposure IE		Exposure IO		Word Type	
		β	t	β	t	β	t
1	-200 to -0	3.329e-02	2.044*	2.723e-02	1.753**	3.440e-03	0.260
2	0 to 200	2.179e-02	1.803**	1.885e-02	1.637	-0.017043	-2.160*
3	200 to 400	4.918e-03	0.329	-1.243e-02	0.871	-5.282e-03	-0.633
4	400 to 600	2.967e-02	1.304	1.380e-02	0.636	-0.004843	-0.365
5	600 to 800	-1.991e-02	-0.858	6.475e-03	0.292	4.120e-03	0.319
6	800 to 1000	5.230e-03	0.204	8.687e-03	0.356	2.514e-02	1.212
7	1000 to 1200	-0.04275	-1.484	-0.02006	-0.730	5.984e-03	0.373
8	1200 to 1400	-1.289e-02	-0.353	-1.253e-02	-0.359	1.223e-03	0.041
9	1400 to 1600	1.535e-02	0.406	-8.953e-03	-0.248	3.599e-03	0.171

*p<.0.05 ** p<.0.1

L1 Learners

For all the time windows, the codes above were also tested with the following results:

```
lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_200L1)
lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_200_400L1)
lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_400_600L1)
lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_600_800L1)
lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_800_1000L1)
lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_1000_1200L1)
lmerTest::lmer(DV~WordType+Exposure+(1|Subject)+(1|TRIAL_LABEL),data=X_1200_1400L1)

lmerTest::lmer(DV~WordType+(1|Subject)+(1|TRIAL_LABEL),data=X_200L1)
lmerTest::lmer(DV~WordType+(1|Subject)+(1|TRIAL_LABEL),data=X_200_400L1)
lmerTest::lmer(DV~WordType+(1|Subject)+(1|TRIAL_LABEL),data=X_400_600L1)
```

```
lmerTest::lmer(DV~WordType+(1|Subject)+(1|TRIAL_LABEL),data=X_600_800L1)
lmerTest::lmer(DV~WordType+(1|Subject)+(1|TRIAL_LABEL),data=800_1000L1)
lmerTest::lmer(DV~WordType+(1|Subject)+(1|TRIAL_LABEL),data=1000_1200L1)
lmerTest::lmer(DV~WordType+(1|Subject)+(1|TRIAL_LABEL),data=X_1200_1400L1)
```

Time Window	Milliseconds	Fixed Predictions					
		Exposure IE		Exposure IO		Word Type	
		β	t	β	t	β	t
1	-200 to -0	-0.011307	-0.700	-0.011307	-0.731	0.002407	0.183
2	0 to 200	-2.908e-04	-0.028	7.411e-03	0.734	-1.310e-02	-1.529
3	200 to 400	1.205e-03	0.095	9.991e-03	0.823	-0.012249	-1.440
4	400 to 600	0.00442	0.216	-0.01668	-0.850	-0.02075	-1.245
5	600 to 800	-1.384e-03	-0.067	-2.140e-02	-1.082	-1.217e-02	-0.726
6	800 to 1000	6.074e-03	0.251	1.315e-02	0.568	-6.395e-03	-0.474
7	1000 to 1200	-6.812e-05	-0.002	1.476e-02	0.474	1.947e-02	0.736
8	1200 to 1400	3.472e-02	1.046	-2.547e-03	-0.080	-0.01058	-0.572
9	1400 to 1600	4.076e-02	1.148	5.096e-02	1.499	2.152e-02	0.746

Research Question 3

L2 Learners

For all the time windows, the codes above were also tested with the following results:

```
lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_200L2)
```

	Fixed Effects	
	β	t
WordType	-1.725e-02	-1.860
PWM	-2.702e-03	-1.358
VerbalF	2.103e-04	0.245
VocabSize	7.718e-06	1.250

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_200_400L2)

	Fixed Effects	
	β	t
WordType	-5.300e-03	-0.636
PWM	-1.155e-03	-0.642
VerbalF	5.551e-04	0.716
VocabSize	-4.766e-06	-0.854

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_400_600L2)

	Fixed Effects	
	β	t
WordType	-4.829e-03	-0.363
PWM	1.991e-03	0.658
VerbalF	-5.876e-04	-0.451
VocabSize	-6.580e-06	-0.701

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_600_800L2)

	Fixed Effects	
	β	t
WordType	4.106e-03	0.318
PWM	7.850e-05	0.019
VerbalF	9.096e-04	0.522
VocabSize	8.773e-06	0.699

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_800_1000L2)

	Fixed Effects	
	β	t
WordType	2.020e-02	1.417
PWM	-3.304e-03	-0.758
VerbalF	5.262e-04	0.280
VocabSize	-3.147e-06	-0.233

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item),data=X_1000_1200L2)

	Fixed Effects	
	β	t
WordType	5.972e-03	0.372
PWM	1.313e-04	0.022
VerbalF	1.959e-04	0.078
VocabSize	-7.716e-06	-0.424

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item),data=X_1400_1600L2)

	Fixed Effects	
	β	t
WordType	3.561e-03	0.169
PWM	3.231e-03	0.699
VerbalF	2.357e-03	1.183
VocabSize	-7.953e-06	-0.554

L1 Learners

For all the time windows, the codes above were also tested with the following results:

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_200L1)

	Fixed Effects	
	β	t
WordType	-1.578e-02	-2.683
PWM	1.261e-03	1.652
VerbalF	-2.005e-04	-0.389
VocabSize	4.591e-06	1.309

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_200_400L1)

	Fixed Effects	
	β	t
WordType	-1.228e-02	-1.438
PWM	6.479e-04	0.806
VerbalF	1.634e-04	0.301
VocabSize	1.011e-06	0.275

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_400_600L1)

	Fixed Effects	
	β	t
WordType	-1.567e-02	-1.369
PWM	1.984e-03	1.219
VerbalF	-1.738e-03	-1.579
VocabSize	8.215e-06	1.097

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item), data=X_800_1000L1)

	Fixed Effects	
	β	t
WordType	-6.189e-03	-0.458
PWM	4.616e-04	0.257
VerbalF	-1.440e-03	-1.188
VocabSize	9.835e	1.193

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item),data=X_1000_1200L1)

	Fixed Effects	
	β	t
WordType	1.421e-02	0.783
PWM	-4.260e-04	-0.224
VerbalF	-1.292e-03	-1.006
VocabSize	2.103e-05	2.418*

*p<0.05

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item),data=X_1200_1400L1)

	Fixed Effects	
	β	t
WordType	-1.090e-02	-0.589
PWM	1.545e-03	0.540
VerbalF	2.906e-03	1.500
VocabSize	2.990e-06	0.227

lmer(DV ~ WordType+PWM+VerbalF+VocabSize + (1 | Subject) + (1 | Item),data=X_1400_1600L1)

	Fixed Effects	
	β	t
WordType	-1.057e-02	-0.534
PWM	3.769e-03	0.971
VerbalF	-2.649e-05	-0.010
VocabSize	1.118e-05	0.620

Appendix 8: LDT Target Words and Primes

Prime	Target Word	Type
Bazz	Blun	Nonword1
Bazz	Grox	Nonword2
Bazz	Tell	Unrelated English Word
Bazz	Send	Related English Word
Gwap	Guzz	Nonword1
Gwap	Yiss	Nonword2
Gwap	Run	Unrelated English Word
Gwap	Eat	Related English Word
Hirp	Heef	Nonword1
Hirp	Fich	Nonword2
Hirp	Cut	Unrelated English Word
Hirp	Walk	Related English Word
Grod	Dwag	Nonword1
Grod	Brex	Nonword2
Grod	Cry	Unrelated English Word
Grod	Wash	Related English Word
Ench	Misc	Nonword1
Ench	Judd	Nonword2
Ench	Cook	Unrelated English Word
Ench	Write	Related English Word

Feam	Dume	Nonword1
Feam	Emps	Nonword2
Feam	Cut	Unrelated English Word
Feam	Play	Related English Word
Flel	Gect	Nonword1
Flel	Dern	Nonword2
Flel	Freeze	Unrelated English Word
Flel	Move	Related English Word
Gope	Nurf	Nonword1
Gope	Owse	Nonword1
Gope	Beach	Unrelated English Word
Gope	Smoke	Related English Word
Thoy	Brir	Nonword1
Thoy	Zalt	Nonword2
Thoy	Draw	Unrelated English Word
Thoy	Kick	Related English Word
Tirl	Weff	Nonword1
Tirl	Brir	Nonword2
Tirl	Bounce	Unrelated English Word
Tirl	Paint	Related English Word
Nush	Meve	Nonword1
Nush	Bymn	Nonword2
Nush	Fry	Unrelated English Word

Nush	Teach	Related English Word
Pisk	Clal	Nonword1
Pisk	Thog	Nonword2
Pisk	Admit	Unrelated English Word
Pisk	Drink	Related English Word
Spoc	Orl	Nonword1
Spoc	Nirs	Nonword2
Spoc	Throw	Unrelated English Word
Spoc	Sing	Related English Word
Woft	Yonk	Nonword1
Woft	Vift	Nonword2
Woft	Lay	Unrelated English Word
Woft	Buy	Related English Word

Appendix 9: GARDEN PATH SENTENCES

Grod [wash]

Plausible

As the girl grodded the clothes felt very soft indeed.

While the child grodded the dishes shone brightly.

Implausible

As the girl grodded the dough felt very soft indeed.

While the child grodded the rocket shone brightly.

Woft [buy]

Plausible

While the man wofted the flower looked more beautiful indeed.

As the lady wofted the cup looked brighter.

Implausible

As the lady wofted the moon looked brighter.

While the man wofted the sun looked more beautiful indeed.

Ench [write]

Plausible

As the student enched the report started an important debate.

As the student enched the summary had a convincing argument.

Implausible

As the student enched the teacher started an important debate.

As the student enched the mother had a convincing argument.

Gwap [eat]

Plausible

As the man gwapped the cookie felt very rough.

While the child gwapped the ice-cream dropped to the floor.

Implausible

While the child gwapped the puppy dropped to the floor.

As the man gwapped the cardboard felt very rough.

Hirp [walk]

Plausible

While the boy hirp the dog got hot and smelly.

While the man hirp the poodle got colder than usual

Implausible

While the boy hirp the milk got hot and smelly.

While the man hirp the water got colder than usual

Flel [move]

Plausible

As the man flel the furniture seemed smaller than usual.

As the girl flel the mug looked more clean

Implausible

As the man flel the planet seemed smaller than usual.

As the girl flel the kitchen looked more clean

Nush [teach]

Plausible

While the teacher nushed the lesson seemed more messy than usual.

As the boy nushed the subject seemed very interesting indeed.

Implausible

While the teacher nushed the house seemed more messy than usual.

As the boy nushed the ceiling looked very nice indeed.

Appendix 10: STATISTICAL CODES AND THEIR RESULTS STUDY 5

Research Question 1

For research question 1 the codes above, and their results, were used.

Research Question 1: Determiner Phrase

lmerTest::lmer (FirstP ~ L1* plaus + (1 | subject) + (1 | item), data= dps)

lmerTest::lmer (FirstFix ~ L1* plaus + (1 | subject) + (1 | item), data= dps)

lmerTest::lmer (Total ~ L1* plaus + (1 | subject) + (1 | item), data= dps)

lmerTest::lmer (RegIn ~ L1* plaus + (1 | subject) + (1 | item), data= dps)

lmerTest::lmer (Regout ~ L1* plaus + (1 | subject) + (1 | item), data= dps)

	Fixed Effects					
	L1		Plausibility		Interaction	
	β	t	β	t	β	t
FirstPass	-0.326	-0.019	-24.296	-1.842*	9.431	0.605
FirstFixation	-4.527	-0.323	3.148	0.338	-5.794	-0.483
Total	-4.424	-0.158	-5.371	-0.232	-19.956	-0.761
Regression In	-0.13960	-1.608	0.03593	0.638	-0.04435	-0.619
Regression Out	2.155e-02	0.532	-6.808e-03	-0.237	1.730e-02	0.425

*p<0.1

Research Question 1: Pseudowords

lmerTest::lmer (FirstP ~ L1* plaus + (1 | subject) + (1 | item), data= pseudo)

lmerTest::lmer (Total ~ L1* plaus + (1 | subject) + (1 | item), data= pseudo)

lmerTest::lmer (RegIn ~ L1*plaus + (1 | subject) + (1 | item), data= pseudo)

lmerTest::lmer (Regout ~ L1* plaus + (1 | subject) + (1 | item), data= pseudo)

	Fixed Effects					
	L1		Plausibility		Interaction	
	β	t	β	t	β	t
FirstPass	48.861	1.945	-30.068	-1.593	6.748	0.252
Total	-59.62	-0.864	54.03	0.891	-17.06	-0.254
Regression In	-0.08617	-0.847	0.03250	0.477	-0.14362	-1.428
Regression Out	4.350e-03	0.109	3.734e-03	0.116	1.298e-02	0.272

Research Question 1: Ambiguous Determiner Phrase

lmerTest::lmer (FirstP ~ L1*plaus + (1 | subject) + (1 | item), data= ambdp)

lmerTest::lmer (FirstFix ~ L1*plaus + (1 | subject) + (1 | item), data= ambdp)

lmerTest::lmer (RegIn ~ L1*plaus + (1 | subject) + (1 | item), data= ambdp)

lmerTest::lmer (Regout ~ L1* plaus + (1 | subject) + (1 | item), data= ambdp)

	Fixed Effects					
	L1		Plausibility		Interaction	
	β	t	*β*	t	*β*	t
FirstPass	-2.251	-0.142	2.835	0.246	9.373	0.561
FirstFixation	-4.3925	-0.293	5.0384	0.511	-0.1542	-0.011
Total	-10.50	-0.303	33.90	1.297	27.77	0.846
Regression In	-0.04716	-0.736	0.01607	0.364	-0.01362	-0.216
Regression Out	-1.871e-02	-0.480	2.543e-03	0.081	5.626e-02	1.236

Research Question 1: Disambiguating Verb

lmerTest::lmer (Total ~ L1* plaus + (1 | subject) + (1 | item), data= disambV)

lmerTest::lmer (Regout ~ L1* plaus + (1 | subject) + (1 | item), data= disambV)

	Fixed Effects					
	L1		Plausibility		Interaction	
	β	t	β	t	β	t
Total	-73.821	-1.630	-9.374	-0.192	43.422	0.875
Regression Out	0.00327	0.087	-0.01117	-0.261	-0.04617	-0.858

Research Question 1: Spill Over

```
lmerTest::lmer (FirstP ~ L1* plaus + (1 | subject) + (1 | item), data= spills)
lmerTest::lmer (FirstFix ~ L1* plaus + (1 | subject) + (1 | item), data= spills)
lmerTest::lmer (Total ~ L1* plaus + (1 | subject) + (1 | item), data= spills)
lmerTest::lmer (RegIn ~ L1* plaus + (1 | subject) + (1 | item), data= spills)
```

	Fixed Effects					
	L1		Plausibility		Interaction	
	β	t	*β*	t	β	t
FirstPass	-11.480	-0.602	-7.029	-0.356	6.102	0.259
FirstFixation	-20.814	-0.938	-7.215	-0.412	15.384	0.609
Total	-34.15	-1.030	35.40	1.171	-14.03	-0.384
Regression In	-0.041963	-0.871	-0.004459	-0.098	-0.025166	-0.446

Research Question 1: Ends

```
lmerTest::lmer (FirstP ~ L1* plaus + (1 | subject) + (1 | item), data= ends)
lmerTest::lmer (FirstFix ~ L1* plaus + (1 | subject) + (1 | item), data= ends)
lmerTest::lmer (Total ~ L1* plaus + (1 | subject) + (1 | item), data= ends)
lmerTest::lmer (RegIn ~ L1* plaus + (1 | subject) + (1 | item), data= ends)
lmerTest::lmer (Regout ~ L1* plaus + (1 | subject) + (1 | item), data= ends)
```

	Fixed Effects					
	L1		Plausibility		Interaction	
	β	t	β	t	β	t
FirstPass	-18.38	-0.461	12.70	0.343	44.35	0.977
FirstFixation	-35.54	-1.294	-25.05	-1.037	41.14	1.306
Total	-9.164	-0.193	35.466	0.641	45.191	0.823
Regression In	-0.15580	-1.196	0.09151	0.940	-0.06361	-0.491
Regression Out	4.350e-03	0.109	3.734e-03	0.116	1.298e-02	0.272

Research Question 2

For research question 2 the codes above, and their results, were used.

Research Question 2: Determiner Phrase

DP: L2 Learners

lmerTest::lmer (FirstP ~ exposure* plaus + (1 | subject) + (1 | item), data= dpsL2)

lmerTest::lmer (FirstFix ~ exposure* plaus + (1 | subject) + (1 | item), data=dpsL2)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= dpsL2)

lmerTest::lmer (RegIn ~ exposure* plaus + (1 | subject) + (1 | item), data= dpsL2)

	Fixed Effect							
	Plausibility		ExpsrIn&Exp		ExpsrIncdnt		plspl:ExI&E	
	β	t	β	t	β	t	β	t
FirstPass	-15.999	-0.754	21.304	1.082	-1.466	-0.071	2.119	0.078
FirstFix	3.5158	0.232	11.9008	0.802	10.3693	0.664	-0.6997	-1.066
Total	-24.348	-0.714	24.095	0.749	0.749	0.059	-1.080	-0.024
Regression In	-0.05122	-0.603	-0.08886	-1.045	0.01181	0.132	0.11994	1.024

DP: L1 Learners

lmerTest::lmer (FirstP ~ exposure*plaus + (1 | subject) + (1 | item), data= dpsL1)

lmerTest::lmer (FirstFix ~ exposure*plaus + (1 | subject) + (1 | item), data=dpsL1)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= dpsL1)

lmerTest::lmer (RegIn ~ exposure* plaus + (1 | subject) + (1 | item), data= dpsL1)

lmerTest::lmer (Regout ~ exposure* plaus + (1 | subject) + (1 | item), data=dpsL1)

	Fixed Effect							
	Plausibility		ExpsrIn&Exp		ExpsrIncdnt		plspl:ExI&E	
	β	t	β	t	β	t	β	t
FirstPass	-38.456	-1.944	-6.724	-0.365	-6.039	-0.311	27.003	1.024
FirstFix	-3.104	-0.198	-12.191	-0.845	-15.603	-1.024	5.429	0.263
Total	-36.05	-1.016	-15.74	-0.492	-29.19	-0.865	49.15	1.073
Regression In	0.06174	0.606	0.04913	0.552	0.07700	0.818	0.01553	0.122
Regression Out	-6.755e-04	-0.014	8.304e-03	0.180	1.288e-02	0.265	1.367e-02	0.208

Research Question 2: Pseudowords

Pseudowords- L2 Learners

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= pseudolL2)

lmerTest::lmer (RegIn ~ exposure* plaus + (1 | subject) + (1 | item), data= pseudoL2)

lmerTest::lmer (Regout ~ exposure* plaus + (1 | subject) + (1 | item), data= pseudoL2)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	*β*	t	*β*	t	*β*	t
Total	6.978	0.077	-14.837	-0.179	63.151	0.746	75.801	0.674
Regression In	-0.12137	-0.951	-0.09589	-0.781	-0.07110	-0.566	0.03650	0.219
Regression Out	0.05309	0.834	-0.08959	-1.348	0.02312	0.338	0.04206	0.465

Pseudowords- L1 Learners

lmerTest::lmer (FirstP ~ exposure* plaus + (1 | subject) + (1 | item), data= pseudoL1)

lmerTest::lmer (FirstFix ~ exposure* plaus + (1 | subject) + (1 | item), data= pseudoL1)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= pseudoL1)

lmerTest::lmer (RegIn ~ exposure* plaus + (1 | subject) + (1 | item), data= pseudoL1)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	β	t	β	t	β	t
FirstPass	-47.240	-1.466	-2.518	-0.084	-36.508	-1.158	1 0.353	0.244
FirstFix	-15.615	-0.629	32.181	1.352	-8.739	-0.348	-11.849	-0.351
Total	167.56	1.856	-10.61	- 0.129	-42.69	-0.492	-213.41	-1.837
Regression In	0.126810	1.016	-0.008907	-0.073	-0.002886	-0.022	-0.079988	-0.465
Regression Out	0.03687	0.689	0.12096	2.416	0.07322	1.386	-0.05261	-0.735

Research Question 2: Ambiguous Determiner Phrase

Ambiguous Determiner Phrase- L2 Learners

lmerTest::lmer (FirstP ~ exposure* plaus + (1 | subject) + (1 | item), data= ambdpL2)

lmerTest::lmer (FirstFix ~ exposure* plaus + (1 | subject) + (1 | item), data= ambdpL2)

lmerTest::lmer (RegIn ~ exposure*plaus + (1 | subject) + (1 | item), data= ambdpL2)

lmerTest::lmer (Regout ~ exposure* plaus + (1 | subject) + (1 | item), data= ambdpL2)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	β	t	β	t	β	t
FirstPass	2.5613	0.123	16.8909	0.850	12.6812	0.606	20.6867	0.749
FirstFixation	5.844	0.353	1 3.344	1.140	5.518	0.455	10.911	0.474
Regression In	0.07767	1.010	-0.00930	-0.120	0.07792	0.946	-0.07335	-0.678
Regression Out	0.0497	0.847	-0.13019	-2.184*	-0.07958	-1.262	0.08287	0.996

*p<0.05

Ambiguous Determiner Phrase- L1 Learners

lmerTest::lmer (FirstP ~ exposure *plaus + (1 | subject) + (1 | item), data= ambdpL1)

lmerTest::lmer (FirstFix ~ exposure* plaus + (1 | subject) + (1 | item), data= ambdpL1)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= ambdpL1)

lmerTest::lmer (RegIn ~ exposure*plaus + (1 | subject) + (1 | item), data= ambdpL1)

lmerTest::lmer (Regout ~ exposure*plaus + (1 | subject) + (1 | item), data= ambdpL1)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	*β*	t	*β*	t	*β*	t
FirstPass	-19.6640	-0.936	-0.7485	-0.036	-7.9856	-0.366	17.0985	0.584
FirstFix	-17.61	-0.962	-18.56	-1.018	-11.57	0.607	27.23	1.067
Total	14.846	0.354	-24.126	-0.628	-4.609	-0.115	27.757	0.516
Regression In	0.10523	1.367	0.07935	1.036	0.1069	1.333	-0.17899	1.669
Regression Out	0.005119	0.099	-0.011135	-0.216	-0.039899	-0.741	-0.003996	-0.055

Research Question 2: Disambiguating Verb

Disambiguating Verb- L2 Learners

lmerTest::lmer (FirstP ~ exposure* plaus + (1 | subject) + (1 | item), data= disambVL2)

lmerTest::lmer (Ffix ~ exposure* plaus + (1 | subject) + (1 | item), data= disambVL2)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= disambVL2)

lmerTest::lmer (RegIn ~ exposure* plaus + (1 | subject) + (1 | item), data= disambVL2)

lmerTest::lmer (Regout ~ exposure* plaus + (1 | subject) + (1| item), data= disambVL2)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	β	t	β	t	β	t
FirstPass	-22.748	-0.768	-2.447	-0.090	-6.184	-0.210	5.206	0.136
First Fix	2.489	0.120	-9.560	-0.481	-19.195	-0.894	-4.960	-0.178
Total	92.43	1.488	27.91	0.518	66.22	1.144	-43.21	-0.574
Regression In	0.001875	0.018	-0.012146	-0.122	0.007297	0.068	0.195233	1.388
Regression Out	-0.01380	-0.200	0.01941	0.313	0.05940	0.899	-0.05691	-0.648

Disambiguating Verb- L1 Learners

lmerTest::lmer (FirstP ~ exposure* plaus + (1 | subject) + (1 | item), data= disambVL1)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	β	t	β	t	β	t
First Pass	26.981	0.974	6.568	0.239	25.820	0.939	-40.215	-1.026

Research Question 2: Spill Over

Spill Over- L2 Learners

lmerTest::lmer (FirstP ~ exposure* plaus + (1 | subject) + (1 | item), data= spillsL2)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= spillsL2)

lmerTest::lmer (RegIn ~ exposure* plaus + (1 | subject) + (1 | item), data= spillsL2) lmerTest::lmer (Regout ~ exposure* plaus + (1 | subject) + (1 | item), data= spillsL2)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	β	t	β	t	β	t
FirstPass	-25.716	-1.154	-17.102	-0.823	-6.603	-0.299	17.981	0.565
Total	-7.189	-0.213	-2.583	-0.079	18.220	0.523	-2.136	-0.042
Reg In	0.00879	0.125	0.01753	0.277	0.07895	1.206	-0.05307	-0.568
Reg Out	0.086577	1.037	0.004893	0.065	-0.038732	-0.491	-0.070672	-0.647

Spill Over- L1 Learners

lmerTest::lmer (FirstFix ~ exposure* plaus + (1 | subject) + (1 | item), data= spillsL1)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= spillsL1)

lmerTest::lmer (RegIn ~ exposure* plaus + (1 | subject) + (1 | item), data= spillsL1)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	β	t	β	t	β	t
FirstFixation	14.98	0.397	17.39	0.514	47.86	1.281	-48.43	-0.900
Total	68.80	1.266	47.23	1.065	54.51	1.113	-65.34	-0.930
Regression In	-2.226e-02	-0.323	7.175e-02	1.157	5.288e-02	0.771	-5.736e-04	-0.006

Research Question 2: Ends

Ends- L2 learners

lmerTest::lmer (FirstP ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL2)

lmerTest::lmer (FirstFix ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL2)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL2)

lmerTest::lmer (RegIn ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL2)

lmerTest::lmer (Regout ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL2)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	β	t	β	t	β	t
FirstPass	-11.31	-0.243	-24.51	-0.583	18.05	0.419	28.87	0.456
FirstFixation	-0.9983	-0.029	14.2284	0.476	21.5847	0.706	-41.7581	-0.926
Total	-46.86	-0.774	-42.43	-0.843	28.82	0.563	112.91	1.488
Regression Out	0.051112	0.339	0.006610	0.046	0.201602	1.358	-0.003902	-0.019

Ends- L1 learners

lmerTest::lmer (FirstP ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL1)

lmerTest::lmer (FirstFix ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL1)

lmerTest::lmer (Total ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL1)

lmerTest::lmer (Regout ~ exposure* plaus + (1 | subject) + (1 | item), data= endsL1)

	Fixed Effects							
	Plausibility		ExpoIn&Exp		ExpoInci		plspl:ExI&E	
	β	t	*β*	t	*β*	t	*β*	t
FirstPass	-25.275	-0.376	7.898	0.118	54.225	0.817	7.898	0.118
FirstFixation	-70.238	-1.492	5.121	0.113	-39.704	-0.881	74.846	1.153
Total	44.44	0.487	30.25	0.377	77.99	0.977	154.78	1.342
RegOut	0.169936	0.946	0.245676	1.408	0.042451	0.245	-0.247006	-0.992

Research Question 3

For research question 3 the codes below, and their results, were used.

Research Question 3: Determiner Phrase

DP: L2 Learners

lmerTest::lmer (FirstP ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= dpsL2)

lmerTest::lmer (FirstFix ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data=dpsL2)

lmerTest::lmer (Total ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= dpsL2)

lmerTest::lmer (RegIn ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= dpsL2)

lmerTest::lmer (Regout ~ PWM*vocab*verbal*plaus + (1 | subject) + (1 | item), data=dpsL2)

Fixed Effects														
	Plaus		PWM		Vocab		VerbalF		Plau:PWM		Plau:VerbalF		Plau:Vocab	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	-1.331e+02	-0.010	4.512e+02	0.696	1.705e+00	0.739	5.348e+02	0.623	9.424e-01	0.002	-6.502e+01	-0.102	-9.760e-03	-0.006
FirstFix	-3.310e+03	-0.326	-6.858e+01	-0.146	-7.267e-02	-0.043	-1.498e+02	-0.241	1.218e+02	0.333	1.315e+02	0.274	3.425e-01	0.264
Total	-1.680e+04	-0.761	5.622e+02	0.599	2.057e+00	0.616	5.107e+02	0.411	5.922e+02	0.745	7.075e+02	0.677	2.141e+00	0.760
Reg In	-8.734e+01	-1.511	-2.973e-01	-0.143	-7.701e-04	-0.105	-1.164e+00	-0.426	2.938e+00	1.412	4.295e+00	1.571	1.056e-02	1.431
RegOut	2.385e+01	0.659	6.938e-02	0.051	-3.857e-05	-0.008	1.563e-01	0.087	-9.246e-01	-0.710	-6.735e-01	-0.394	-3.215e-03	-0.696

DP: L1 Learners

lmerTest::lmer (FirstP ~ PWM*vocab*verbal*plaus + (1 | subject) + (1 | item), data= dpsL1)

lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF+ plaus + (1 | subject) + (1 | item), data=dpsL1)

lmerTest::lmer (Total ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= dpsL1)

lmerTest::lmer (RegIn ~ PWM*vocab*verbalF* plaus + (1 | subject) + (1 | item), data= dpsL1)

lmerTest::lmer (Regout ~ PWM*vocab*verbalF* plaus + (1 | subject) + (1 | item), data=dpsL1)

Fixed Effects														
	Plaus		PWM		VerbalF		Vocab		Plau:PWM		Plau:VerbalF		Plau:Vocab	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	-1.201e+03	-0.391	3.483e+00	0.020	1.212e+01	0.127	4.279e-02	0.132	6.480e+01	0.366	2.792e+01	0.293	1.215e-01	0.375
FirstFix	5.762e+02	0.241	7.667e+01	0.479	5.562e+01	0.642	1.883e-01	0.641	-2.543e+01	-0.184	-2.499e+01	-0.337	-6.320e-02	-0.250
Total	1.872e+03	0.354	5.000e+02	1.953*	2.754e+02	1.996*	-1.559e+01	-1.934*	-1.823e+02	-0.597	-3.821e+01	-0.233	-2.354e-01	-0.421
Reg In	-9.792e+00	-0.666	4.286e-01	0.437	1.828e-02	0.034	7.852e-04	0.436	3.425e-01	0.403	3.661e-01	0.802	9.771e-04	0.629
Reg Out	9.558e+00	1.250	7.382e-01	1.693	4.684e-01	1.989*	1.402e-03	1.751	-5.733e-01	-1.298 -	3.691e-01	-1.557	-1.019e-03	-1.261

*p<0.1

Research Question 3: Pseudowords

Pseudowords- L2 Learners

lmerTest::lmer (FirstFix ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= pseudoL2)

lmerTest::lmer (Total ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= pseudoL2)

lmerTest::lmer (RegIn ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= pseudoL2)

lmerTest::lmer (Regout ~ PWM*vocab*verbal* plaus + (1 | subject) + (1 | item), data= pseudoL2)

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstFix	8.823e+03	0.594	-7.456e+02	-1.596	-8.614e+02	-1.596	-2.624e+00	-1.560	-2.702e+02	-0.502	-3.495e+02	-0.551	-7.741e-01	-0.401
Total	4.434e+04	0.934	1.368e+03	0.963	1.376e+03	0.833	4.727e+00	0.925	-1.569e+03	-0.912-	1.870e+03	-0.921	-5.368e+00	-0.870
Reg In	-1.867e+01	-0.264	9.166e-01	0.429	1.080e+00	0.435	3.384e-03	0.440	6.379e-01	0.249	8.072e-01	0.267	2.442e-03	0.265
RegOut	1.295097	0.471	0.038435	0.431	0.060370	0.553	6.688e-04	1.005	-0.038220	-0.393	-0.055688	-0.467	-4.965e-04	-0.631

Pseudowords- L1 Learners

lmerTest::lmer (FirstP ~ PWM*vocab*verbal*plaus + (1 | subject) + (1 | item), data= pseudoL1)

lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF* plaus + (1 | subject) + (1 | item), data= pseudoL1)

lmerTest::lmer (Regout ~ PWM*vocab*verbalF* plaus + (1 | subject) + (1 | item), data= pseudoL1)

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	-4.765e+03	-0.965	-5.444e+02	-2.557*	-2.420e+02	-2.101*	-8.801e-01	-2.246*	2.986e+02	1.053	1.584e+02	1.025	5.170e-01	0.990
FirstFix	-3.255e+03	-0.824	-3.720e+02	-2.151*	-1.673e+02	-1.787	-6.063e-01	-1.905	2.014e+02	0.888	1.115e+02	0.902	3.510e-01	0.840
Reg Out	-7.280e-01	-2.093*	-7.280e-01	-2.093*	-4.254e-01	-2.262*	-1.366e-03	-2.134*	6.355e-01	1.324	3.724e-01	1.424	1.196e-03	1.353

*p<0.05

Research Question 3: Ambiguous Determiner Phrase

Ambiguous Determiner Phrase- L2 Learners

lmerTest::lmer (Total ~ PWM*vocab*verbalF *plaus + (1 | subject) + (1 | item), data= ambdpL2)
lmerTest::lmer (RegIn ~ PWM*vocab*verbalF *plaus + (1 | subject) + (1 | item), data= ambdpL2)
lmerTest::lmer (Regout ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= ambdpL2)

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
Total	-2.427e+04	-0.908	8.161e+02	0.900	9.082e+02	0.889	3.296e+00	1.021	8.939e+02	0.930	9.838e+02	0.897	3.016e+00	0.886
RegIn	5.052e+00	0.103	-2.167e-01	- 0.125	-2.633e-01	-0.136	-2.074e-04	-0.034	-1.177e-01	-0.067	-7.415e-02	-0.037	-1.355e-03	-0.218
Reg Out	-2.122e+00	-0.056	-5.885e-01	-0.595	-4.578e-01	-0.404	-2.066e-03	-0.589	7.754e-02	0.057	6.894e-03	0.004	-1.671e-04	-0.034

Ambiguous Determiner Phrase- L1 Learners

lmerTest::lmer (FirstP ~ PWM*vocab*verbalF *plaus + (1 | subject) + (1 | item), data= ambdpL1)

lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= ambdpL1)

lmerTest::lmer (Total ~ PWM*vocab*verbalF *plaus + (1 | subject) + (1 | item), data= ambdpL1)

lmerTest::lmer (Regout ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item, data= ambdpL1)

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	1.790e+03	0.540	2.443e+01	0.155	4.410e+01	0.517	1.201e-01	0.418	-8.568e+01	-0.445	-5.576e+01	-0.535	-1.930e-01	-0.549
FirstFix	1.585e+03	0.548	-1.415e+01	-0.093	2.040e+01	0.249	1.324e-02	0.048	-7.806e+01	-0.465	-4.090e+01	-0.450	-1.749e-01	-0.571
Total	-1.119e+03	-0.184	-3.595e+01	-0.095	-3.064e+01	-0.149	3.748e-02	0.054	1.390e+02	0.393	7.762e+01	0.406	1.535e-01	0.238
Regout	-1.236e+01	-1.504	-2.223e-01	-0.526	-1.324e-01	-0.579	-3.542e-04	-0.460	6.791e-01	1.422	4.115e-01	1.592	1.308e-03	1.502

Research Question 3: Disambiguating Verb

Disambiguating Verb- L2 Learners

```
lmerTest::lmer (FirstP ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL2)
lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL2)
lmerTest::lmer (Total ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL2)
lmerTest::lmer (Regout ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL2)
```

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	-7.094e+03	0.355	-9.902e+02	1.574	-1.017e+03	1.419	-3.483e+00	1.554	3.036e+02	0.424	-1.687e-01	0.000	1.160e+00	0.464
FirstFix	1.744e+04	1.185	-2.808e+02	0.600	-2.859e+02	0.537	-8.376e-01	0.502	-5.973e+02	1.135	-2.093e+00	1.137	3.024e-02	0.500
Total	-4.822e+04	1.233	-6.626e+01	0.058	-9.432e+01	0.072	-1.124e-01	0.028	1.742e+03	1.245	1.773e+03	1.014	1.013e-02	0.069
RegOut	-5.060e+01	1.135	-8.376e-01	0.841	-1.143e+00	0.982	-2.906e-03	0.824	1.895e+00	1.187	2.411e+00	1.228	6.505e-03	1.160

Disambiguating Verb- L1 Learners

```
lmerTest::lmer (FirstP ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL1)
lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL1)
lmerTest::lmer (Total ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL1)
lmerTest::lmer (RegIn ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL1)
lmerTest::lmer (Regout ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= disambVL1)
```

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	-1.592e+02	0.035	-2.569e+02	1.061	-1.206e+02	0.930	-4.259e-01	0.972	1.194e+01	0.045	-4.276e+00	0.030	1.221e-02	0.026
FirstFix	1.180e+03	0.489	-1.165e+02	0.865	-5.647e+01	0.782	-1.681e-01	0.689	-5.534e+01	0.390	-2.882e+01	0.375	-1.355e-01	0.530
Total	-1.746e+03	0.166	-3.844e+02	0.697	-2.532e+02	0.858	-8.371e-01	0.840	2.134e+01	0.034	-2.101e+01	0.062	1.388e-01	0.124
Reg In	2.205e+01	1.164	1.052e+00	1.199	4.237e-01	0.907	1.766e-03	1.119	-1.263e+00	1.133	-6.759e-01	1.120	-2.432e-03	1.211
Reg Out	-6.914e+00	0.647	-1.457e-01	0.334	-1.109e-01	0.479	-2.734e-04	0.350	4.439e-01	0.706	2.334e-01	0.685	7.149e-04	0.632

Research Question 3: Spill Over

Spill Over- L2 Learners

lmerTest::lmer (FirstP ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL2)

lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL2)

lmerTest::lmer (Total ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL2)

lmerTest::lmer (RegIn ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL2)

lmerTest::lmer (Regout ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL2)

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	1.374e+03	0.091	-5.273e+02	0.988	-6.884e+02	1.123	-1.789e+00	0.974	-1.600e+01	0.030	5.782e+01	0.092	-1.404e-01	0.076
FirstFix	-4.549e+03	0.419	-6.177e+02	1.590	-7.911e+02	1.772	-2.073e+00	1.550	1.867e+02	0.485	2.788e+02	0.618	5.554e-01	0.417
Total	7.898e+03	0.322	4.606e+02	0.769	3.692e+02	0.523	1.598e+00	0.772	-2.791e+02	0.321	-3.511e+02	0.345	-1.025e+00	0.341
Reg In	-1.502e+01	0.324	-8.432e-01	0.775	-7.799e-01	0.607	-3.479e-03	0.925	6.172e-01	0.375	2.499e-01	0.130	2.271e-03	0.399
Reg Out	6.938e+01	1.295	-1.154e-05	1.172	3.389e-04	1.233	2.956e-04	1.259	-2.388e+00	1.257	-2.768e+00	1.244	-8.612e-03	1.311

Spill Over- L1 Learners

lmerTest::lmer (FirstP ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL1)

lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL1)

lmerTest::lmer (Total ~~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL1)

lmerTest::lmer (RegIn ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL1)

lmerTest::lmer (Regout ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= spillsL1)

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	4.508e+02	0.079	-1.189e+02	0.455	-6.449e+01	0.459	-2.676e-01	0.576	-9.682e+01	0.286	-4.929e+01	0.269	-5.856e-02	0.096
FirstFix	-5.884e+03	0.885	-5.835e+02	1.771	-2.679e+02	1.512	-1.064e+00	1.810	3.200e+02	0.813	1.306e+02	0.614	6.165e-01	0.873
Total	-2.489e+03	0.286	-1.351e+02	0.268	-9.987e+01	0.368	-3.675e-01	0.407	3.991e+01	0.077	1.816e+01	0.065	2.769e-01	0.300
Reg In	-3.655e+00	0.304	3.521e-01	0.601	1.205e-01	0.383	4.293e-04	0.411	2.253e-01	0.317	7.386e-02	0.192	5.425e-04	0.425
RegOut	-8.933e+00	0.566	1.985e-01	0.295	6.744e-02	0.186	3.006e-04	0.252	5.546e-01	0.595	2.150e-01	0.426	1.001e-03	0.597

Research Question 3: Ends

Ends- L2 learners

lmerTest::lmer (FirstP ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL2)

lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL2)

lmerTest::lmer (Total ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL2)

lmerTest::lmer (Regout ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL2)

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	-1.410e+04	0.564	-5.773e+02	0.754	-8.755e+02	0.936	-1.941e+00	0.729	5.693e+02	0.631	7.625e+02	0.708	2.104e+00	0.671
FirstFix	-2.744e+04	0.788	-4.416e+02	0.400	-8.209e+02	0.609	-1.490e+00	0.388	1.071e+03	0.851	1.683e+03	1.118	3.915e+00	0.896
Total	-5.604e+04	1.336	-6.460e+02	0.491	-1.254e+03	0.778	-2.128e+00	0.464	2.057e+03	1.358	2.793e+03	1.538	7.075e+00	1.344
Reg Out	-7.388e+01	-0.621	1.720e+00	0.410	6.907e-01	0.136	6.931e-03	0.472	2.485e+00	0.580	3.812e+00	0.739	8.574e-03	0.577

Ends- L1 learners

lmerTest::lmer (FirstP ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL1)

lmerTest::lmer (FirstFix ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL1)

lmerTest::lmer (Total ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL1)

lmerTest::lmer (RegIn ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL1)

lmerTest::lmer (Regout ~ PWM*vocab*verbalF*plaus + (1 | subject) + (1 | item), data= endsL1)

	Fixed Effects													
	Plausibility		PWM		VerbalF		VocabS		Plau:PWM		Plau:VerbalF		Plau:VocabS	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t
FirstPass	-1.841e+04	1.397	-6.900e+02	0.958	-3.752e+02	0.973	-1.131e+00	0.879	1.127e+03	1.446	5.980e+02	1.443	1.919e+00	1.378
FirstFix	7.514e-06	1.388	2.410e-04	1.159	1.234e-04	1.117	-1.499e-01	1.475	-4.427e+01	1.445	4.728e-03	1.438	5.927e-02	1.229
Total	-2.355e+04	1.462	-1.049e+03	1.241	-5.556e+02	1.227	-1.780e+00	1.181	1.416e+03	1.485	7.269e+02	1.434	2.483e+00	1.459
Regression Out	3.529e+01	1.068	2.043e+00	1.321	9.391e-01	1.130	3.477e-03	1.260	-2.349e+00	1.204	-1.181e+00	1.137	-3.623e-03	1.038

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