THE INFLUENCE OF PHONOLOGICAL SIMILARITY IN ADULTS LEARNING WORDS IN A SECOND LANGUAGE

BY

Melissa Stamer

Dissertation submitted to the graduate degree program in Curriculum and Teaching
and the Graduate Faculty of the University of Kansas
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy

____
Michael S. Vitevitch, PhD, Chairperson

____
Manuela Gonzalez-Bueno, PhD, Chairperson

Committee Members

____
Joan A. Sereno, PhD, Chairperson of Minor

____
Lizette Peter, PhD

____
Suzanne Rice, PhD

The Dissertation Committee for Melissa Stamer certifies
that this is the approved version of the following dissertation:

THE INFLUENCE OF PHONOLOGICAL SIMILARITY IN ADULTS LEARNING WORDS IN A SECOND LANGUAGE

____
Michael S. Vitevitch, PhD, Chairperson

____
Manuela Gonzalez-Bueno, PhD, Chairperson

Committee Members

____
Joan A. Sereno, PhD, Chairperson of Minor

____
Lizette Peter, PhD

____
Suzanne Rice, PhD

Table of Contents

Lists of Tables

Lists of Figures

Abstract

Neighborhood density refers to the number of similar sounding words to a target word (Luce & Pisoni, 1998) and influences first language word learning in adults learning English (Storkel, Armbruster, & Hogan, 2006). There are two processes in word learning: lexical configuration and lexical engagement (Leach & Samuel, 2007). Lexical configuration refers to the speaker learning the sounds of the word. Lexical engagement refers to when the novel word is integrated into the lexicon and participates in lexical processes such as competition. The present work is the first to examine how neighborhood density influences lexical configuration and lexical engagement in second language word learning.

Third-semester Spanish students performed four word learning tasks. The present results suggest neighborhood density influences lexical configuration and lexical engagement where words from a dense neighborhood are learned more accurately than words from a sparse neighborhood. The psycholinguistic and pedagogical implications of these findings are discussed.

Acknowledgements

The idea for this dissertation topic came into conception the summer of 2007. The final draft before my defense was accepted December 2009. After a successful defense on February 17, 2010, I was finally able to graduate that May. The past three years would not have been possible without help and support.

Dr. Michael Vitevitch, my adviser and co-chair, molded me into an academic professional. As an expert in psycholinguistics, he taught me everything I need to know about running a lab, being a professor, presenting at conferences, interviewing, and reviewing and submitting papers. He funded me throughout graduate school rescuing me from theoretical syntax years ago. During my PhD program, he read countless drafts of my dissertation. He met me nearly weekly for months planning the methodology, refining the methodology, discussing implications of the results, and how to write it up – which was the part that was the most difficult for me. He made sure I was more than ready for the defense with a solid dissertation. Mike was always honest and straightforward about the quality of my work and if it weren't for him, I never would have made it this far.

Dr. Manuela Gonzalez-Bueno, adviser and co-chair, also read numerous drafts and offered invaluable feedback. It was she who took me into the School of Education at KU and offered to be my adviser. She made sure I would take all the courses I needed, got all the signatures required, and jumped through all the hoops to graduate in due time.

Dr. Joan Sereno, chair of my minor (Linguistics), was extremely helpful with my concept and my methods. She was always straightforward and would ask questions that made me think about my interpretations or motivations. It was Dr. Sereno's Introduction

to Psycholinguistics class that piqued my interest in psycholinguistics. Without her, I may not have succeeded in graduate school.

Dr. Lizette Peter gave me many comments and critiques on my dissertation. She also was quick to offer job search advice. I only had the opportunity to have her for a single class – multicultural education – but her teaching style has influenced the kind of professor I would like to be.

Dr. Suzanne Rice was one of my favorite teachers in graduate school. Although her area of expertise is outside mine, she taught me the finer points of theory and history in education. She turned me into a Deweyan and was always there to give me the pat on the back and words of encouragement I needed.

My family played an integral part of my success. My father was nothing but supportive since I was born. He showed me unconditional love throughout and I always knew he was proud of me. My mom, also my best friend, was always there to listen, to talk, to hang out – whatever I needed. Like Mike, she also partially funded my education. I am forever indebted to her and hope to be like her when I'm a mom. My brother, although not always there due to work, was supportive in his own way. We took our dog, Ate (Ah-tay) to the park and often went to the farmer's market.

Josh Smith, my boyfriend, is the most patient person I know. He gave me time and space when I needed it, he pushed me to work when I wouldn't, and he gracefully wore headphones when playing his video games to give me the silence I required.

Eric Yandell, my best friend, was always there to listen to me, support me, encourage me, and congratulate me. Karen, a friend in academics as well, although in Spain, was quick to contact me if need be and was always supportive.

The KU Writing Center, and especially Matt Egging, was an extremely helpful resource. Not only did the appointments keep me on track, but they also helped with my grammatical mistakes and fluency. Matt was very patient and also did his best to understand my topic and offer useful writing advice.

I would also like to acknowledge the National Institutes of Health-National Institute of Deafness and Other Communication Disorders (NIH-NIDCD R01 DC 006472) for the funding the Spoken Language Laboratory and me.

1. Introduction

Children seem to learn words in their first language effortlessly. In fact, after a child learns approximately 50 words, generally around the second year, a vocabulary explosion occurs and word learning accelerates. By adulthood, the average person has learned 60,000 words in the first language (McMurray, 2007).

Adults also appear to learn words easily and frequently. It is estimated that adults learn 1,000 words per year, which translates to approximately three words per day per year (Nation & Waring, 1997) in their first language (L1). However, it does not appear to be as easy for adults learning novel words in a second language (L2) as it is for children or adults learning novel words in a first language. In the present paper, second language refers to the language adults are learning second in their life. Although the adults in the present study are studying their second language, Spanish, in the classroom in an English speaking country, second language or L2 will be used to describe word learning by adults in a second language classroom.

Adults tend to struggle when learning new words in an L2 and, according to Bley-Vroman (1989) and his Fundamental Difference Hypothesis, adults vary in the amount of success they have when learning an L2. Adults rarely gain native-like proficiency in L2 vocabulary acquisition. If adults who are learning new words in their L1 have little trouble, just as children have little trouble, why do adults who are learning new words in an L2 have more difficulties? What is it about learning an L2 as an adult that makes word learning so effortful? Are there any strategies that adults can employ to learn words more effectively in the L2?

One explanation for the discrepancy between word learning in an L1 as a child or an adult versus word learning in an L2 as an adult is the influence of age (e.g., Flege, 1999; Johnson & Newport, 1989; Lenneberg, 1967; White, 1992). When adults study an L2 for the first time in the United States (generally in middle or high school), the language is taught after the onset of puberty. This, of course, contrasts with how the L1 was learned. The L1 has been acquired continuously since birth and did not begin abruptly at the onset of puberty. Puberty tends to be considered a turning point in language acquisition.

According to the Critical Period Hypothesis (CPH), there is a window of time before the onset of puberty where language is learned unconsciously (Lenneberg, 1967). Biologically, the CPH refers to the amount of plasticity in the brain. The more plastic, or flexible, the brain is, the more easily it acquires language. The hypothesis predicts and empirical evidence supports that there is a decline in language learning ability, leading to decreased success after a certain age generally thought to be puberty (Birdsong & Molis, 2001; Flege, Munro, & MacKay, 1995; Hakuta, Bialystok, & Wiley, 2003; Johnson & Newport, 1989; White, 1992). Additional neuroimaging studies have shown differences in the location of where first and second languages are stored depending on whether the second language was acquired before or after the critical period (Kim, Relkin, Lee, & Hirsch, 1997). These studies suggest that age does play a role in creating difficulties in acquiring new words during second language acquisition. So, although, adults can still learn new words in a second language, they seem to struggle more with the second than the first language during word learning (Bley-Vroman, 1989).

It does not suffice, however, to blame the differences in word learning on age alone. There are other differences and influences to consider. Children learn their L1 very differently from how adults generally learn an L2. For example, children are completely immersed in their L1 environment, whereas adults tend to learn second languages in a classroom setting. Children use their L1 every day, whereas adults may only use their L2 for an hour a day, for example. Therefore, L1 children and L2 adults may employ different strategies when learning novel words in an L1 versus an L2, respectively.

The present study focuses on the acquisition of the word form by monolingual English speakers learning Spanish and examines which types of word forms are learned more efficiently than others. The present work explores whether learners in a second language, like adult learners in their L1, have the two stages of word learning: lexical configuration and lexical engagement. The objective of the present study was to examine the dissociation between the two stages of word learning in second language learners using real words from the target language, Spanish. It is important not only to explore how learners acquire representations, but also how they are created.

To examine how novel words are acquired and how new mental representations are created, the missing piece of the L2 word acquisition process was examined: the word form. It has been shown that the word form plays a role in word learning. The present study examines the influence of the psycholinguistic variable *neighborhood density*: a measure of phonological similarity that has been found to influence lexical, or word, retrieval from memory in English (Luce & Pisoni, 1998; Vitevitch, 2002; Vitevitch & Sommers, 2003; Vitevitch, Stamer, & Sereno, 2008) and Spanish (Vitevitch &

Rodríguez, 2005; Vitevitch & Stamer, 2006, 2009) during perception and production. To explore whether second language learners also have the two stages of lexical configuration and lexical engagement the present study is a two-part study with the second part occurring 48 to 72 hours later (Dumay & Gaskell, 2007; Gaskell & Dumay, 2003; Leach & Samuel, 2007).

Research has shown that children rely on a variety of strategies when learning novel words in their first language. One strategy that children may employ during word learning is the use of innate biases or ways that children learn language with which they are born. Certain researchers believe that inborn biases help an L1 learner decide more quickly among hypotheses when presented with new words (e.g., Au & Glusman, 1990; Gershkoff-Stowe & Smith, 2004; Markman, 1990, 1991, 1992; Markman & Hutchinson, 1984; Markman, Wasow, & Hansen, 2003; Merriman & Bowman, 1989; Quine, 1960, 1964; Woodward, 1992). A bias helps the L1 learner narrow down the list of possibilities and thus eases word learning. Biases are generally researched under the assumption that children need to learn what sounds make up the word, the word form, the word meaning and to make the link between word form to the word meaning. There are four major biases that have been heavily researched and are considered important as children learn novel words: the taxonomic bias (Markman & Hutchinson, 1984), the whole-object bias (Quine, 1960), the shape bias (Gershkoff-Stowe & Smith, 2004), and the mutual exclusivity principle (e.g., Au & Glusman, 1990; Markman & Wachtel, 1988; Markman, et al., 2003; Merriman & Bowman, 1989). These biases are primarily to help the child form the link between a new word form and a new word meaning.

However, when an adult is learning an L2, it is assumed that the word meanings from the L1 have already been stored and are accessible in the lexicon. Therefore, when an adult learns a new word in a new language, instead of making a link between a new word form and a *new* word meaning, generally the adult is simply making the link between the new word form and an *old* word meaning. It is thus unclear whether biases are used as a novel word learning strategy by L2 learning adults since biases mainly focus on the acquisition of the word meaning. This difference in what L2 learners must learn when learning a word also leads to the question: why is it generally so difficult for L2 adults to learn words when they already have the meaning of the word learned from their previous L1 exposure? Second language learning adults need to learn the sounds that make up the word, the word form itself, and need to make the link between the new word form and the already-existing meaning. Therefore, focusing research on the word form in L2 word acquisition is crucial as that is the missing part of the equation of what an adult must learn when learning novel words in an L2. The present study examines how the word form, or lexical representation, is acquired and influenced by other word forms in the lexicon.

Since adults may not need to rely on biases because the emphasis in L2 word learning is not on making the link between meaning and word form, it is important to understand how the word form is acquired in general. Many researchers have examined how the word form is acquired by children and on what strategies children may employ when learning novel words. It has been observed that children rely on bootstrapping techniques (Werker & Yeung, 2005), phonological similarity (Charles-Luce & Luce, 1990, 1995; Cheung, 1995; Demke, Graham, & Siakaluk, 2002; Dollaghan, 1994;

Storkel, 2001, 2002, 2004a, 2004b; Swingley & Aslin, 2002, 2007; Treiman & Breaux, 1982) and statistical regularities in the sound signal (Saffran, Aslin, & Newport, 1996).

The influences of phonological similarity and statistical learning are particularly interesting because both children and adults appear to be sensitive to them during word learning. For example, looking at English-speaking adults learning made-up words, Strokel, Armbruster, and Hogan (2006) found that words with many similar sounding words were more effectively learned than words with fewer similar sounding words. Carlson (2007) found that English-speaking adults learning Spanish as an L2 relied on statistical regularities to decide if a Spanish word was a real word in Spanish or a made-up, nonsense word. Therefore, there may be strategies that both children and adults employ during word learning, but whether the strategies are used while an adult is learning an L2 is a different question.

Extracting statistical information from the speech signal is a sublexical process, which focus on the phonology of the word, whereas relying on the influence of phonologically similar words is a lexical process which focus on the word as a whole. Second language research has shown that adults can use statistical regularities to help in word learning, but whether adults can use lexical information, such as phonological similarity to help learn novel L2 words has different implications. In order to use lexical information during novel word learning, the learner must create a novel word representation in the lexicon. The new representation must, therefore, act in a similar manner as the previously stored representations and participate in lexical processes such as competition. Therefore, when examining adult L2 learning, it is not only important to analyze whether the adults are influenced by phonological similarity, but also if they create a novel word representation in the mental lexicon and, additionally, what role phonological similarity plays in that creation.

Though children and adults in a first language learning environment learn words and create mental representations effortlessly, adults in second language learning contexts have difficulty when learning a second language. This may be because second language learning adults already have a lexicon from their first language when they begin learning a second language. Therefore, when learning an L2, the new L2 representations will be added into an already existing and functioning lexicon. Whether the L2 entries are added to the L1 lexicon or to a new lexicon is beyond the scope of this paper. However, it is important to note that regardless of where new L2 entries are being stored, there will be some sort of interaction with or influence from the L1 lexicon to the new L2 lexicon (see Gass, 1996 for a discussion about L1 and L2 transfer) as the adult lexicon and the lexical representations are dynamic in nature (Gaskell & Dumay, 2003; Leach & Samuel, 2007; see Storkel, 2002 for a review about child restructuring lexicons). The existence of the L1 lexicon may be a reason why adults struggle when learning L2 words or, on the contrary, the existence of an L1 lexicon may be an advantage that adults use. For example, the existence of an L1 lexicon during L2 word learning may allow a bootstrapping technique from the first lexicon to the second in order to learn words more efficiently without external help, but it is not well understood how the first and second language lexicons interact. It is unclear whether they are two separate lexicons or a single lexicon or to what degree they may influence each other. The important point for this paper is that adults who are beginning to learn an L2 already have representations from the L1 stored in the lexicon.

Adults learning a second language already have a phonological, a lexical and a semantic representation for each word stored in the L1 lexicon. When a new word from the L2 is being acquired, adults may draw from the L1 lexicon's previously stored semantic representation. By this line of logic, what the adult is missing is only the word form and the link to the already existing semantic representation. Adults do not necessarily need to acquire a new L2 semantic representation because the L1 semantic representations already exist, so the focus in L2 learning should be on learning the word form. Because the word form is so fundamentally important during L2 word learning, it is possible that characteristics about the word form, such as phonological similarity, will influence the lexical representation and will be more readily observed.

The influence of phonological similarity has been shown to affect word learning in children (Charles-Luce & Luce, 1990, 1995; Cheung, 1995; Demke, et al., 2002; Dollaghan, 1994; Storkel, 2001, 2002, 2004a, 2004b; Swingley & Aslin, 2002, 2007; Treiman & Breaux, 1982) and in adults (Storkel, et al., 2006) in the L1. Children and adults acquire novel words that have more overlap with previously stored words than novel words that have little overlap with previously stored words. For example, it would be easier to acquire *cat* because there are many similar sounding words stored in the English lexicon, but a word like *pig*, where there are few similar sounding words stored in the lexicon would be more difficult to acquire.

Phonological similarity aids in word learning. Phonological similarity is also thought to be one way the lexicon is organized. Similar sounding words tend to be stored together in groups called neighborhoods. Because phonological similarity appears to play a large role in lexical organization and the acquisition of new lexical representations in the L1, it is possible that adults learning words in an L2 may also rely on phonological similarity as a strategy to help them learn novel L2 words and to add new lexical entries to the lexicon.

Phonological similarity is not the only strategy on which adults learning a second language can rely. Adults learning a second language may rely on completely different cognitive strategies than L1 learners altogether. As shown by research on biases, L1 learners rely on unconscious deductive reasoning. It is possible that adults use a more conscious deductive reasoning or even inductive reasoning, guessing or mnemonic strategies, when learning novel words. Because there may be different processing strategies between L1 learners and L2 learning adults, there may be differences between what has been found in the L1 child and the L1 adult word learning literature and the results of the present study examining L2 word learning adults. Or, again, adults may rely on similar language learning strategies as children and adults in the L1, such as an influence of phonological similarity, when learning words in a second language. It is, however, unclear whether and how phonological similarity will influence adult word learning in an L2. This dissertation begins to explore how adults learn words in a second language, focusing primarily on the acquisition of the word form given the influence of phonological similarity.

There are limitations to the present study. For example, conducting research in a carefully controlled environment, such as a language laboratory, is ideal for collecting reaction time data and for ensuring that each participant is treated exactly the same; however, as the present study is a word learning study, it is extremely rare that words are learned in the manner conducted in the present study. Words are learned through every day interactions, through reading, and often in context. Words in the present study are carefully controlled and presented in isolation matched with a picture during the Exposure Phase where the participant learns the words. Although this method may be a limitation to the application in a classroom, for example, the present procedure is necessary to examine the psycholinguistic mechanisms of word learning. Once the mechanisms of word learning are understood, these mechanisms can be further explored in a classroom setting.

The present study examines how words are learned by English speaking adults learning Spanish and how the newly acquired words are integrated into the lexicon. Lexical characteristics of the word-form, such as phonological similarity, were manipulated while other characteristics of the word form were controlled to gain a better understanding about the influence of the word form, specifically the influence of phonological similarity, in word learning. In order to better study how the word form plays a role in word learning, a measure of phonological similarity called *neighborhood density*, was manipulated and the influence thereof was examined and interpreted within a psycholinguistic and pedagogical framework.

The dissertation will be structured as follows: Chapter two will be a detailed review of the literature as well as a review of the present and previous research shaping the background and motivation for the present study. Chapter three will describe the method, procedures, and stimuli used in the various tasks within the experiment. Chapter four will present the results with the proper statistical analyses. Chapter five will provide a discussion and interpretation of the results. Chapter six will discuss the implications of the results and future research directions for the study of word learning in a second language.

2. Literature Review

Learning a word in a first language appears to be nearly effortless; however, when learning words in a second language as an adult, it is more difficult for most adults (Bley-Vroman, 1989; Krashen, 1982). It is possible that learners employ certain strategies when learning novel words in the first language such as relying on phonological similarity, i.e., utilizing how similar the novel word is to already existing words or representations in the lexicon. Adults and children learning words in their first language have more success in learning the words that have more overlap with previously stored words than words with less overlap with previously stored words in the lexicon (e.g., Demke, et al., 2002; Storkel, 2004a; Storkel, et al., 2006). It is possible that this pattern will also be observed with second language learners.

Before discussing second language learners, it is important to understand the first language word learning processes. But in order to understand word learning and the word learning process, it is important to understand exactly what occurs when a person is learning a novel word. In order to learn a word, the learner must learn phonological, lexical, and semantic representations as well as integrate these representations into the lexicon. The initial process of learning the three representations of novel words is referred to as *lexical configuration* (Leach & Samuel, 2007). For example, when the novel word "duck" is learned, the learner will learn the sounds of "duck" [d, ^, k], the word chunk [d^k], and that "duck" refers to a bird that can swim or fly, lives in lakes, and quacks. Most of the previous research examining first language word learning has focused on the role of lexical configuration in word learning (e.g., Storkel, 2001; Storkel, et al., 2006; Swingley & Aslin, 2000, 2007).

The next stage of word learning, referred to as *lexical engagement,* is where the newly learned representation interacts with other previously learned representations, either through competition, inhibition, or facilitation (Leach & Samuel, 2007). For example, when a person has learned the word “duck,” in order to retrieve that word, other words that are similar sounding to “duck” may also be activated, words such as “suck,” “luck,” “dock,” “deck,” “dud,” and “done.” As other words are activated, depending on the linguistic process employed, the activated similar sounding words may either compete with “duck” (thus slowing down lexical retrieval) or facilitate the retrieval of “duck” (thus speeding up lexical retrieval). The competition or facilitation between the novel word and the previously stored word is an example of lexical engagement, as the novel word has a mental representation that interacts in some way with other representations in the lexicon. Once a word is involved in lexical engagement, Leach and Samuel suggest that the novel word has become fully integrated into the lexicon; thus, the novel word is considered to be learned and available for lexical retrieval. It is clear that phonological similarity plays a role in lexical configuration, but less clear which specific lexical influences affect the creation of a novel mental representation and whether phonological similarity plays a role in lexical engagement.

This dissertation examines how word forms from a second language (i.e., Spanish) are learned by monolingual, English-speaking adults and how those word forms are integrated into the mental lexicon. Although much work has analyzed how adults learn words in various second languages including Spanish, English, and German (e.g., Barcroft, 2002, 2003; Carlson, 2007; Cheung, 1996; Finkbeiner & Nicol, 2003; Maekawa, 2006; Speciale, Ellis, & Bywater, 2004), those studies have not necessarily examined how characteristics of the word form play a role in L2 word learning. The aforementioned studies have addressed the role of semantics (Barcroft, 2002, 2003; Finkbeiner & Nicol, 2003), phonological knowledge (Carlson, 2007; Maekawa, 2006), phonological awareness (Cheung, 1995), and phonological memory (Cheung, 1996; Speciale, et al., 2004) in L2 word learning in adults. Furthermore, few studies have examined the creation and integration of mental representations into the L2 lexicon.

The present study focuses on the acquisition of the word form by monolingual English speakers learning Spanish and examines which types of word forms are learned more efficiently than others. The present work explores whether learners in a second language, like adult learners in their L1, have the two stages of lexical configuration and lexical engagement. It is important not only to explore how learners acquire representations, but also how they are created. To examine how novel words are acquired and how new mental representations are created, the missing piece of the L2 word acquisition process was examined: the word form. It has been shown that the word form plays a role in word learning. The present study examines the influence of the psycholinguistic variable *neighborhood density*: a measure of phonological similarity that has been found to influence lexical, or word, retrieval from memory in English (Luce & Pisoni, 1998; Vitevitch, 2002; Vitevitch & Sommers, 2003; Vitevitch, et al., 2008) and Spanish (Vitevitch & Rodríguez, 2005; Vitevitch & Stamer, 2006, 2009) during perception and production. To explore whether second language learners also have the two stages of lexical configuration and lexical engagement the present study is a two-part study with the second part occurring 48 to 72 hours later (Dumay & Gaskell, 2007; Gaskell & Dumay, 2003; Leach & Samuel, 2007).

In order to understand the impact of the present work, it is crucial to examine what literature has been the focus in the study of word learning and where the literature of those studies is lacking. Most of the work in word learning with an emphasis on examining the influence of neighborhood density has been on examining children (Charles-Luce & Luce, 1990; Dollaghan, 1994; Storkel, 2002, 2004a; Swingley & Aslin, 2002, 2007) and adults (Storkel, et al., 2006) learning words in their L1. However, there is currently little to no work examining the influence of phonological similarity in L2 word learning in adults, and more specifically, learning Spanish as an L2.

To begin to examine the question of how adults learn words in an L2, it is important to understand how words in general are learned. Words have three components: the *phonemes* or sounds, the *lexeme* or the word itself, and the *semantics* or the meaning. The job of a learner is to connect the three parts of a word together so when the word is accessed in the future, it is retrieved and understood. In a first language, the learner must learn all three representations and link all three representations together. In a second language, it is possible that that the learner will draw upon an already stored semantic representations from the first language. Therefore, the learner will need to learn the phonological representation (the phonemes) and the lexical representation (the lexeme) and link these two representations to the previously stored L1 semantic representation (the meaning). The existence of a semantic representation from the first language is one of the differences between first and second language word learning.

It is possible that the differences between first and second language learners will yield differences in word learning in the second language from what has been found in the first language word learning research. However, it is also possible that the same phenomena observed in first language word learning research will be found in the present study about second language word learning. It is the goal of this literature review to explore the possibilities of the present study and examine the crucial research that has contributed to the word learning field.

2.1 Differences between L1 acquisition and L2 acquisition

It is possible that the differences between learners of an L1 and learners of an L2 will create discrepancies between what has been found in the L1 word learning literature and what will be found in the present study. Such differences include, but are not limited to, age of acquisition, manner of acquisition, amount of input, and strategies used for acquisition.

The first and maybe the most obvious difference is age of acquisition. Many words of a first language are learned during childhood and most literature examining word learning focuses on children (e.g., Chambers, Onishi, & Fisher, 2003; Charles-Luce & Luce, 1990, 1995; Demke, et al., 2002; Dollaghan, 1994; Garlock, Walley, & Metsala, 2001; Golinkoff et al., 2000; Golinkoff, Shuff-Bailey, Olguin, & Ruan, 1995; Hirsh-Pasek & Golinkoff, 1996; Liu, Golinkoff, Goroff, & Carpenter, 2001; Markman, 1999; Merriman & Bowman, 1989; Mervis, Golinkoff, & Bertrand, 1994; Metsala, 1999; Morrisette, 2000; Storkel, 2001, 2002, 2004a, 2004b, 2006; Storkel & Rogers, 2000; Swingley & Aslin, 2000, 2002, 2007; Treiman & Breaux, 1982; Woodward, 1992). Although there have been a few studies that examine word learning in adults (Gaskell & Dumay, 2003; Leach & Samuel, 2007; Storkel, et al., 2006), the majority of the word learning literature focuses on children. When comparing children and adults in word learning, age differences in language learning are generally attributed to the Critical Period Hypothesis (CPH, Lenneberg, 1967).

The CPH refers to the amount of plasticity in the brain, which influences language acquisition. The hypothesis predicts that there will be a decline in language learning ability leading to decreased success after a certain age, generally thought to be the onset of puberty, especially as shown in L2 pronunciation (Birdsong & Molis, 2001; Flege, et al., 1995; Hakuta, et al., 2003). Behavioral and neurological studies have shown differences in language success between early and late learners (Johnson & Newport, 1989; Kim, et al., 1997; Perani et al., 1998; White, 1992). An early learner is generally defined as a person who has learned the language before puberty and a late learner is generally defined as a person who has learned the language after puberty. Behavioral studies have shown differences in pronunciation and in grammatical accuracy between early learners and later learners (Johnson & Newport, 1989; White, 1992). Neurological studies have shown differences in the amount of activation of the L2 between earlier and later learners (Perani, et al., 1998) as well as differences in the location within the brain where the L1 and L2 are stored (Kim, et al., 1997). The above studies show differences between adults who have begun to learn a second language and children who have learned a first language.

Another question is how the critical period affects adults learning new words in either an L1 or an L2. Clearly, the critical period impacts second language word learning by adults, but it remains unclear whether the critical period impacts L2 word learning in a completely negative manner. Adults do not appear to have trouble learning words in their L1 (Gaskell & Dumay, 2003; Leach & Samuel, 2007; Storkel, et al., 2006) suggesting that maybe there is something special about being an adult and learning words in a second and new language. If the critical period influences L2 word acquisition, then it is crucial that adults learning words in an L2 develop strategies that would help the word learning process. One of the strategies that could be developed, relying on phonological similarity, is addressed in the present work.

Second language acquisition (SLA) researchers have attempted to quantify how age of acquisition differences affect second language learning (Bley-Vroman, 1989; Krashen, 1982). Although the subject is controversial, Bley-Vroman (1989) attempted to concretely describe how age influences language learning in the Fundamental Difference Hypothesis (FDH). His hypothesis works well with the CPH and with the data from Perani et al. (1998) in that the differences in SLA occur when language is learned before versus after the onset of puberty. The FDH, like the CPH, recognizes that second language learning adults and first language learning children vary in the amount of success they have with learning the language (Bley-Vroman, 1989) implying that there is something special about learning an L2 as an adult.

Researchers have observed that, in general, children effortlessly acquire their first language successfully, regardless of the mismatch in input and output (Chomsky, 1965). Adults, however, struggle and often never gain native-like proficiency (Bley-Vroman, 1989). These distinctions are not only attributed to age differences, but are also often attributed to the manner in which children generally learn language versus how adults generally learn language.

Commonly, adults are taught their second language through formalized instruction, i.e., explicit language rules. Formalized instruction will often focus on the grammar of the language, leaving the learner only to memorize the word form. Children, however, do not overtly memorize word forms to learn words. Instead, the act of acquisition is more implicit and unconscious in nature. Children may, therefore, rely on biases (e.g., Au & Glusman, 1990; Markman, 1990, 1991; Quine, 1960; Woodward, 1992) or various psycholinguistic factors that influence the acquisition of the word form (Storkel, 2001, 2002, 2004b; Swingley & Aslin, 2000, 2002, 2007; Treiman & Breaux, 1982) to help them learn language, including how the lexicon becomes organized, for example, by phonological similarity (Storkel, 2002).

Adults may also employ similar cognitive strategies to learn words in an L2. However, it is important to note that words in an L2, especially in a classroom foreign language environment, are heard by the L2 learning adults far less frequently than the words that a child learned in the L1. Although adult L2 learners may rely on associations between the novel words presented and words that are phonologically similar that have been previously stored in the L2 lexicon, there still may be differences due to the type and amount of L2 input.

Additionally, because there are differences in the manner and amount of input during word learning between adults learning an L2 and children and adults learning an L1, adults learning an L2 may rely on completely different cognitive strategies from children and adults learning an L1 altogether. Instead of learning a second language like the first language was learned, second language learning adults may employ deductive reasoning, inductive reasoning, guessing or mnemonic strategies when learning words. On the other hand, learners may rely on unconscious processes to learn novel words that are similar to those used in the L1, such as an influence of phonological similarity, when learning words in a second language. Although phonological similarity, or more specifically in the present study, neighborhood density, has been shown to influence word learning in children and adults learning an L1, it is unclear how neighborhood density will influence adults learning words in L2 Spanish.

Although the focus of the present work is how adults learn words in a second language, it is also important to understand the similarities and differences between how children learn words in a first language and how adults learn words in a second language. Like adults learning words in a first language, previous work has shown that children utilize phonological similarity when learning words (Charles-Luce & Luce, 1990, 1995; Demke, et al., 2002; Dollaghan, 1994; Storkel, 2002, 2004a, 2004b; Swingley & Aslin, 2002, 2007). However, when children learn words in their first language, they are unlike adults learning a second language. When adults are learning a second language, a phonological, a lexical, and a semantic representation for each word in the L1 lexicon has already been created. Therefore, unlike children's lexicons, the semantic representation is present and the adult is missing only the word form and the link to the already existing semantic representation. It is possible that this is why children seem to rely on biases, which predominantly focus on acquiring semantic representations. While adults do not necessarily need to acquire a new L2 semantic representation because the L1 semantic representations already exist, it is possible that characteristics such as neighborhood density that influence the lexical representation will be more prevalent.

Additionally, adults will have already organized their L1 lexicon in a particular manner (although it is important to note that the lexicon is still dynamic and not static) whereas when children are learning an L1, they are constantly organizing and reorganizing (Storkel, 2002). It is understood how L1 lexicons are arranged from various spoken word recognition and spoken word production studies (Luce & Pisoni, 1998; Vitevitch, 1997; Vitevitch & Sommers, 2003; Vitevitch, et al., 2008) and thus it is suggested that speakers rely on phonological similarity as a manner of organization for lexical retrieval in order to recognize and produce words. The influence of neighborhood density clearly affects lexical retrieval in that previous work (e.g., Luce & Pisoni, 1998; Vitevitch, 1997; Vitevitch & Sommers, 2003; Vitevitch, et al., 2008) has shown varying reaction times and accuracy rates between words that are considered to have many similar sounding words and words that are considered to have few similar sounding words. When looking at second language learners, insight into the organization of their lexicon may be gained from analyzing the reaction times, accuracy rates, and retention rates.

2.2 Neighborhood density in English and Spanish

2.2.1 Definition of neighborhood density

In order to better answer the question of how phonological similarity will influence adult word learning in Spanish, it is important to understand how phonological similarity can be measured. One measure of phonological similarity is by phonological neighborhood density, often referred to as neighborhood density. Neighborhood density is defined as the number of similar sounding words (neighbors) that are phonologically similar to a given target word. A neighbor is formed from the addition, deletion or substitution of any given phoneme in the target word (e.g. Luce & Pisoni, 1998). For example, if a person were learning the word *kit*, the argument would be that similar sounding words help the learner acquire *kit* as a novel word. Words, such as ***s****kit* or *kitt**en*** where a phoneme was added, *_it* where a phoneme was deleted, or *sit, cat, kid,* where phonemes were substituted into any position of the word, may aid in learning the novel word *kit* because they are all (in this example) previously existing lexical neighbors. Neighborhood density does not only affect the acquisition or retrieval of monosyllabic words. It also has been shown to influence the lexical access of longer words (Vitevitch, et al., 2008), although when words have more than six phonemes, the number of neighbors are closer to zero (Frauenfelder, Baayen, Hellwig, & Schreuder, 1993).

When measuring neighborhood density, the variable, although continuous, is often grouped into two categories: *dense* or *sparse*. The use of these groups makes it easier to compare and analyze the influence of neighborhood density between groups of words as well as increasing the power of the study. The groups are formed by looking at a lexicon and using a median split to create two groups where one group has words that are considered to be from *dense neighborhoods* and the other group has words that are considered to be from *sparse neighborhoods*.

An example of a word from a dense neighborhood would be the word *cat* with neighbors such as *scat, mat, bat, rat, pat, sat, vat, fat, gnat, cab, cad, calf, cash, cap, can, kit, cut, coat,* and *at.* Words from dense neighborhoods have many similar sounding words. An example of a word from a sparse neighborhood would be the word *pig* with neighbors such as *fig, wig, big, peg, pin,* and, *pitch*. Words from a *sparse* neighborhood have fewer similar sounding words. (N.B.: these are just some of the neighbors of *cat* and *pig* and are just a representative sample for explanatory sake.)

Neighborhood density is a measure of phonological similarity. This measure is derived from the substitution, deletion, and addition of a single phoneme from a given target word. There are other measures of phonological similarity; however, this particular measure of phonological similarity is used in the present study because previous researchers have used the same measure and have observed an influence of neighborhood density in a variety of linguistic processes (Luce & Pisoni, 1998; Storkel, 2004a; Storkel, et al., 2006; Vitevitch, 1997, 2002; Vitevitch & Luce, 1998; Vitevitch & Rodríguez, 2005; Vitevitch & Stamer, 2006; Vitevitch, et al., 2008).

2.2.2 The influence of neighborhood density in English

Neighborhood density has been shown to influence a variety of linguistic processes such as spoken word recognition, spoken word production, and word learning (Luce & Pisoni, 1998; Storkel, et al., 2006; Vitevitch, 2002; Vitevitch & Sommers, 2003). It is important to examine the various linguistic processes in terms of neighborhood density because, in the present work, the research examines word learning which encompasses spoken word recognition and spoken word production. If there is an effect of neighborhood density in first language linguistic processes, then there will be a greater chance that an effect in second language linguistic processes will be observed.

In first language spoken word recognition in English speaking adults, the influence of neighborhood density has been found to be *competitive* (Luce & Pisoni, 1998; Vitevitch, et al., 2008). A competitive effect occurs when the target word and all similar sounding words within the neighborhood are activated, making the target word more difficult to retrieve. For example, when trying to retrieve the word *kit,* words such as *skit, it, lit, fit, knit, pit, sit, cat, cot, kid, kill, kin,* and *kiss* will be activated as well, making it more difficult for *kit* to stand out as the target. On the other hand, when trying to retrieve a word from a smaller neighborhood, such as *pig* (with the neighbors: *fig, gig,* *jig, peg, pitch, pill, pin*), it is easier because there is less competition. The competitive effect of neighborhood density in spoken word recognition has been found to influence the retrieval of monosyllabic word in English (Luce & Pisoni, 1998) and bisyllabic words in English (Vitevitch, et al., 2008).

Although competition has been the observed influence of neighborhood density in spoken word recognition in English, *facilitation* has been the observed influence in spoken word production (Vitevitch, 1997, 2002; Vitevitch & Sommers, 2003). Facilitation in spoken word production suggests that words produced from a dense neighborhood will be produced more quickly than words produced from a sparse neighborhood. This is, of course, the opposite influence as found in spoken word recognition in English.

Spoken word recognition and spoken word production are equally important when discussing word learning because when a word is learned, in order to use a spoken novel word, the word will be recognized and produced. The observed influence of neighborhood density during the act of spoken word recognition in English is competition while the observed influence of neighborhood density during the act of spoken word production is facilitation. Competition and facilitation are part of what Leach and Samuel (2007) refer to as lexical engagement which is the stage in which a novel word is considered to be learned.

In the word learning literature where the influence of neighborhood density is investigated, typically the focus is on the initial learning of words, which is what Leach and Samuel (2007) refer to as *lexical configuration*. For example, Storkel, Armbruster, and Hogan (2006) gave adult speakers 16 nonwords paired with non-objects. Half of the stimuli were considered to be from dense neighborhoods and the other half of the stimuli were considered to be from sparse neighborhoods. A picture naming task was given to the participants as a measure of learning. In this picture naming task, a picture was shown to the participant and the participant was asked to name the picture as accurately as possible. The dependent measure of the picture naming task was accuracy. The authors found that the adult participants learned a higher proportion of the novel words that were considered to be from a dense neighborhood than novel words that were considered to be from a sparse neighborhood. This result is similar to the effect found with children learning novel words, in that children also show a density advantage (Storkel & Maekawa, 2005).

In conjunction with the work with adults (Storkel, et al., 2006) and children (Storkel & Maekawa, 2005), whether children learned dense words more easily than sparse words was also examined by Demke, Graham, and Siakaluk (2002). The authors presented two groups of children with a novel word. In one group, after hearing the novel word, the children would hear some phonological neighbors of the newly learned word. In the other group, after hearing the novel word, the children would not hear words that were phonologically similar to the novel word. They found that children who heard the phonological neighbors of the novel word learned the word more effectively. Their results suggest that phonological neighbors aid in maintaining traces of the newly learned word. In other words, the connections made between novel words and neighbors already integrated into the lexicon aid in word learning. The work of Demke, Graham, and Siakaluk (2002) may be an example of lexical engagement.

Another area of research that may be similar to lexical engagement is *redintegration* (Roodenrys, 2009). Redintegration refers to the occurrence of words that are forgotten in short term memory (STM) but are reconstructed from long term memory (LTM). In other words, words stored in the LTM redintegrate representations in the STM. Redintegration is also influenced by neighborhood density. Words from a dense neighborhood are redintegrated more accurately than words from a sparse neighborhood. As a word is redintegrated, its neighbors are activated. A word with more neighbors will have more phonological support and will be retrieved more accurately.

In addition to the effectiveness of learning a word, words acquired early are often words that are considered to be from dense neighborhoods (Storkel, 2004a). It is possible that the higher number of connections between lexical entries aid children and adults in learning words. Learning a word that is unlike any other word may be more easily forgotten and thus learned with more difficulty as was also shown by Demke Graham, and Siakaluk (2002). In general, there is an observed density advantage when children (Storkel & Maekawa, 2005) and adults (Storkel, et al., 2006) learn a novel word. If the novel word has many similar sounding words, the child or adult will learn that word earlier (Storkel, 2004a) and more easily (Demke, et al., 2002) than a word with fewer similar sounding words.

2.2.3 The influence of neighborhood density in Spanish

The influence of neighborhood density can be observed across languages. Neighborhood density has been examined in English and Spanish, for example (Vitevitch & Rodríguez, 2005; Vitevitch & Stamer, 2006). In first language spoken word recognition tasks with native English-speaking adults, it has been found that the influence of neighborhood density is *competitive*. Therefore, words from a sparse neighborhood are recognized more quickly and more accurately than words from a dense neighborhood (Luce & Pisoni, 1998).

In Spanish speaking adults presented words in Spanish, a very different influence of neighborhood density is observed from that found in English. In spoken word recognition in Spanish there is *facilitation.* Words from a dense neighborhood are recognized more quickly and more accurately than words from a sparse neighborhood (Vitevitch & Rodríguez, 2005).

In examining spoken word production in English, it has been found that there is facilitation where words from a dense neighborhood produced more quickly and more accurately than words from a sparse neighborhood (Vitevitch, 2002; Vitevitch & Sommers, 2003). However, when looking at Spanish spoken word production, a reversal from English is also found, just like the reversal found in spoken word recognition. Vitevitch and Stamer (2006) observed *competition* among neighbors in Spanish production. Words from a sparse neighborhood were produced more quickly and more accurately than words from a dense neighborhood.

There is a robust influence of neighborhood density in English and in Spanish as shown in spoken word recognition and spoken word production, regardless of language. Neighborhood density has been shown to influence word learning in English speaking adults. Therefore, there should be an observed influence of neighborhood density in the present study examining the influence of neighborhood density in English-speaking adults learning Spanish as a second language. In other words, based on the previous research on the influence of neighborhood density in English and Spanish spoken word processes, there should be *some* influence of neighborhood density, regardless of the direction of the effect.

2.2.4 Adults in their native language

Just as it is important to understand how children acquire words in their first language, it is important to understand how adults continue to acquire and integrate novel words in their first language. Two studies have focused on how adults learn and integrate spoken novel words into their native lexicon (Gaskell & Dumay, 2003; Leach & Samuel, 2007). Each study suggested that the word learning process includes at least two ordered steps. The first step which Gaskell and Dumay (2003) call *phonological learning* and Leach and Samuel (2007) call *lexical configuration* refers to the initial learning of the phonological sequences of novel words. The initial learning process includes learning the sounds and meaning(s) of the novel words, but not necessarily creating the representation. The second step which Gaskell and Dumay call *lexicalization* and Leach and Samuel call *lexical engagement* refers to the integration of novel words into the lexicon. The integration of a novel word into a lexicon suggests that the word will interact dynamically with other lexical representations as its own lexical representation and will participate in competition and facilitation during various linguistic processes.

The second part of novel word learning, lexical engagement, has several consequences that are dependent on how the lexicon is organized. If the lexicon is organized by phonological similarity (Luce & Pisoni, 1998) and words that are phonologically similar compete in English recognition (Luce & Pisoni, 1998; Marslen-Wilson & Tyler, 1980; McClelland & Elman, 1986; Norris, 1994) and facilitate one another in Spanish recognition (Vitevitch & Rodríguez, 2005), then it should be observed that a novel word participates in competition during English spoken word recognition or in facilitation during Spanish spoken word recognition once it has been fully integrated into the lexicon. Additionally, as words enter the lexicon, the structure of the neighborhoods within the lexicon will become denser in nature (Charles-Luce & Luce, 1990). Finally, in spoken word production among native speakers, words that are integrated into the lexicon that are considered to be from a dense neighborhood should be produced more slowly than words that are considered to be from a sparse neighborhood in English (Vitevitch, 2002) and more quickly in Spanish (Vitevitch & Stamer, 2006). Once a word has become fully integrated into the lexicon, lexical influences, such as neighborhood density, should be observed.

In order to examine word learning, Gaskell and Dumay (2003) used novel words that closely relate to words that already exist in the lexicon. For example, the authors used the stimulus item, *cathedruke* which overlaps with the existing entry in the lexicon, *cathedral*. Gaskell and Dumay found, using a lexical decision task, that when the participant was first exposed to a novel word, the effect was facilitory suggesting that *cathedruke* activated *cathedral*, the closest matching representation, rather than creating its own representation. This finding suggested that, because the novel word did not have its own novel representation, the novel word was not fully integrated into the lexicon. This first step of novel word learning is part of phonological learning. However, over the course of five days, facilitation was no longer observed. Instead, *cathedruke* competed with *cathedral*, suggesting that *cathedruke* had its own representation independent of *cathedral*. The researchers conclude that, once the novel word is observed to have its own lexical representation independent of already existing words in the lexicon, it is considered to be fully integrated into the lexicon. This second step of novel word learning is part of lexicalization.

It is important to note that the authors only found effects for novel words that overlapped with previously stored words from the onset. The authors found no effect for words that varied on the onset and overlapped on the offset, e.g. *yothedral.* Although the study did not find integration effects for words that are made-up neighbors as per the definition of a neighbor used in the present study (the addition, substitution, or deletion of any phoneme in a target word (Luce & Pisoni, 1998)), the results give a starting point to further examine the word learning process. Gaskell and Dumay (2003) suggest that phonological information, such as sublexical information, is learned quickly, but full integration into the lexicon where a novel word has its own representation and will participate in lexical processes as a lexical entry may take more time. Additional research will need to be completed in order to fully examine the influence of neighborhood density in novel word learning.

Leach and Samuel (2007) expanded on Gaskell and Dumay's (2003) work. They further defined and examined what Gaskell and Dumay observed in the two-step novel word learning process of phonological learning and lexicalization. Unlike Gaskell and Dumay, Leach and Samuel created nonwords that were not closely related to words that were previously stored in the lexicon (e.g., *bibershack*). The authors used a variety of tasks to test for lexical configuration and lexical engagement.

To test lexical configuration which is considered to be the first step of novel word learning, Leach and Samuel used a three-alternative recognition judgment task similar to Storkel (2001) and a threshold discrimination task where words were presented in noise.

In the first task, participants were presented with three auditorily recorded items presented randomly: one target word and two foils that varied from the target word by only one phoneme (i.e., phonological neighbors). The participants were asked to press the button corresponding to the target word. The dependent measures in the first task were reaction times and accuracy rates. In the second task, participants were presented with items in noise. Each item was played repeatedly and with each repetition, the noise decreased by ten percent. The participants were instructed to press a button when they thought they heard the item clearly and then were instructed to type the item they heard. The dependent measures in the second task were level of noise and accuracy rates.

Each task, like Gaskell and Dumay, was presented daily for up to five days. The recognition task showed accuracy improvement over the course of four days. Additionally, reaction times were faster by the end of four days. The threshold task also showed improvement in that the participants could hear the target item in higher levels of noise by the end of the fifth day and were also more accurate. The two tasks show that lexical configuration improves over the course of four to five days, which corroborates with the results of Gaskell and Dumay (2003). Both studies suggest that incorporating a novel word fully into the lexicon takes time, but learning the sublexical information, just the sounds of the word, occurs very quickly.

In addition to lexical configuration, Leach and Samuel (2007) examined whether novel words became integrated into the lexicon which they referred to as lexical engagement. The authors used two tasks: phonemic restoration and perceptual learning. In a phoneme restoration task, a phoneme in an auditorily presented item is replaced with an extraneous sound. The participant is to replace the extraneous sound with the correct sound by saying the item correctly. In the perceptual learning task, the participants were asked to do an old-new recognition task. They were first exposed to a list of 20 items comprising ten words and ten non-words. Then the participants heard a second list which had some items from the first list and some brand new words. Words that had appeared on the first list were to be labeled as “old” and words that only appeared on the second list were to be labeled as “new.” Within the first list were six critical items where the last phoneme was slightly mispronounced. This task was done to expose the participants to the new words to be learned. After the old-new recognition task, the participants were asked to do a phoneme categorization task based a phoneme in the trained words (in this case, /s/and /Σ/). If an item was presented with an /s/ as a phoneme in the word, and the participant categorized the ambiguous /s/-/Σ/ sound as /s/, the word was considered to be fully integrated into the lexicon. For example, if the target was “bibersack” /βαΙβ™σΘκ/ and the participant heard the ambiguous /s/-/Σ/ form of “bibersack” and still classified the item as /βαΙβ™σΘκ/ instead of /βαΙβ™ΣΘκ/, then /βαΙβ™σΘκ/ was assumed to have created its own mental representation. These tasks were presented, like the lexical configuration tasks, for five days once a day. Participants showed maximum improvement in the final two days of the experiment.

The results of Gaskell and Dumay (2003) and Leach and Samuel (2007) demonstrate that word learning involves at least a two-step process where the first step is more or less getting acquainted with the sounds and meanings of the words and the second step is creating a mental representation in the lexicon for the novel word. Both studies employ a five-day paradigm showing improvement over the course of the study with the fastest reaction times and highest accuracy rates being observed on the final day.

Additionally, both studies show that for a novel word to have its own mental representation in the lexicon, it takes time. These studies seem to suggest that it takes about five days for a novel item to fully integrate into the lexicon. However, a recent study by Dumay and Gaskell (2007) suggests that the crucial aspect of creating a new mental representation for a spoken word is a 24-hour time period with sleep to elapse. Therefore, mental representations should be integrated into the lexicon within a shorter time period than that suggested initially by Gaskell and Dumay (2003) and Leach and Samuel (2007).

The works of Gaskell and Dumay (2003) and Leach and Samuel (2007) are crucial in understanding the integration of novel words into the lexicon. However, neither study directly manipulated the word forms to examine how various psycholinguistic lexical properties may influence word form. The authors did manipulate phonemes in the novel items to make them more apt to compete with already existing members of the mental lexicon, but they did not manipulate any known influences, such as neighborhood density, on lexical acquisition. The present study aims to manipulate neighborhood density in a small set of novel Spanish words for English-speaking to learn.

Storkel, Armbrüster and Hogan (2006) did examine a psycholinguistic aspect of word learning. The authors created novel nonwords in order to examine the influence of neighborhood density on word learning in monolingual, English speaking adults. Therefore, Storkel, Armbrüster, and Hogan (2006) created words such as /*hif*/ with real-word neighbors "*leaf*," "*half*," and "*heap*" that were derived from existing lexical entries that were considered to be part of either a dense neighborhood or a sparse neighborhood. The authors found that adults learned novel words with a dense neighborhood more effectively than novel words with a sparse neighborhood suggesting that, in word learning by adults, words from dense neighborhoods are more easily learned than words from sparse neighborhoods.

Although Storkel, Armbrüster, and Hogan (2006) examined a psycholinguistic influence on the acquisition of words, the authors did not differentiate between or explore lexical engagement or lexical configuration. The adults in the study were only tested once during one day and were not examined a second time to further explore the influence of neighborhood density on how novel words are integrated into the lexicon. Therefore, additional research should be conducted to explore the influence of neighborhood density in novel word learning *and* integration with adults in English and other languages.

All three studies examining how adults learn novel words explored monolingual, English speaking adults (Gaskell & Dumay, 2003; Leach & Samuel, 2007; Storkel, et al., 2006). Two of the studies examined how novel words are integrated into the lexicon (Gaskell & Dumay, 2003; Leach & Samuel, 2007) and only one study examined the specific influence of neighborhood density regarding word learning in adults (Storkel, et al., 2006). However, the influence of neighborhood density, an influence on lexical items, has not been examined regarding how novel words are integrated into the lexicon. Furthermore, no study has examined how neighborhood density will influence the acquisition and integration of novel L2 words (not made-up nonwords) into the lexicon.

It is understood that the influence of neighborhood density is not limited to adults speaking English. Neighborhood density has also influenced the spoken word recognition (Vitevitch & Rodríguez, 2005) and spoken word production (Vitevitch &

Stamer, 2006) of Spanish speaking adults. Therefore, the influence of neighborhood density is present in various linguistic processes in both English and Spanish.

The questions to be answered, then, are how would neighborhood density influence the word learning of English speaking adults learning Spanish? And, how would neighborhood density influence the integration of novel word forms into the lexicon of English speaking adults learning Spanish? Previous work examining monolingual children and adults have found that, in English, words from a dense neighborhood will be learned more effectively than words from a sparse neighborhood (Storkel, 2001). Having more similar sounding words aids in the word learning process in English, but there have been reversals between English and Spanish in spoken word recognition and spoken word production. Therefore, it is unclear in which direction the influence of neighborhood density will be observed during second language word learning since word learning is measured in terms of recognition and production tasks.

Previous research has shown a robust influence of neighborhood density with adults learning their L1, but not an L2 and it is important to understand how the influence of neighborhood density will present in adults learning words in second language Spanish. Which pattern L2 learning adults learning words in Spanish will follow – whether it is the pattern found in English spoken word recognition and production or Spanish spoken word recognition and production – is unclear. Word learning literature suggests that when learning words (based on measures of spoken word recognition and spoken word production), words with a dense neighborhood are learned more efficiently and more easily than words with a sparse neighborhood (Storkel, et al., 2006), but when Spanish is included, due to the reversals observed in the spoken word recognition

(Vitevitch & Rodríguez, 2005) and production literature (Vitevitch & Stamer, 2006), it is not clear how the influence of neighborhood density will affect adult L2 word learning and the integration of novel L2 word forms.

2.2.5 Second language learning adults

Although the word learning literature cited so far has focused on monolingual English speaking adults learning words in their first language, the second language literature has not neglected second language learning adults. The question of how adults learn words in a second language has been addressed by many researchers (Barcroft, 2002, 2003, 2007; Carlson, 2007; Finkbeiner & Nicol, 2003; Maekawa, 2006; Trofimovich, 2008). The emphasis in some studies has been on the role of semantics in adult learning words in a L2. For example, in L1 English adults learning L2 Spanish, Barcroft (2002) requested some of the participants ask questions about the new vocabulary words presented (e.g., how can this object be used?). Participants that questioned novel words learned them more effectively than words that were not questioned. In another L1 English-L2 Spanish study, adults were introduced to novel words that were either presented in semantically related or semantically unrelated groups. It was found that words that were presented in semantically unrelated groups were not learned as effectively, suggesting that presenting words based on semantic relatedness is beneficial when learning novel words in an L2 (Finkbeiner & Nicol, 2003). These studies focused on the role of semantics and the effect semantics has in acquiring the word form. It is well understood that L2 learners of Spanish benefit from grouping words together semantically and, as a result, most Spanish texts are arranged in that fashion (e.g., VanPatten, Lee, & Ballman, 2004).

A third study (Trofimovich, 2008) found an interesting interaction between semantics and the amount of phonological sensitivity in L2 word learners of varying levels of language exposure (which was based on length of residence in the L2 environment). Learners with less experience with the L2 were found to focus more on the semantics of the words rather than phonological information. This may be because learners with less experience may store phonological information episodically, meaning that the words stored are associated with the speaker and the situation. However, learners with more experience with the L2 were more sensitive to phonological information and have the ability to generalize across speakers and situations (Trofimovich, 2008). The above studies address how semantics and language experience play a role in adult L2 word learning; however, the question that remains is how the characteristics of the word form influence word learning.

Carlson (2007) did examine how characteristics of the word form influence word learning. He sought to answer whether adult English speakers learning Spanish would learn the fine-grained probabilistic aspects of the target grammar as their exposure to Spanish increased, i.e., whether adults would rely on statistical regularities in order to better learn diphthongization in Spanish. In order to test whether L2 learners learned the fine-grained patterns in Spanish, he looked at how well learners segmented the words in a conditional lexical decision task. The participants were instructed to say *palabra* “word” if the stimulus presented was a word and to repeat the stimulus if it was a nonword. Carlson found that adults did in fact rely on statistical regularities and patterns when learning words in Spanish. Although Carlson examined how adults learn words in an L2, he focused more on the phonological level of L2 word acquisition, i.e., the segmental level. Therefore, he did not examine the lexical level of word learning or how words are integrated into the lexicon. Consequently, more research needs to be done in order to fully understand how lexical factors, such as neighborhood density, influence adult word learning in Spanish.

Another study that examined how adults learn words in a second language was done by Maekawa (2006). Her participants were native Japanese speaking adults learning English as a second language. Her study focused on the influence of phonological representations, or phonological knowledge, in second language word learning. Her stimuli were composed of nonwords that followed English phonotactics[1] but violated Japanese phonotactics in order to examine how phonological knowledge influenced novel word learning in an L2.

Maekawa found that phonological knowledge influenced novel word learning in an L2. Words composed of sounds common in both languages, English and Japanese, were learned better than words composed of sounds only found in English (and not in Japanese). Although Maekawa focused on how the characteristics of the word form influence word learning, she *controlled* rather than manipulated neighborhood density. Additionally, she was testing the influence of phonological knowledge on the phonological representation during word learning in the phonological representation whereas, in the present study, the influence of neighborhood density on the lexical representation during word learning was examined. Furthermore, Maekawa did not examine any influence on how novel words become integrated into the lexicon when adults learn a second language. Although Carlson (2007) and Maekawa (2006) examined

[1] Phonotactics refer to the likelihood that a sound or set of sounds will appear in a word in a language.

psycholinguistic influences on the word form, there is still a gap in the understanding of how adults learn and integrate novel words from a second language.

2.3 Summary

Although various psycholinguistic factors have been analyzed to understand how adults learn the word form in an L2, neighborhood density has been neglected as the primary influence. In the first language, neighborhood density has been shown to have a robust influence on the recognition, production, and acquisition of spoken words in adults in an L1, but little work has examined how this characteristic affects word learning in L2. The present study will examine how neighborhood density influences native English-speaking adults learning words and integrating novel lexical representations into the lexicon from second language Spanish.

Neighborhood density has been shown to influence English speaking adults and Spanish speaking adults in spoken word recognition. In English, spoken word recognition words from a sparse neighborhood are recognized more quickly and more accurately than words from a dense neighborhood (Luce & Pisoni, 1998). In Spanish spoken word recognition, however, words from a dense neighborhood are recognized more quickly and more accurately than words from a sparse neighborhood (Vitevitch & Rodríguez, 2005). There is an apparent reversal in the influence of neighborhood density between English and Spanish in spoken word recognition with adult native language speakers.

Neighborhood density has also been shown to influence English speaking adults and Spanish speaking adults in spoken word production. In English, words from a dense neighborhood are produced more quickly and more accurately than words from a sparse neighborhood (Vitevitch, 1997). In Spanish, and words from a sparse neighborhood are produced more quickly and more accurately than words from a dense neighborhood (Vitevitch & Stamer, 2006). Just as found in spoken word recognition, the influence of neighborhood density is different for English and for Spanish in spoken word production.

Along with spoken word recognition and spoken word production, there is also a robust influence of neighborhood density in English word learning. Words from a dense neighborhood tend to be learned more accurately than words from a sparse neighborhood in children and adults (Storkel, 2001; Storkel, et al., 2006). Additionally, as the lexicon grows, dense neighborhoods become denser and sparse neighborhoods tend to stay sparse (Charles-Luce & Luce, 1990). It is clear that neighborhood density plays a role in not only the recognition and production of spoken words, but also the learning of spoken words as well as how the lexicon restructures when new lexical representations are integrated. Because there are differences between languages regarding the influence of neighborhood density, it is difficult to make a concrete prediction on how neighborhood density will influence native English speakers learning novel words in L2 Spanish. However, given the previous results in past literature, it is clear that there will be some influence of neighborhood density – especially once novel words become integrated into the lexicon. It is expected that, in the present study, there will be some influence of neighborhood density in the acquisition and integration of novel L2 words; although, the direction of the influence is less clear.

The present study examines the influence of neighborhood density on word learning in L2 Spanish by L1 English speakers. Neighborhood density is examined in terms of lexical configuration, the initial learning of the sounds of the words, and lexical engagement, how the words are integrated into the mental lexicon. The results of the present study are discussed in terms of a psycholinguistic and pedagogical framework.

3. Method

3.1 Participants

After receiving approval from the Human Subjects Committee at the University of Kansas, 45 participants were recruited from third semester Spanish classes by word of mouth and fliers. Participants received monetary compensation in exchange for their participation. All participants were native English speakers enrolled third semester Spanish at the University of Kansas. No participant reported a hearing or speaking disorder.

3.2 Materials

3.2.1 Questionnaire

A questionnaire was used in this study to control for various characteristics that influence L2 learning: length of residence in a foreign country where the L2 was spoken, age of acquisition, manner of learning the L2, other languages spoken, languages spoken at home, parental fluency in other languages, at what point in school language instruction was received, amount of language used/exposed to in daily activities, language preference, and foreign countries visited. These factors are derived from a meta-analysis performed by Li, Sepanski, and Zhao (2006) on questionnaires used in second language acquisition research. The authors identified the questions that were used in the majority of the questionnaires in previous research and tested these questions for validity and reliability. A version of this questionnaire was used in the present study and is available in Appendix 7.2. Additional questions were added to ensure that participants were appropriately enrolled in third semester Spanish and to inquire about other Spanish classes taken at the university-level. The questions were coded and put into a simple regression as independent variables. The goal of the regression was to see how much variability was accounted for in the dependent variable (accuracy) by the factors in the questionnaire. In other words, the regression and questionnaire were used to ensure there were no differences between the participants that participated in the present study and that any differences perceived in the present experiment were due to differences manipulated in the stimulus items.

3.2.2 Lexicon

It was assumed that the L2 lexicon for the participants in this study includes all of the words in the glossary of the textbook *¿Sabías que... ?: Beginning Spanish* (VanPatten, et al., 2004). The researcher digitized the glossary and created the Beginning Spanish Lexicon consisting of approximately 3,900 words. The words were then analyzed for Spanish word frequency, neighborhood density, Spanish neighborhood frequency, number of phonemes and number of syllables. Word frequency refers to the number of times a word occurs out of a million words. Neighborhood frequency refers to the average frequency of the neighbors to a given target word. All word characteristics came from Sebastián Gallés, Martí Antonín, Carreiras Valiña, and Cuetos Vega (2000) where the characteristics are based on native and adult speakers of Spanish (Table 1). No stimulus word used in this study was found in the Beginning Spanish Lexicon (otherwise, the stimulus item would not be considered novel).

Table 1. Characteristics of the entries in the Beginning Spanish Lexicon

Word Characteristics	Mean	Median	Mode	Min	Max
Number of Letters	7.49	7	8	1	17
Number of Phonemes	7.40	7	7	1	17
Familiarity	6.57	6.51	9	0	9
Word Frequency	743.07	55	1	1	264721
Log Word Frequency	1.64	1.74	0	0	5.42
Neighborhood Density	6.83	3	2	0	150
Neighborhood Frequency	121.83	22.67	1	1	11731
Log Neighborhood Frequency	1.32	1.36	0	0	4.07

Note. Word frequency and neighborhood frequency are measured in number of occurrences per million. Neighborhood density is measured in number of neighbors. The log transform is to help normalize the distribution.

It is common to use a dictionary-based lexicon or a corpus in psycholinguistic research. For example, Luce and Pisoni (1998) used Webster's Pocket Dictionary which contained 20,000 entries. Although it is understood that not every word will be known to the participant, it is a foundation for what entries may be in the adult beginner Spanish lexicon. It is important to note that third semester Spanish students had just completed the book in the previous semester; therefore, it is possible that most of the words are, in fact, known to some of the participants. It is also probable that words outside of the proposed lexicon will be unknown to the learner because the assumed lexical knowledge of the learner is the transcribed glossary of *¿Sabías que... ?: Beginning Spanish* (VanPatten, et al., 2004).

Not every entry listed in the glossary was transcribed into the Beginner Spanish Lexicon. No proper nouns or conjugated verb forms (only infinitives) were included in the lexicon. Verbs were not used because they are generally more difficult to picture than nouns. Previous research examining L1 word learning showed that neighborhood density influences the learning of verbs in the same manner as with nouns (Storkel, 2003). Regarding the use of only infinitives, the debate about which architecture is used in the lexicon to account for regular and irregular verbs is out of the scope of this dissertation; however, it is important to acknowledge when constructing an assumed beginner Spanish lexicon. This lexicon followed a single-system model for the structure of the lexicon (Burzio, 2002; McClelland & Patterson, 2002; c.f., Pinker & Ullman, 2002). The advantage of assuming a single-system connectionist model is that the model observes the phonological regularity within the irregular verbs. Dual-route models essentially dismiss irregular verbs as having any regularity and thus creates representations for each conjugation (Pinker & Ullman, 2002). The single-system model is the simplest solution to verb storage. Although it is important to acknowledge how verbs might be stored in a beginner L2 lexicon, the stimuli used in the present study were nouns – not verbs. The Beginning Spanish Lexicon created for the present study is, again, an approximation of the typical learner's lexicon.

3.2.3 Stimuli

Two lists of eight words, for a total of 16 stimulus items, were created for the study and each participant was only given one list to learn, or eight stimulus items. The words were nouns chosen from a fourth-semester or a higher level Spanish class in order to assure that none of the words were likely known by third semester Spanish students (therefore no stimulus item was found in the Beginning Spanish Lexicon). Each word was able to be depicted with a picture and was paired with the appropriate object depicting the word. For example, the stimulus word *pato* meaning “duck,” was paired with a picture of a duck. All pictures used were black and white line drawings from Snodgrass and Vanderwart (1980). Verbs were not used because they are generally more difficult to picture than nouns. Previous research examining L1 word learning showed that neighborhood density influences the learning of verbs in the same manner as with nouns (Storkel, 2003). See Appendix 7.1 for the stimuli used in the present study.

3.2.3.1 Neighborhood Density

The stimuli on each list varied in neighborhood density. Four of the words were considered to be from a dense neighborhood and four of the words were considered to be from a sparse neighborhood based on the characteristics of the Beginner Spanish Lexicon. A median split was used to determine which words are from a dense neighborhood and which words are from a sparse neighborhood (see Table 2 for a list of statistical characteristics for the stimuli). Words with more than three neighbors were considered to be from a dense neighborhood and words with less than three neighbors were considered to be from a sparse neighborhood. Additionally, when a word is said to have four neighbors, the four neighbors are all words found in the beginner lexicon. An ANOVA was used to ensure that there were statistical differences in neighborhood density between the conditions, F (1, 12) = 18.24; $p < .05$. There was no difference of neighborhood density between lists, F (1, 12) = 0.73, $p > .05$.

Table 2. List of means and standard deviations for the lists of stimuli used in all tasks

	List A		List B	
Word Characteristics	Dense	Sparse	Dense	Sparse
Spanish Neighborhood Density	5.5 (2.9)	1.0 (0.8)	4.0 (1.4)	1.0 (1.2)
Spanish Word Frequency	3.8 (1.7)	7.1 (5.9)	9.3 (6.4)	5.7 (7.5)
Spanish Log Neighborhood Frequency	3.5 (0.5)	3.3 (1.8)	2.7 (0.2)	1.9 (2.2)
English Neighborhood Density	18.25 (12.84)	15.75 (10.1)	12.75 (12.76)	21.75 (15.44)
English Word Frequency	8.5 (3.4)	59.5 (85.5)	243 (436.3)	29.5 (37.60)
English Log Neighborhood Frequency	1.92 (.80)	2.03 (0.2)	1.71 (.37)	2.20 (.40)

Note. Word frequency and neighborhood frequency are measured in terms of occurrences per million. Neighborhood density is measured in terms of number of neighbors. Standard deviations are listed below the means in parentheses.

3.2.3.2 Matched Characteristics of Stimuli

All stimulus items followed a Consonant-Vowel-Consonant-Vowel (CVCV; e.g., "pato" /p-a-t-o/) sequence and had only two syllables (e.g., "pato" [pa.to]). Additionally, all words were matched on word frequency. Word frequency was considered to be 0 because all the stimulus items are considered nonwords until learned as real words thus having no occurrences in the Spanish learner's lexicon. However, the words used were checked in a native Spanish language database (Sebastián Gallés, Martí Antonín, Carreiras Valiña, and Cuetos Vega, 2000) to ensure no differences in native speaker word frequency between conditions, $F(1, 12) = .002$;, $p > .05$ or between lists, $F(1, 12) = 0.52$; $p > .05$ (means and standard deviations listed in Table 2). Neighborhood frequency was calculated using values from the same database. The log values of neighborhood frequency were used to more normalize the distribution. There were no differences between conditions regarding neighborhood frequency, $F(1, 12) = 0.97$; $p > .05$ or between lists, $F(1, 12) = .64$; $p > .05$ (means and standard deviations listed in Table 2).

The onsets were also matched across conditions. In list A, there were two /b/-onsets (e.g., /beka/, *beca*, “hood”), one /k/-onset (e.g., /kuɲa/, *cuña*, “wedge”), and one /p/-onset (e.g., /pato/, *pato*, “duck”) in each condition, dense and sparse. In list B, there was one /b/-onset (e.g., /bala/, *bala*, “bullet”), one /k/-onset (e.g., /kubo/, *cubo*, “bucket”), and two /p/-onsets (e.g., /poso/, *pozo*, “well”) in each condition, dense and sparse. Controlling the onset is important in any word production experiment because it has been shown that different phonemes trigger the microphone (which triggers the reaction time) differently.

3.2.3.3 English Characteristics

The English translations of the stimuli were also analyzed for word frequency, neighborhood density, and neighborhood frequency. There were no differences between conditions, dense and sparse, or between lists (all F’s $(1, 12) < 2.34$, all p’s $> .05$). See Table 2 for additional information. Words were analyzed for English characteristics because it is assumed that when first seeing a picture of a “duck,” the participant will initially think duck in English, the L1, instead of pato in Spanish, the L2. So, to ensure that there was no influence of the English translations’ word frequency, neighborhood density or neighborhood frequency, the researcher also controlled the English translation characteristics of the Spanish stimuli.

3.2.3.4 Sound Files

All stimuli were recorded in isolation by a native speaker of Spanish at a normal speaking rate in an IAC sound attenuated booth using a high quality microphone. The stimuli were recorded digitally using a Marantz PMD671 solid state recorder at a sampling rate of 44.1 kHz. The sound files were edited using Sound Edit 16 (Macromedia, Inc.). The amplitude of the sound files was adjusted with the Normalize function to amplify the words to their maximum value without clipping or distorting the sound and without changing the pitch of the words. Additionally, each sound file was cushioned on either side with 100.1 ms of silence to ensure no popping noises during presentation.

The mean total sound file duration for the dense words in List A was 665 ms (*sd* = 55) and for the sparse words was 619 ms (*sd* = 17). The mean sound file duration for the dense words in List B was 667 ms (*sd* = 58) and for the sparse words was 645 ms (*sd* = 24). An ANOVA was used to verify that the sound files in both conditions were matched for total file durations, F (1, 12) = 2.51; $p > .05$ as well as matched across lists, F (1, 12) = 0.43; $p > .05$. Controlling the duration of the sound files is important because reaction times were measured from the onset of the sound file. If the sound files vary in duration, it may adversely influence the results.

3.3 Procedure

The procedure for the present study was adapted from Storkel, Armbrüster, and Hogan (2006), Leach and Samuel (2007) and Gaskell and Dumay (2003). However, the present procedure varied slightly from the three studies in that there were two sessions two to three days apart (Dumay & Gaskell, 2007). The decision to have only two sessions was based on the research of Dumay and Gaskell (2007) as well as to maintain retention of the participants.

3.3.1 First Session

3.3.1.1 Pretest

A typical first session proceeded as follows: the participant was asked to fill out consent forms before starting the experiment. Additionally, questionnaires were brought in completed by the participants. The participant was then asked to participate in one of two tasks measuring previous knowledge of the stimuli. One task was a picture naming task to test productive knowledge. In a picture naming task, each novel word is presented paired with the appropriate picture. The participant was asked to name the picture using the appropriate Spanish word to the best of his or her ability. Accuracy was the only dependent measure.

3.3.1.1.1 Picture Naming Task

During the picture naming task, participants were seated in front of an iMac running PsyScope 1.2.2. (Cohen, MacWhinney, Flatt, & Provost, 1993) with a set of Koss SB-30 headphones with a mounted microphone that triggered the voice key. The computer program, PsyScope, controlled stimulus presentation and response collection. A voice key triggered response times with millisecond accuracy, but reaction times were not analyzed until after the Exposure Phase. A typical trial in the picture naming task was as follows: a string of asterisks "*****" appeared on the screen for 500 ms. Immediately following was a picture. The participant was asked to name the picture in Spanish as accurately as possible. As soon as the participant began the response, the voice key triggered the next trial. Responses were recorded using a DAT player and high quality tapes which were analyzed later for accuracy. Additionally, the researcher transcribed, online, the results as the participant produced them.

3.3.1.1.2 Three-alternative forced-choice Task

The other task was a three-alternative forced-choice (3AC) task to test receptive knowledge. The participant heard a single, pre-recorded word and was visually presented with three pictures. The three pictures included the target referent (e.g., *pato* "duck"), a foil picture that matched the target in onset and another foil that did not match the onset. Neither picture was semantically related to the target. Additionally, the words were counterbalanced across trials. Each word was presented with each other word exactly the same number of times. This created three counterbalanced versions of the 3AC task. The three versions were counterbalanced across participants.

During the 3AC task, the participant was seated in front of an iMac with a set of Beyerdynamic DT 100 headphones. The iMac ran PsyScope 1.2.2 (Cohen, et al., 1993) interfaced with a New Micros button box that has a timing board to provide millisecond accuracy and recorded responses. After a 5 word practice trial using Spanish words from the Beginning Spanish Lexicon, the participant was instructed to choose the appropriate response as accurately as possible. Each trial proceeded as follows: a string of asterisks "*****" appeared on the screen for 500 ms followed immediately by the simultaneous presentation of the three pictures and the auditory presentation of the target word. The pictures each had a colored circle (red, yellow, and green) underneath representing the corresponding buttons on the response box. All trials were randomized by PsyScope. Results were analyzed in terms of accuracy rates. Additionally, whether the picture naming task or the 3AC task was given first was counterbalanced across participants.

Before participating in these tasks, the participants should have had no prior exposure to the novel words thus giving a baseline for the experiment. The predicted result was that no pictures were named correctly. The researcher listened to the participant responses during the picture naming task in order to ensure that no pictures were known prior to the task. The results of the 3AC task were not analyzed until testing on the first day was completed.

Any participant that correctly identified any word in the list presented during the picture naming task was given the other list, if possible (due to counterbalancing issues). If the participant again identified any picture from the other list, the participant was given the list with fewer words recognized. All words recognized during the picture naming task were removed from further analyses. This concluded the Pretest phase.

3.3.1.2 Exposure Phase

After the baseline picture naming and 3AC tasks, the participant was exposed to a digital notebook that contained an auditory recording of the word and its picture. The same pictures presented in the baseline picture naming and the three-alternative forced-choice tasks were used. Each picture was matched with the appropriate auditorily recorded word and was presented on an iMac while participants listed with a set of Beyerdynamic DT 100 headphones. The iMac ran PsyScope 1.2.2 (Cohen, et al., 1993) which randomly presented each picture for 3000 ms ten times. A typical trial within the digital notebook proceeded as follows: a string of asterisks appeared on the screen "*****" for 500 ms. Immediately following the asterisks, a picture and an auditorily recorded word were presented. The participant heard the word at the same time the picture appeared on the screen. The picture remained on the screen until 3000 ms concluded so the participant could process the word and its image. Each word was presented in five emotions using varying intonations – happy, sad, angry, neutral, and frightened (Singh, 2008). There was no response needed from the participant. After the digital notebook was finished, each participant had ten exposures to the novel words where the correct word was matched with the appropriate picture before continuing in the experiment. This concluded the Exposure Phase.

3.3.1.3 Posttest 1

After the Exposure Phase, the same two tasks used in the Pretest were used in the first posttest. These tasks were designed to examine lexical configuration, or the participants' ability to recognize sounds and sound sequences (Leach & Samuel, 2007). The dependent measures for each task in the first posttests were reaction times and accuracy rates. The responses to the picture naming task were again transcribed and scored. A response was scored as correct if all the phonemes matched the intended stimulus, partially correct if all but one phoneme matched the intended stimulus, and incorrect if more than one phoneme did not match the intended stimulus. This scoring rubric was used in Posttest 1 and 2 but not the pretest because in the pretest, participants generally gave either a completely incorrect Spanish word or the English.

3.3.2 Second Session

For the second session, participants were asked to return 48-72 hours after the first session. In the second session there was no Exposure Phase. There were four posttest tasks during the second session: the picture naming task, the three-alternative forced-choice task (both identical from the first session), a perceptual identification task, and an old-new task. The perceptual identification task had one dependent measure: accuracy rates. The old-new task had two dependent measures: reaction times and accuracy rates. The latter two tasks were designed to examine lexical engagement, or the integration of the novel words into the lexicon (Leach & Samuel, 2007).

3.3.2.1 Posttest 2

The same picture naming and 3AC tasks were given during the second day. Reaction times and accuracy rates were dependent measures for both tasks. The researcher followed the exact procedure in Posttest 2 as in Posttest 1. All equipment used was the same. Both tasks were counterbalanced across participants with the perceptual identification task that was also given during the second session.

3.3.2.2 Perceptual Identification Task

In the perceptual identification (PID) task, targets and foils were presented in noise. Foils were used because there are only eight target words and the author wanted to reduce the chance that the participants were using other cognitive strategies to respond. The targets were the eight stimulus items and the foils were the same words from the old-new task. The signal to noise ratio (S/N) was +18dB. Sound Edit 16 was used to add noise to the sound files by adding white noise equal in duration to each sound file. The white noise was 18dB less in amplitude than the mean amplitude of the sound file. Given that the participants are second language speakers, the S/N ratio was +18dB to allow for disassociation in accuracy rates between dense and sparse without having floor or ceiling effects. The participant was seated in front of an iMac running PsyScope 1.2.2 (Cohen, et al., 1993) with a set of Koss SB-30 headphones with a mounted microphone and a computer keyboard.   The participant was asked to identify the word heard by orally repeating it and pressing the spacebar on the keyboard when finished. The participant was allowed to verbally change the response before pressing the spacebar and there was no voice key trigger or timer. Accuracy was the only dependent measure.

Each participant was given five practice trials using words from the Beginning Spanish Lexicon. Following the practice session, a typical trial was as follows: each trial began with a string of asterisks "*****" for 500 ms. Immediately following was a stimulus word or a foil presented in noise. The participant had as much time as needed to orally repeat the word that was presented. Each word was presented only one time. The participant was able to make any changes to the response before pressing spacebar to begin the next trial. Participants were instructed to provide the best answer before pressing the spacebar. All trials were randomized by PsyScope.

3.3.2.3 Old-New Task

The first task given to all participants on the second day was the old-new task. In the old-new task, the participants heard the eight words they learned during the first session in addition to twenty-two foils which were never presented during the first session. The foils were words from the Beginning Spanish Lexicon that were assumed to be known by the participant. Foils were comparable in syllable length and structure to the target words and only used the onsets that were also used in the stimuli. Foils were not included in the final analysis as they were presented simply as distracters to decrease the likelihood that the participant would guess the next word. Since there were only eight words in the stimulus set, each word had a 12.5% chance of being guessed; thus, a correct response suggested that a participant had in fact learned a word and integrated it into the lexicon versus using another strategy such as guessing.

The same equipment used in the 3AC task was used in the old-new task. The participants were instructed to press "OLD," as marked on the response box, if the word presented auditorily was one of the eight words they had learned from Day 1 and "NEW," as marked on the response box, if it was not. All responses for "OLD" were analyzed for reaction times and accuracy rates. There was no practice session for this task. If there had been a practice test with the instructions to label words previously heard in the first session as "old" and not heard in the first session as "new" then some of the eight words in the study would have to be used in the practice session and thus omitted from the final results. Therefore, there was no practice session because it was crucial to be able to analyze each word. A typical trial was as follows: a string of asterisks "*****" appeared on the screen for 500 ms. Immediately following was an auditorily presented item (no picture was presented during this task). The participant was asked to answer by pressing the appropriate button on the response box as quickly and as accurately as possible. All trials were randomized by PsyScope. Reaction times and accuracy rates were the dependent measures. This task was modified from Leach and

Samuel's (2007) old-new task in that words were not presented with any mispronunciations and each word was only presented once.

4. Results

Three participants were excluded from the final analysis. One participant was excluded due to technical problems, another due to the native language not being English, and the third due to a self-reported speech disorder.

All results were examined using a repeated measures analysis of variance (ANOVA). Regarding the picture naming task and the three-alternative forced-choice task, analyses where accuracy was a dependent variable were submitted to a 3 (test; Pretest, Posttest 1, Posttest 2) X 2 (neighborhood density; dense and sparse) repeated measures ANOVA where *list* was a two-level between factor. Multivariate analysis of variance (MANOVA) tests were used to compare Pretest to Posttest 1, Pretest to Posttest 2, and Posttest 1 to Posttest 2 within density (and within each task). Paired-sample t-tests were used to compare differences in responses between dense and sparse within test. Analyses where reaction time was a dependent measure within the picture naming and the Three-alternative forced-choice tasks only, the data were submitted to a 2 (test; Posttest 1 and Posttest 2) X 2 (neighborhood density; dense and sparse) repeated measures ANOVA. No follow-up tests were needed as none of the reaction time data yielded significant results. In the two tasks that occurred only on day 2, the Old-New and Perceptual Identification tasks, a 2-way repeated measures ANOVA with neighborhood density as a within factor and list as a between factor was conducted to examine accuracy rates and reaction times.

A second trained speech scientist scored a random sample of 50% of the results. Reliability scoring was at minimum 80%. The trained speech scientist and the author agreed on more than 80% of the scored data in the picture naming and perceptual identification tasks.

4.1 Picture Naming Task

In the picture naming task, a participant was shown a picture and asked to name the picture as quickly (in the posttests) and as accurately (in all tests) as possible using the appropriate Spanish word just learned. Three tests were administered to examine the influence of neighborhood density on the accuracy of word learning during a production task. The first test was a Pretest which was given before the Exposure Phase to verify that the participants did not have a lexical representation of the novel words in the lexicon. In other words, the Pretest was used to ensure that the participants had not previously learned any of the stimuli before the experiment. The Pretest supplied baseline or a starting point of what each participant already knew. This measurement gave a number to which the post-exposure test values could be compared. Accuracy was the only dependent measure during the Pretests.

The second test given was Posttest 1 which was the first test after the Exposure Phase on the same day as the Pretest was given. The third test was Posttest 2 which was the final test and was given on the second day of testing. Each of the posttests examined word learning. If word learning occurred, then a difference between the Pretest and each posttest should be observed. Additionally, it was predicted that there would be differences between the two posttests (Gaskell & Dumay, 2007) after 24 hours had elapsed. In the present experiment, it is predicted that words from a dense neighborhood will be produced more accurately than words from a sparse neighborhood within each posttest and that overall accuracy will improve from the pretest to each posttest.

The responses made by each participant were transcribed and compared to the intended output. In the stringent criterion response analysis, responses were categorized as either right or wrong. Only completely correct responses were included in the final analyses. The participant was given little leeway in pronunciation. The researcher did not count the pronunciation of "bato" wrong when the intended output was "pato" due to the VOT differences between Spanish and English (Lisker & Abramson, 1964). Responses due to an improper triggering of the voice-key (for example, "uh," "er," "pa-pato", or "el pato") were excluded from the final analyses.

In a separate analysis, the lenient criterion response analysis, results were counted correct if 3 of the 4 phonemes matched the intended output. Only responses counted as "correct" were included in the analysis. The participant was given the same leeway with VOT as in the stringent criteria response analysis condition.

In addition to the author, another trained speech scientist scored a random sample of the data. Each phoneme of the participant response was matched to find the reliability. There was an 88.75% overlap of agreement between the two researchers.

4.1.1 Accuracy Rates – stringent criterion response analysis

A repeated measures ANOVA was used to examine the influence of neighborhood density across time. There was a significant interaction between test and neighborhood density, $F(2, 78) = 8.63$, $p < .05$. In the MANOVA follow-up tests, the alpha level was .017 as a Bonferoni correction was used because three follow up tests were conducted per task. In the dense condition, the means of the Pretest was 3.1%

correct (*sd* = 1.2), the mean of Posttest 1 was 49.4% correct (*sd* = 4.3), and the mean of Posttest 2 was 49.4% (*sd* = 4.6) correct. In the dense condition, there were statistically significant differences between the Pretest and Posttest 1, $F(1, 40) = 104.33$, $p < .017$, and between Pretest and Posttest 2 $F(1, 40) = 89.42$, $p < .017$, but not between Posttest 1 and Posttest 2, $F(1, 40) = 0.003$, $p > .017$ (i.e., the critical alpha-level for this analysis). Although participants showed no statistically significant change between Posttest 1 and Posttest 2, the results suggest that participants did perform differently from the Pretest to each of the posttests when responding to dense words.

In the sparse condition, the mean of the Pretest was 0.60% correct (*sd* = 0.60), the mean of Posttest 1 was 35.5% correct (*sd* = 4.7), and the mean of Posttest2 was 27.3% correct (*sd* = 3.8). There were statistically significant differences between the Pretest and Posttest 1, $F(1, 40) = 58.97$, $p < .017$, between the Pretest and Posttest 2, $F(1, 40) = 40.43$, $p < .017$ but not between Posttest 1 and Posttest 2, $F(1, 40) = 4.18$, $p > .017$. Although participants showed no statistically significant change between Posttest 1 and Posttest 2, the results suggest that participants did perform differently from the Pretest to each of the posttests with sparse words as well as dense words.

In the paired-sample t-test where alpha = 0.05, differences of neighborhood density within each test were examined. There was a statistically significant difference between how participants produced dense words and how participants produced sparse words in Posttest 1, $t\ (40) = 3.18$, $p < .05$, and in Posttest 2, $t\ (40) = 5.27$, $p < .05$, such that dense was more accurate than sparse. However, there was not a statistically significant difference between how participants produced dense words and how participants produced sparse words in the Pretest $t\ (40) = 1.67$, $p > .05$. The results of the paired sample t-test suggest that there were differences between how participants responded to dense words and how participants responded to sparse words after being exposed to the novel words.

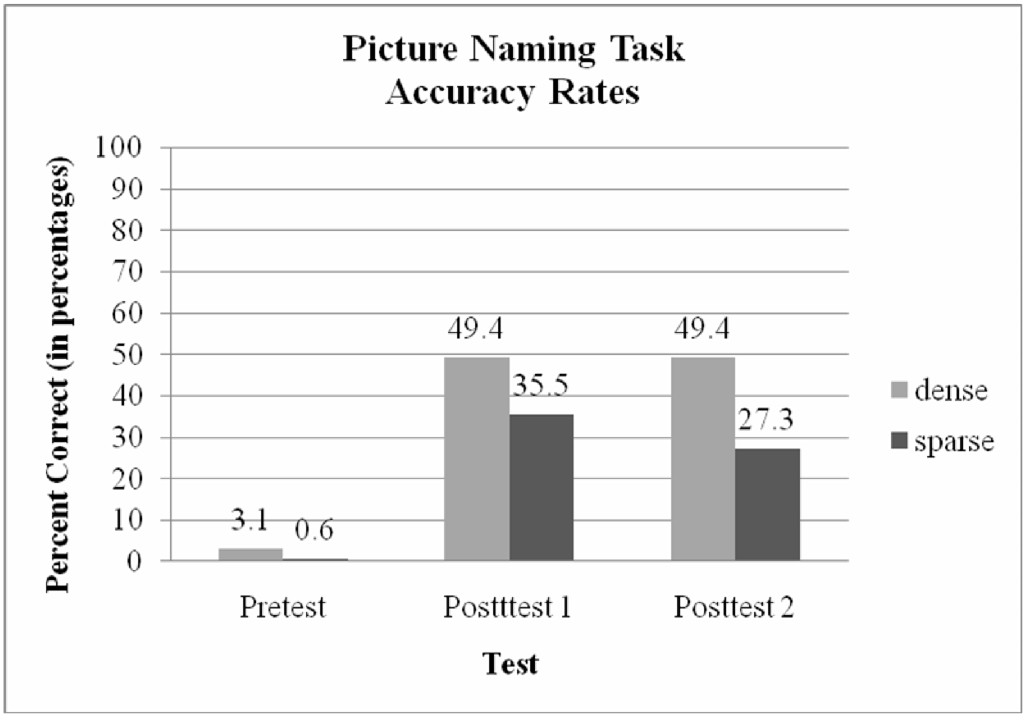


Figure 4-1. Accuracy rates in picture naming over time (stringent criterion). Although dense and sparse were not significantly different in the Pretest, they were significantly different from each other in both posttests where dense words were more accurately named than sparse words. Additionally, there are statistically significant differences in accuracy between the Pretest and each posttest.

4.1.2 Reaction Times – stringent criterion response analysis

Responses where the output matched the target output that were above 3776 ms and below 600 ms in List A and responses above 3397 ms and below 600 on List B were excluded from the final analyses. The values above 3776 ms and 3397 ms were two standard deviations above the mean for each respective list. Anything below 600 ms was considered a mistrigger of the microphone and only a single response was eliminated from the data which accounted for less than 1% of the data. A total of 14 responses were excluded from the final analysis which accounted for approximately 2% of the data.

The overall reaction time data for this task was not statistically significant between the posttests or between dense and sparse. There was no main effect of neighborhood density, $F(1, 21) = 2.95$, $p > .05$, or of test $F(1, 21) = 1.90$, $p > .05$. All means and standard deviations are given in Table 3. Given the large amount of variability in the data reaction time did not appear to be a good predictor for word learning in this task.

Table 3. List of means and standard deviations from the picture naming task (stringent criterion)

Test	Dense	Sparse
Posttest 1	1215.60 ms	1336.56 ms
	(99.84)	(114.72)
Posttest 2	1066.68 ms	1223.04 ms
	(68.63)	(113.74)

Note. Standard deviations are listed below the means in parentheses.

4.1.3 Accuracy Rates – lenient criterion response analysis

Unlike the stringent criterion response analysis, only the posttests were included in the lenient response analysis. This was because the majority of the responses in the Pretest were in English and not in Spanish. The few responses made in Spanish were either completely incorrect in that the participant did not give the correct Spanish word by any means, or completely correct. Therefore, only two tests were examined to investigate the influence of neighborhood density on the accuracy of word learning during a production task. The first test was Posttest 1 which was the first test after the

Exposure Phase on the same day that the Pretest was given. The second test was Posttest 2 which was the final test and was given on the second day of testing. Each of the posttests was given to examine word learning.

A repeated measures ANOVA was used to examine the influence of neighborhood density across time. There was a significant interaction between test and neighborhood density, $F(1, 40) = 5.15$, $p < .05$. The mean of the dense words in Posttest 1 was 64.5% correct (*sd* = 4.6) and the mean of the sparse words in Posttest 1 was 54.8% correct (*sd* = 4.9). The mean of the dense words in Posttest 2 was 62.7% (*sd* = 4.4) correct and the mean of the sparse words in Posttest 2 was 41.9% correct (*sd* = 3.7). Although participants did significantly better on the first posttest than they did on the second posttest and words considered to be dense were responded to more accurately than words that were considered to be sparse, there was a greater difference between the accuracy rates in the responses to dense words than to sparse words in Posttest 2.

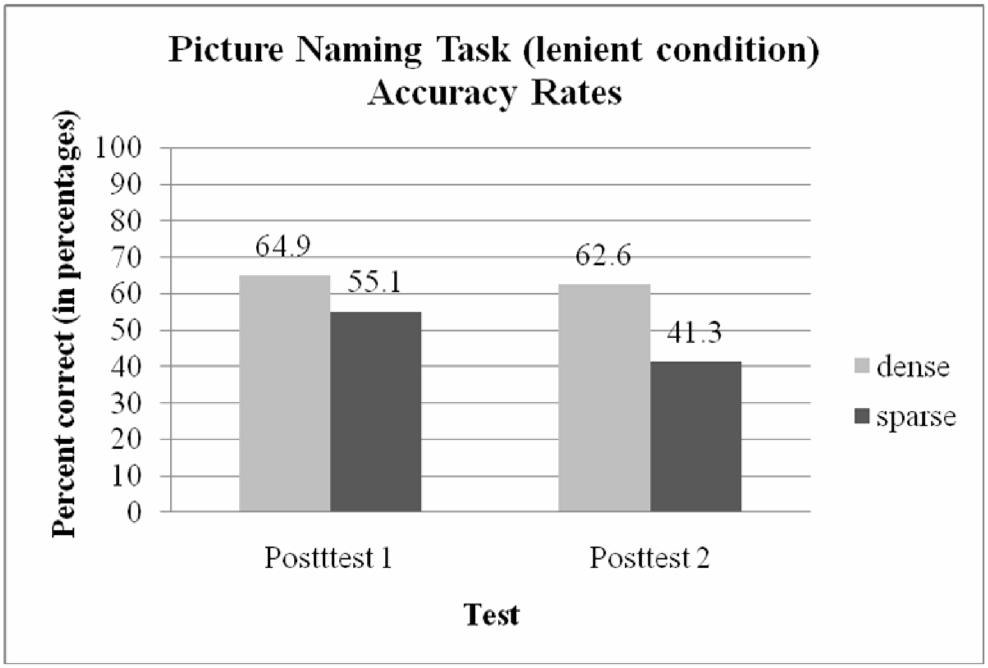


Figure 4-2. Accuracy rates in picture naming over time (lenient criterion). Significantly different accuracy rates between Posttest 1 and Posttest 2. Accuracy rates are also significantly different within each test between dense and sparse.

4.1.4 Reaction Times – lenient criterion response analysis

The same cutoffs used in the stringent response analysis criteria were used in the lenient response analysis criteria. The overall reaction time data for this task was not statistically significant. There was no main effect of neighborhood density, $F(1, 34) = 3.33$, $p > .05$, or of test $F(1, 34) = 0.51$, $p > .05$. Means and standard deviations are listed in Table 4. Reaction time data was not a good predictor for word learning in this task given the large amount of variability.

Table 4. List of means and standard deviations from the picture naming task (lenient criterion)

Test	Dense	Sparse
Posttest 1	1174.28 ms	1305.40 ms
	(63.55)	(62.96)
Posttest 2	1237.72 ms	1311.89 ms
	(62.79)	(90.94)

Note. Standard deviations are listed below the means in parentheses.

4.2 Three-alternative forced-choice (3AC) task

In the 3AC task, participants were asked to respond by matching the appropriate picture to the auditorily presented word using a three-button response box as quickly (in the posttests) and as accurately (in all tests) as possible. Three tests were administered to examine the influence of neighborhood density on the accuracy of word learning during a spoken word recognition task. The same format of testing was followed in the 3AC task as was in the picture naming task. Only correct responses were included in the final analyses.

4.2.1 Accuracy Rates

The accuracy rates from the Pretest did not differ from chance. Proportions less than or equal to .44 (the dense mean correct) or proportions less than or equal to .48 (the sparse mean correct) did not statistically significantly differ from chance (.33) using a binomial test of proportions (all p's > .72, Graphpad Software, 2002-2005). Therefore, the participants did not exhibit any prior receptive knowledge in the 3AC task before the Exposure Phase.

A repeated measures ANOVA was used to examine the influence of neighborhood density across time. There was a significant interaction between test and neighborhood density, $F(2, 78) = 13.61$, $p < .05$. In the MANOVA follow-up tests, the alpha level was .017 because three follow up tests were conducted per task. In the dense condition, the means of the Pretest was 43.6% correct (*sd* = 4.2), the mean of Posttest 1 was 95.2% correct (*sd* = 1.8), and the mean of Posttest 2 was 83.7% correct (*sd* = 3.8). In the dense condition, there were statistically significant differences between the Pretest and Posttest 1, $F(1, 40) = 108.81$, $p < .017$, between Pretest and Posttest 2, $F(1, 40) = 53.07$, $p < .017$, and between Posttest 1 and Posttest 2, $F(1, 40) = 10.04$, $p < .017$. In this task, participants showed a statistically significant difference between each test; however, it was not in the direction as predicted by Leach and Samuel (2007) or Gaskell and Dumay (2003). The previous work suggests that the second posttest should be the most accurate of the three tests given; however, in the present study, like the picture naming task, the first posttest had the highest accuracy rate.

In the sparse condition, the mean of the Pretest was 47.6% correct (*sd* =3.8), the mean of Posttest 1 was 64.3% correct (*sd* = 3.6), and the mean of Posttest 2 was 60.6% correct (*sd* = 3.4). There were statistically significant differences between the Pretest and Posttest 1, $F(1, 40) = 11.12$, $p < .017$, but not between Pretest and Posttest 2, $F(1, 40) = 6.12$, $p = .018$, or between Posttest 1 and Posttest 2, $F(1, 40) = 0.89$, $p > .017$. Participants showed no statistically significant change between Posttest 1 and Posttest 2; however from pretest to each of the posttests, the results suggest that participants did learn given the means increased significantly between the pretest and Posttest 1 and marginally significant between the pretest and Posttest 2. In both conditions, participants demonstrated learning from the pretest to each of the posttests.

In the paired-sample t-test where alpha = 0.05, differences of neighborhood density within each test were examined. There was a statistically significant difference between how participants produced dense words and how participants produced sparse words in Posttest 1, $t(40) = 8.07$, $p < .05$, and in Posttest 2, $t(40) = 4.43$, $p < .05$, but there was not a statistically significant difference between how participants produced dense words and how participants produced sparse words in the Pretest $t(40) = -0.76$, $p > .05$. The results of the paired sample t-test suggest that there were differences between how participants responded to dense words and how participants responded to sparse words after being exposed to the words in that dense words are responded to more accurately than sparse words.

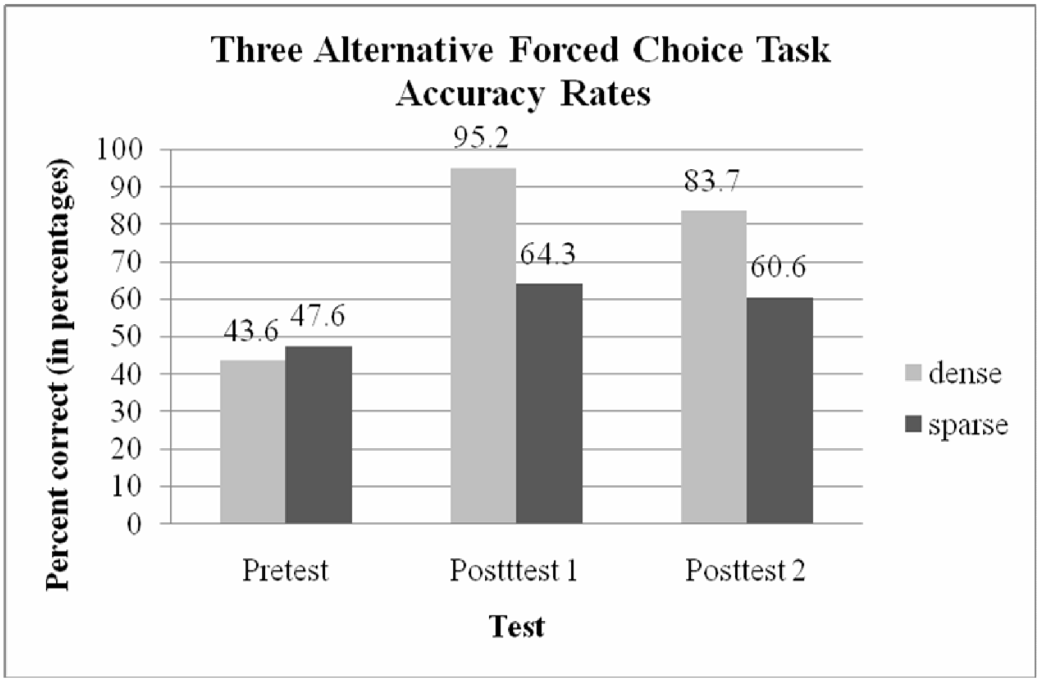


Figure 4-3. Accuracy rates in the referent identification task over time. The difference between density is statistically significant in Posttest 1 and Posttest 2 suggesting that words from dense neighborhoods are recognized more accurately than words from sparse neighborhoods. However, there is no statistically significant difference between the Pretest and Posttest 2 like there is between the Pretest and Posttest 1.

4.2.2 Reaction Times

Responses where the output matched the target output that were above 2638 ms and below 600 ms in List A and responses above 2293 ms and below 600 on List B were excluded from the final analyses. The values above 2638 ms and 2293 ms were two standard deviations above the mean. A total of 54 responses were excluded from the final analysis which accounted for approximately 11% of the data. It is important to note that 46 of the eliminated responses came from participants in List B suggesting that List B, although not significantly different from List A in any characteristic, may have been more difficult for participants than List A given that their responses were eliminated more often than those from List A. Additionally, half of those responses that were eliminated were made only by four participants. Two of the four participants had responses eliminated from Posttest 1 and a different two participants had responses eliminated from Posttest 2. Eliminating these four participants from the final analysis changed nothing statistically. Any response below 600 ms was considered an improper triggering of the microphone and only a single response was eliminated from the data, which accounted for less than 1% of the data.

The overall reaction time data for this task was not statistically significant. There was no main effect of neighborhood density, $F(1, 34) = .154$, $p > .05$ or of test $F(1, 34) = .453$, $p > .05$. Means and standard deviations can be found in Table 5. Reaction time data was not a good predictor for word learning in this task given the large amount of variability in the sparse condition.

Table 5. List of means and standard deviations from the 3AC task

Test	Dense	Sparse
Posttest 1	1412.31 ms	1388.19 ms
	(38.35)	(78.24)
Posttest 2	1400.05 ms	1464.08 ms
	(37.09)	(48.73)

Note. Standard deviations are listed below the means in parentheses.

4.3 Perceptual Identification Task

A repeated measures ANOVA was used to examine the influence of neighborhood density on accuracy which was the only dependent measure in the perceptual identification task. There was a statistically significant difference between dense and sparse in neighborhood density, $F(1, 39) = 4.49$, $p < .05$. In the dense condition, the mean was 86.4% correct (*sd* = 2.7) and in the sparse condition, the mean was 79.3% correct (*sd* = 3.3) suggesting the words from a dense neighborhood were recognized more accurately than words from a sparse neighborhood. In addition to the author, another trained speech scientist analyzed a random sample of the data. They averaged an 89.88% agreement in scoring the data.

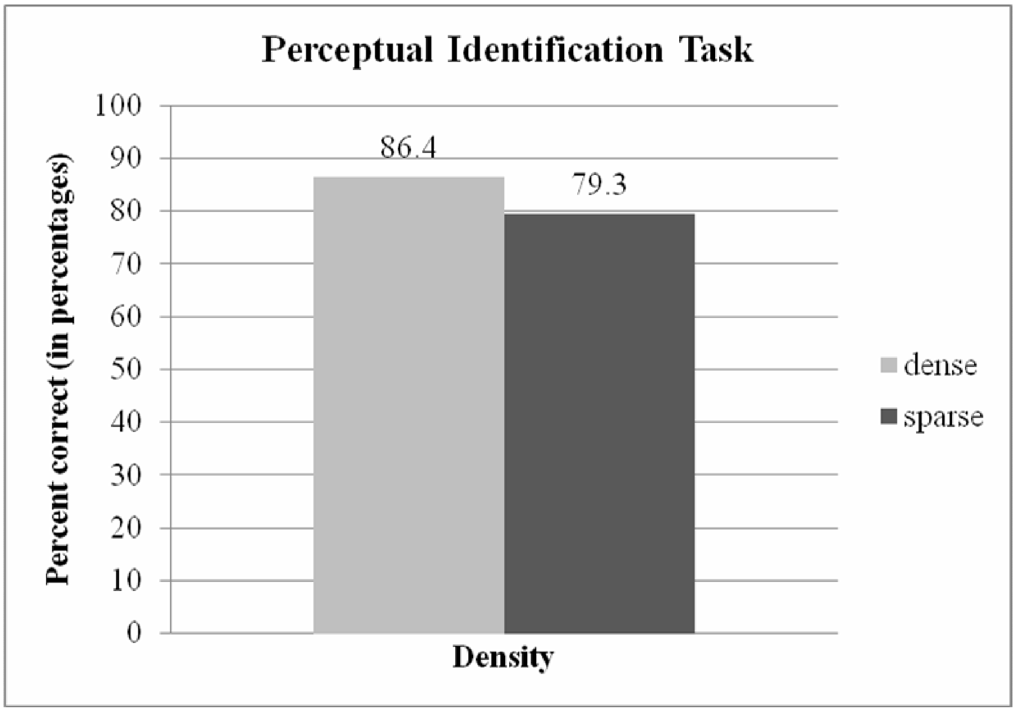


Figure 4-4. Results of the perceptual identification task. Dense words were recognized more accurately than sparse words.

4.4 Old-New Task

In the old-new task, participants were asked to decide as quickly and as accurately as possible if the auditorily presented stimulus was originally presented in the first day, thus being labeled as "OLD," or was not originally presented in the first day, thus being labeled as "NEW." The old-new task was only given on the second day for the purpose of examining lexical engagement (Leach & Samuel, 2007). Reaction times and accuracy rates were the dependent measures.

4.4.1 Accuracy Rates

A repeated measures ANOVA was used to examine the influence of neighborhood density on accuracy in the old-new task. There was no statistically significant difference between dense and sparse in neighborhood density, $F(1, 39) = 0.19$, $p > .05$. In the dense condition, the mean was 90.1% correct (*sd* = 2.9). In the sparse condition, the mean was 91.4% correct (*sd* = 2.3). This is the only task where there was not a statistically significant difference in the accuracy rates between dense and sparse. It is possible that this dependent measure was not sensitive enough to capture any differences in that there was a high level of accuracy – a ceiling effect. However, it is important to note that, although accuracy was not statistically significantly different, there was no speed-accuracy trade-off in that words from a sparse neighborhood were responded to more accurately than words from a dense neighborhood and in the reaction time data, sparse words were responded to significantly faster than dense words and sparse words.

4.4.2 Reaction Times

Responses where the output matched the target output that were above 2465 ms and below 400 ms in List A and responses above 3052 ms and below 400 on List B were excluded from the final analyses. The values above 2465 ms and 3052 ms were two standard deviations above the mean for each respective list. Anything below 400 ms was considered to be an inappropriate response as it was too fast for an actual response –

these responses accounted for less than 1% of the data. A total of 17 responses were excluded from the final analysis which accounted for approximately 5% of the data.

A repeated measures ANOVA was used to examine the influence of neighborhood density on reaction times. There was a statistically significant difference between dense and sparse, $F(1, 39) = 5.69$, $p < .05$. Words from a sparse neighborhood (mean = 1334.15 ms, *sd* =39.32) were responded to more quickly than words from a dense neighborhood (mean = 1424.64 ms, *sd* =48.10) suggesting that the newly learned words are involved in competition. This is the only task where reaction time data proved to be significantly different.

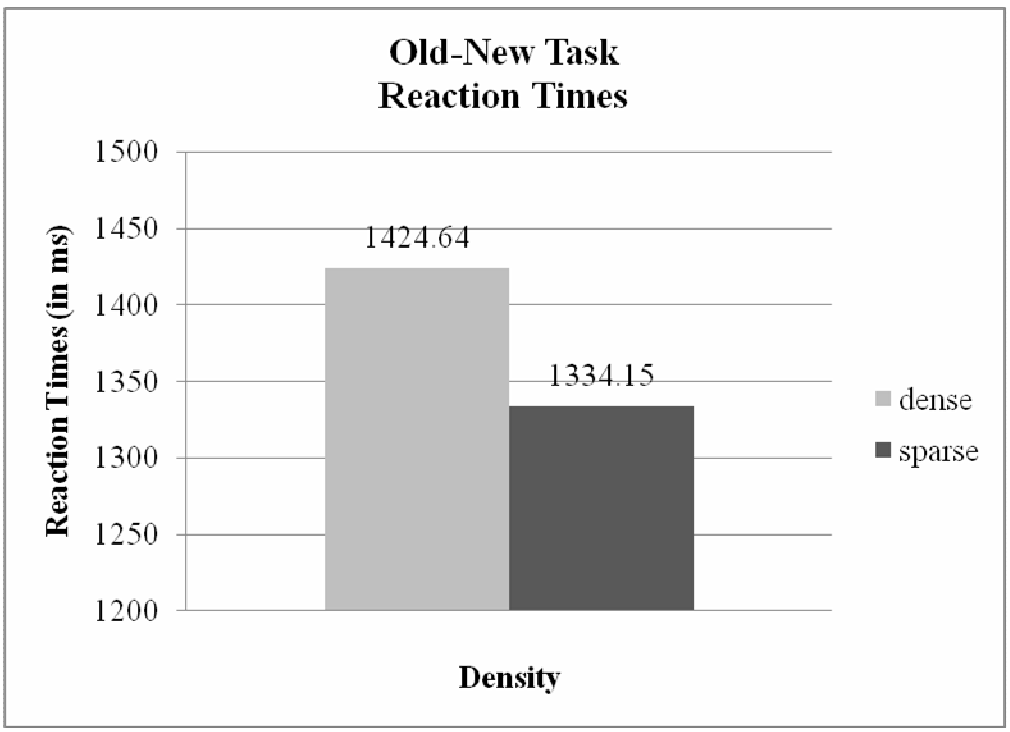


Figure 4-5. Reaction time data from the old-new task. There was a significant difference between dense and sparse words where words from a sparse neighborhood were responded to more quickly than words from a dense neighborhood.

4.5 Questionnaire Analysis

A simple linear regression was used to analyze the influence of other known factors during second language word learning on the dependent variables, accuracy and reaction time. The 3AC task, looking at the accuracy rates in Posttest1, was the most predictive task in that there were consistently large F-values and high levels of significance. The elements from the questionnaire, such as age of acquisition, amount of language use, and years lived abroad, were used as the independent variables to calculate how much variability would be predicted in the accuracy rates of the 3AC task. None of the factors from the questionnaire accounted for a significant amount of variability in the results from the 3AC task (all r's $< .25$; all F's < 2.75, all p's $> .05$). Therefore, any observed differences in the present data are due to the manipulation of the independent variable neighborhood density and not to any differences in the population

5. Discussion

In the present study, English-speaking adults learning Spanish as a foreign language were asked to recognize and produce words in Spanish as quickly and as accurately as possible. Previous work has shown that there is a dissociation between the initial stage of word learning, lexical configuration, where learners learn the facts of the words (i.e., sounds, meanings, syntactic role) and the next stage of word learning, lexical engagement, where the novel word has its own representation and participates in lexical processes such as competition. The objective of the present study was to examine the dissociation between the two stages of word learning in foreign language learners using real words from the target language, Spanish, as well as to examine the influence of phonological similarity on both stages of word learning to see if there was any added benefit to have many similar sounding words in the lexicon related to the target or few similar sounding words in the lexicon related to the target.

In order to examine the influence of neighborhood density, the stimuli were divided into two groups based on phonological similarity. One group of words was considered dense and the other sparse. Dense words had many phonologically similar words and sparse words had few phonologically similar words. For example, *pato*, was considered dense with the neighbors of *dato, palo*, *pata*, *plato*, *gato*, *paso*, *rato,* and *pavo* which are all found in the Beginning Spanish Lexicon. The stimulus item, *puño* was considered sparse with the neighbor *puro* which is also found in the Beginning Spanish Lexicon. The results of the present study suggest that words from a dense neighborhood were recognized and produced, and therefore learned, more accurately than words from a sparse neighborhood. Furthermore, the results of the present study suggest that neighborhood density influences lexical configuration and lexical engagement in a foreign language.

Overall, there was an influence of neighborhood density on word learning. Neighborhood density influenced the two stages of word learning: lexical configuration and lexical engagement. The influence of neighborhood density was found in the first posttests in the picture naming and three-alternative forced-choice tasks, supported lexical configuration, as well as in the second posttests in the picture naming and the three-alternative forced-choice task, as well as in the old-new and the perceptual identification tasks, supported lexical engagement. Participants were given a time period of at least 24 hours to elapse as suggested by Dumay and Gaskell (2007) thus suggesting that the second session examined lexical engagement. In the PID task, a participant cannot access a word through noise without accessing the lexicon or without having a newly created, independent representation from the novel word in the lexicon. The old-new task was thought to access the lexicon; however, this was incorrect as the old-new task was utilizing another type of memory – episodic memory. The present results supported the hypothesis that there would be some influence of neighborhood density in word learning by adults in a second language.

5.1 Influence of neighborhood density in second language word learning

As predicted by previous work (Storkel, et al., 2006), neighborhood density influences word learning – even in a second language. Neighborhood density is defined as the number of words that differed phonologically from a given target word by a single phoneme. In the present work, words from a dense neighborhood were learned in second language Spanish more accurately than words from a sparse neighborhood in all but one task – the old-new task. In the old-new task, there was no significant difference in responding to words from a dense neighborhood versus responding to words from a sparse neighborhood. Regarding accuracy in the old-new task, there was a ceiling effect where both accuracy rates were near 90%. Given the results in accuracy for the old-new task, this task behaved differently than the other three tasks. It was determined that the participants did not need to access the lexicon to perform the old-new task.

In the Pretests, accuracy rates were very low and below chance so there was no difference in neighborhood density which suggests that the words in the initial presentation were unknown to the learner. After the Pretest, there was an Exposure Phase where the participant heard each of the eight stimulus items five times. After the Exposure Phase, the participants took Posttest 1 in the picture naming task and the 3AC task. In each of the posttests in the picture naming and 3AC tasks, there were statistically significant differences between dense words and sparse words where dense words were produced and recognized more accurately than sparse words suggesting that neighborhood density influences word learning in second language Spanish. It is clear that neighborhood density influences word learning in both lexical configuration and lexical engagement.

It has been shown in previous work that neighborhood density influences word learning in first language speakers (and now, in second language speakers). It has also been shown that neighborhood density influences the initial stage of word learning, lexical configuration, in first language speakers, but how does neighborhood density influence lexical configuration in second language learners? And more importantly how does neighborhood density influence the integration of novel words into the second language learner's lexicon, or lexical engagement? The following two sections explore the role neighborhood density plays in lexical configuration and lexical engagement.

5.1.1 Lexical configuration

Lexical configuration is defined as the initial learning of the word characteristics such as the sound and meaning of the word (Leach & Samuel, 2007). The tasks designed to examine lexical configuration were the picture naming task and the three-alternative forced-choice task (3AC). More specifically, within these tasks, the results comparing the accuracy rates in the Pretest to Posttest 1 were examined as well as the results regarding accuracy rates pertaining to the influence of neighborhood density within Posttest 1.

Posttest 1 was given directly after the Exposure Phase, thus the participants had heard each stimulus word a total of six times. A single instance of each stimulus word was heard in the Pretest in the 3AC task, but not paired with any feedback suggesting the accuracy of the participant response. Stimuli were only heard once in the 3AC task, a receptive task, but were not heard during the picture naming task which was a production task. The final five times the stimuli were heard before the posttests were from the Exposure Phase where each time the word was presented with the correct picture, thus creating the beginning of an accurate lexical entry. The results discussed regarding lexical configuration are only of the dependent measure, accuracy, because no reaction time data was significant. It is possible that only the accuracy data is significant because the representation is not whole as the word has just begun being learned and reaction time data (an online process) is more sensitive than accuracy data (an offline[2] process). The learner, at the point of lexical configuration, has just learned the bare bones of the word – the sounds and the meaning. The novel word itself is not a full representation in the lexicon. There may be a partial or weak representation, but it is not detailed like that of a native speaker where neighborhood density influences lexical processing. It may also be due to the tasks themselves as only one task showed any significant difference in reaction times, which will be discussed in the lexical engagement section.

Comparing the Pretest to the first posttest, the overall accuracy rates improved from the Pretest to Posttest 1 suggesting that lexical configuration had occurred and that the participants were beginning to learn the words. Within the first posttest, the accuracy rate results suggest that second language Spanish words from a dense neighborhood were learned more accurately than second language Spanish words from a sparse neighborhood. The present results converge with previous research examining the influence of neighborhood density in word learning (Storkel, et al., 2006) where adults learned made-up nonwords from dense English neighborhoods more accurately than made-up nonwords from sparse English neighborhoods.

Given what has been found in the English adults learning English-like non-words related to the English lexicon (Storkel, et al., 2006) and the present results, it is clear that neighborhood density influences word learning, i.e., lexical configuration, regardless of whether the learner is a first or second language word learner. These results suggest that a common mechanism might be employed to learn regardless of the target language. Because the nature of a dense neighborhood where words in a dense neighborhood have more phonological overlap, there is more phonological support, or overlap, between the

[2]An *offline process* is a process that is not captured during the processing but rather after.

novel word and the words in the dense neighborhood. For example, when the learner learned the novel word *pato, pato* received phonological reinforcement from *dato, palo, pata, plato, gato, paso, rato,* and *pavo* which are all words that were previously stored in the Beginner Spanish Lexicon. Therefore, when learning a word that will become a member of a dense neighborhood, the novel word's representation, even in the early stages of lexical configuration, is stronger due to the larger amount of phonological overlap and is thus more accurately. However, when given a word to learn that is a member of a sparse neighborhood, such as *puño,* the only phonological support in the previously existing neighborhood is *puro.* In the sparse neighborhood, there is less phonological reinforcement making the sparse word's initial representation weaker, and thus it is less accurately.

5.1.2 Lexical engagement

The main objective of the present study was to examine how neighborhood density influences lexical engagement. Lexical engagement was defined as the latter part of word learning where words were integrated into the lexicon thus having their own, independent representation and participating in psycholinguistic processes such as competition. There were five instances where lexical engagement was analyzed. The first was comparing the Pretest to the second posttest, which was administered 48-72 hours after the first posttest. Dumay and Gaskell (2007) suggested that after a 24-hour time period, novel words would be integrated into the lexicon suggesting that lexical engagement had occurred. The second instance in examining lexical engagement was between the first and second posttests. The same principle applies from Dumay and Gaskell (2007) where 24 hours had passed, and thus lexical engagement had occurred if the novel words were integrated. The third instance was within the second posttest. Again, because this test was administered at least 24 hours after the first, it can be assumed that lexical engagement had the opportunity to occur. All of the above instances refer only to the picture naming and 3AC tasks, as these were the only two tasks to have more than one occurrence and the only two tasks where performance could be compared across time.

The final two instances to examine how words are integrated into the lexicon were two tasks specifically designed to analyze lexical engagement. The old-new task and the perceptual identification task were roughly derived from Leach and Samuel (2007). In the old-new task, it was assumed that the participant would have to access the entire word representation in order to establish whether the word was *old*, i.e., learned during the first session, or *new*, i.e., not heard during the first session. In the PID task, although this task was not used to examine lexical engagement in the Leach and Samuel paper, it was assumed that, in order to retrieve a word in noise accurately, the participant must activate the word's representation thus accessing the lexicon.

The results of the present study suggest that neighborhood density influences lexical engagement. Overall, words from a dense neighborhood were learned and integrated into the lexicon more accurately than words from a sparse neighborhood. Starting with the Pretest to Posttest 2 comparison, there was an increase in accuracy from the Pretest to the second posttest in the picture naming task in both the dense and sparse conditions suggesting that the novel words did in fact become integrated into the lexicon.

The results in comparing the Pretest to Posttest 2 for the 3AC task are not as clean as the results from the picture naming task. There was only a difference in accuracy in words from a dense neighborhood between the Pretest and Posttest 2 suggesting that in the 3AC task, which was a receptive task, dense words were fully integrated into the lexicon. Words from a sparse neighborhood did not differ significantly in Posttest 2 from the Pretest which suggests that, in a receptive task, sparse words are not as strongly integrated into the second language learner's lexicon.

The picture naming task showed differences in the dense and sparse conditions whereas the 3AC task showed differences only in the dense condition. It is possible that producing a novel word gives the representation a slight boost that simply recognizing the word does not. When a person has to produce a novel word, the lexicon has to be searched for the appropriate word and the word must be produced from scratch whereas when a word is recognized, the speaker simply has to match the input to a previous representation that has been stored. At this point in word learning, it is assumed that the novel words have in fact been integrated into the leaner's lexicon and are acting as independent representations. Therefore, it makes sense that the weaker representations, i.e., words from a sparse neighborhood, are given enough of a boost from being produced that they are also improved from the Pretest to Posttest 2. In the receptive 3AC task, only the words from the dense condition showed significant improvement from the Pretest to Posttest 2. This is possibly due to the fact that the sparse words, having weaker and less complete representations, were not given an additional boost given that the 3AC task is an easier task. Learners were also possibly relying on other processing strategies to figure out the matches whereas with the picture naming task, the learner had to pull up the entire representation each time in order to produce the word. Lexical engagement only occurred in the dense condition in both tasks suggesting that dense words are more easily and more accurately integrated into the lexicon than sparse words. In order for sparse words to be integrated into the lexicon, it seems like they need an extra boost, which is what production might do in the context of learning. Having to recall a word is more difficult than simply recognizing it and it is seems that the recalling of the words for the picture naming task gave the sparse words the extra boost they needed to be integrated in the lexicon.

In the picture naming task, a production task, words from a dense neighborhood were produced more accurately than words from a sparse neighborhood. In the 3AC task, words from a dense neighborhood were recognized more accurately than words from a sparse neighborhood. These results are interesting in that, given the previous research, the influence of neighborhood density varies based on what process is occurring and in what language. In English spoken word production, facilitation is found (Vitevitch, 2002), whereas in spoken word recognition, competition is found (Luce & Pisoni, 1998). In Spanish spoken word production, competition is found (Vitevitch & Stamer, 2006) whereas in spoken word recognition (Vitevitch & Rodríguez, 2005), facilitation is found. This of course leads to the question of what happens in word learning where both production and recognition are involved. The literature regarding neighborhood density and word learning is from English where words from dense neighborhoods are learned more effectively and more accurately than words from a sparse neighborhood.

In the present study, the same mechanism that is found in English word learning appears to be occurring in second language Spanish word learning by English speaking adults. Words from a dense neighborhood appear to be more phonologically supported and thus integrated more quickly than words from a sparse neighborhood. Additionally, the study that focuses on English adult word learning and neighborhood density only goes as far as to discuss lexical configuration (Storkel, et al., 2006). It was evident that neighborhood density influenced lexical configuration. Now the current results suggest that neighborhood density also influences lexical engagement and a similar mechanism as used in the first stage of word learning, lexical configuration, appears to be active in the second stage of word learning where words are integrated into the lexicon.

Another area where lexical engagement was tested was between Posttest 1 and Posttest 2. These results do not parallel the results found in the Pretest and Posttest 2 comparison. Only one condition in one task was found to be significantly different – the 3AC task in the dense condition where words from a dense neighborhood were recognized less accurately in Posttest 2 than words from Posttest 1. It is possible that given the few exposures the participants had during the study, they were not able to easily retain the words across time. In order to get a difference between Posttest 1 and Posttest 2, the participants have to do better (or worse) on Posttest 2 than they did on Posttest 1 which was immediately after the Exposure Phase. It is logical that participants would do significantly better from the Pretest to Posttest 1 as well as between the Pretest and Posttest 2 (which occurred in all conditions, the picture naming dense condition, the picture naming sparse condition, and the 3AC dense condition, but not the 3AC sparse condition), but it is more difficult to see results between Posttest 1 and Posttest 2.

The results comparing Posttest 1 and Posttest 2 do not follow what authors who have researched lexical engagement previously would predict. The scores did not increase from Posttest 1 to the final posttest as they did in previous research (Gaskell & Dumay, 2003; Leach & Samuel, 2007) This is most likely due to the participants only having two sessions rather than four to five. Leach and Samuel (2007) and Gaskell and Dumay (2003) had increases in accuracy over time; however, they had given their participants more exposures to the novel words than in the present study. Additionally, their participants were native English speakers learning made-up nonwords meant to follow English phonotactics or that words that were closely related to English words whereas the participants in the present study were presented novel words consisting of L2 phonotactics that were not necessarily closely related to L1 words. The present study only had two occasions where participants learned the words versus the four to five occasions in previous studies examining lexical engagement.

It is also possible that the results from Posttest 1 to Posttest 2 did not improve in all four conditions because the learners are learning a foreign language. The studies from Leach and Samuel and Gaskell and Dumay were first language studies where their participants had years of exposure to the first language and its structure to help remember novel words in a first language. The participants of the present study were second language learners with up to one year of college exposure and an average of 2.8 years of Spanish exposure in high school, 0.9 years in junior high, and 0.5 years in elementary. Even with just over 5 years of exposure, no second language learner in the present had ever study studied abroad suggesting that each participant learned Spanish as a foreign language. Learning Spanish as a foreign language means that Spanish was learned in another language environment – in this case, English – making it more difficult to realize patterns of structures and sounds needed to make it easier to learn novel words in Spanish (due to the less time being exposed to the second language). The language situation of second language learners in the present study is very different from the first language learner who is constantly exposed to the first language structure and sounds for the first 18 years of life, making it easier to learn novel words.

The third place that examined lexical engagement was within Posttest 2. Both the picture naming and 3AC tasks had differences in neighborhood density within Posttest 2. In the picture naming task, words from a dense neighborhood were produced more accurately than words from a sparse neighborhood. In the 3AC task, words from a dense neighborhood were recognized more accurately than words from a sparse neighborhood. Putting these two tasks together, it is evident that words from a dense neighborhood were learned more accurately than words from a sparse neighborhood suggesting that words from a dense neighborhood are integrated into the lexicon more effectively than words from a sparse neighborhood. Therefore, neighborhood density influences lexical engagement in second language Spanish adult learners.

It is important to note that reaction time data was not significant in the previous lexical engagement tasks just as reaction time data was not significant in the lexical configuration tasks. Earlier, it was argued that the representation was not whole and was weak. It is possible that the novel word, although acting as its own independent and dynamic representation in the lexicon after lexical engagement, is still weak. It is assumed, that with time, use or exposure, the representation would strengthen and reaction time data might show a difference between conditions. In the present study, however, word frequency was very low and given the present method, the frequency of each word is equivalent regardless of condition. The participant heard each novel word only ten times in the Exposure Phase which was the only part of the present study that matched the word to the appropriate semantic meaning or picture, thus suggesting that the word frequency of each word was matched and also very low.

Although there are differences in neighborhood density between the words, it is possible that given the small amount of times the words were heard, the representation of each word, dense and sparse, is still at an early stage of word learning and thus weak. With such a weak representation, even though the lexical representations of the words from a dense neighborhood are slightly stronger than the lexical representations of the words from a sparse neighborhood, reaction time data is not significantly different between the two groups. However, it is assumed that with more exposure and use, there may eventually be differences in reaction times between words from a dense neighborhood and words from a sparse neighborhood.

It has been shown that word frequency is positively correlated to neighborhood density in that words from a dense neighborhood tend to occur more often in Spanish than words from a sparse neighborhood (Vitevitch & Rodríguez, 2005). Therefore, it is predicted that the representations of the words from a dense neighborhood will become stronger and will continue to be stronger than those representations of words from a sparse neighborhood. This will be further discussed in the Structure of the L2 Lexicon.

Even though reaction time data was not significant in the present study, it is important to note that accuracy rates were. Accuracy rates, although an offline process, still capture differences in processing between the present conditions. Accuracy rates were still significantly different showing that lexical engagement did occur and was influenced by neighborhood density. Words from a dense neighborhood formed stronger representations than words from a sparse neighborhood allowing speakers to learn words from a dense neighborhood more accurately than words from a sparse neighborhood.

The other tasks designed to examine lexical engagement were the old-new and perceptual identification tasks. In the perceptual identification task (PID) it was found that words from a dense neighborhood were recognized more accurately than words from a sparse neighborhood. These results are similar to those found in the 3AC and picture naming tasks during Posttest 2. These results follow the pattern of results found in first language word learning in lexical configuration where words from a dense neighborhood are learned more accurately than words from a sparse neighborhood (Storkel, et al., 2006). In addition to following the typical pattern of results observed in word learning, the results from the PID task suggest that the learners are following what has been found in Spanish spoken word recognition where words from a dense neighborhood are recognized more accurately than words from a sparse neighborhood (Vitevitch & Rodríguez, 2005). The 3AC task also followed the typical pattern observed of native Spanish speakers recognizing words in Spanish, however, the picture naming task did not. In spoken word production in Spanish, speakers produced words from a sparse neighborhood more accurately than words from a dense neighborhood (Vitevitch & Stamer, 2006). These results therefore suggest that the learners are not necessarily governed by a language specific mechanism of processing, but more of a universal word learning mechanism where words from a dense neighborhood are learned more accurately than words from a sparse neighborhood.

The old-new task, however, does not fit into the theory that there is a universal word learning mechanism. Designed to examine lexical engagement, the old-new task, showed no difference between conditions in accuracy rates but did show a difference between conditions in reaction times. None of the previous tasks showed significant differences between conditions in reaction times. In the old-new task, words from a sparse neighborhood were recognized more quickly than words from a dense neighborhood suggesting evidence of competition as found in English spoken word recognition (Luce & Pisoni, 1998).

It is odd that this particular task was so different from the other three tasks. It is also odd that the present results suggest that the learners are relying on English-language mechanisms of spoken word processing to decide whether a word appeared in the previous session or not whereas the other three tasks showed support of a universal learning mechanism. It is possible that in this task, learners are relying on a first language processing strategy because it is more effective due to years of use whereas the second language processing strategy is still new and therefore less effective. It is possible that the difference found between the old-new task and the PID tasks is a matter of timing where the PID task was clearly not timed and the old-new task was, however, this does not stay true in that the 3AC and picture naming tasks which were timed. There were no differences in reaction times in the 3AC and picture naming tasks. It is possible that the type of task caused the difference between the old-new and PID tasks. The PID task was offline where only accuracy rates are collected and the old-new task was online where reaction time data is collected in conjunction with accuracy rates. It is possible that the lack of time-pressure in the PID task allowed the participant to develop a strategy to perform the task rather than rely on automatic processes. Given the greater amount of overlap in dense neighborhoods, the participants might have been engaging in a strategy to piece together words while accessing the Spanish lexicon. The results of the PID task followed a pattern of Spanish word recognition whereas with the old-new task, there was the pressure of time. Therefore, the participants relied on the more comfortable processing strategy from English and that this difference may have lead to participants developing different strategies to process novel words during each task. However, this explanation still does not follow what was found in the picture naming and 3AC tasks. A better explanation of the results from the old-new task is in order.

One possible explanation for the discrepancy in results between the PID task and the old-new task is that there was noise in one task and not the other. In the PID task, the participant hears the word mixed with white noise and therefore the word is slightly distorted. In the old-new task, the participant is presented with a word without any noise in the background. Maybe by not having the noise in the background in the old-new task, where words were presented in isolation without distortion, the participant were not provided any clues, such as a picture or distortion to activate other possible candidates. In the PID task, words were presented in noise. It is possible that this distortion allowed other words in the Spanish lexicon (see Vitevitch, submitted, for an analysis of the amount of overlap found between an English and a Spanish lexicon) to become more active as the participants were choosing a word to retrieve because words are more confusable when presented in noise than without noise. Words are more confusable when in noise because fricatives and affricates are drowned out and the overall sound quality of the word is decreased by the white noise. Sounds become distorted, much like listening to an out-of-tune radio station. Bits and pieces of the words may be clear, but in the end, the listener is guessing the words by finding the best match between the distorted input and stored lexical representations. Therefore, when words are presented in noise, it is assumed that the speaker fully accesses the lexicon, like in the PID task.

It is possible that the learners in the PID task used a strategy similar to what has been found in first language research in redintegration (Roodenrys, 2009). Small parts of the novel words presented in noise are heard by the listener who is able to recall the word in its entirety based on the small parts. In first language redintegration research, it has been found that words from a dense neighborhood are recalled more accurately than words from a sparse neighborhood. This pattern of the influence of neighborhood density found in the redintegration literature where dense words are remembered more accurately than sparse words has also been found in the learning literature (Storkel, et al., 2006). In other words, there is something special about a word when it is a member of a dense neighborhood versus being a member of a sparse neighborhood. The extra information that being a member in a dense neighborhood, i.e., more overlap with other words in the lexicon, gives to a novel word or a word being retrieved from memory, seems to help the speaker.

However, redintegration still does not explain why the PID task followed a pattern typically observed in the word learning literature and Spanish spoken word recognition while the old-new task still does not fit. The PID task fits nicely with the other results of the present study from the 3AC and picture naming tasks. The old-new task does not. The simplest explanation of why the old-new task continues to go against the grain would be that it is not a lexical task.

The old-new task does not follow the same pattern of results as shown in the picture naming task, 3AC task, or the PID task. The previous discussion assumes that the participants in the old-new task must access the lexicon to decide whether a word presented has appeared before on a list or not. The only way for neighborhood density to be an influence of word learning and lexical engagement is if the lexical representation of the word is indeed accessed; however, given the nature of the old-new task, it is not necessary to access the lexical representation to be able to answer whether or not a word appeared on a list before. Instead, the old-new task appears to be more of a memory task and participants probably did not need to access the lexicon to perform well on this task. Participants are almost certainly just remembering whether the word was on the list given in the study session or not. This type of memory is referred to as noetic memory. Noetic memory, a type of episodic memory, describes the ability that participants can remember the event of an item's appearance on a list, or whether the participants know that the item occurred during another task without actually remembering the specific occurrence and are still able to make an appropriate judgment based on experience (Tulving, 2002). Essentially, participants in the old-new task were simply acknowledging that a word presented had been or had not been in the study session or presented in a previous task during the previous session and did not need to access the lexicon to make this judgment.

In the memory literature, remembering items that "stick out" is referred to as the von Restorff effect (von Restorff, 1933). Previous research has shown that items that are unique are remembered better or more accurately (e.g., Erickson, 1963, 1965; Govardhan, Sandeep, & Rao, 1973; Holmes & Arbogast, 1979; Johnston, Hawley, Plewe, Elliott, & DeWitt, 1990). This idea can extend to the reaction time difference in the old-new task. In accuracy, more accurate results are considered to be better than less accurate results. In reaction times, faster response times are considered to be better than slower reaction times. In the old-new task, words from a sparse neighborhood, or more unique items, were responded to faster, or better, than words from a dense neighborhood, or less unique items. Sparse words would be considered to be unique items because the neighborhoods are smaller and there is less overlap among words. Dense words would be considered to be non-unique items because the neighborhoods are large and there is more overlap, or redundant information, among words. Therefore, the old-new task shows evidence of the von Restorff effect where unique items are responded to better than less unique items.

The theories in memory regarding noetic memory and the von Restorff effect help explain the results of the old-new task and also show that the lexicon was not accessed during the task. Therefore, because the task did not access the lexicon, there can be no concluded influence of neighborhood density. Therefore, the old-new task will be excluded from further discussion on lexical engagement because the lexicon was never accessed to perform the task.

It is clear that, in a lexical task, neighborhood density influences lexical engagement. Words from dense neighborhoods are learned more accurately than words from sparse neighborhoods. This pattern is found in the first language word learning literature regarding lexical configuration (Storkel, et al., 2006) as well as in the present study with second language learners. Adults have many cognitive strategies to help in word learning and neighborhood density is one of them. Neighborhood density not only influences the first stage of word learning – lexical configuration – where the guts of the word is learned, but also the second stage of word learning – lexical engagement – where words are integrated into the lexicon.

5.2 Implications of the present findings

5.2.1 Psycholinguistic implications

5.2.2 Influence of neighborhood density

The present study is consistent with previous work found in the L1 word learning literature where words from a dense neighborhood are learned more effectively than words from a sparse neighborhood (Storkel, et al., 2006). It is clear that neighborhood density influences word learning in L1. However, the present study added that not only does neighborhood density influence word learning during L2 lexical configuration, but neighborhood density also influences L2 word learning during lexical engagement in L2, or the integration of novel words into the lexicon. Additionally, the present work suggests that second language learning adults learn and integrate novel words from dense neighborhoods more effectively than novel words from sparse neighborhoods.

The influence of neighborhood density may be due to the nature of a dense neighborhood. Words in a dense neighborhood have a lot of phonological overlap. For example, when learning the word "bill" for the first time, the learner may have the words *hill, kill, fill, pill, ball, bell, bid, bin,* and *big* already stored in the lexicon. Learning the word "bill" is not learning new sounds or sequences but putting together a new chunk of old sounds and sequences. The learner is already familiar with the [bI] from *bid, big,* and *bin,* the [Il] from *hill, kill, fill,* and *pill*, and the [b+V+l] sequence from *ball* and *bell*. The same concept is present in second language word learning. When learning the Spanish word *pato*, an English speaker with the Beginner Spanish Lexicon will also activate the phonologically similar words: *pata*, *dato*, *gato, rato*, *palo, paso*, and *pavo*. *Pata* reinforces the [pat-] beginning, *dato, gato,* and *rato* reinforce [-ato] ending, and *palo,* *paso,* and *pavo* reinforce [p-to]. However, given a sparse word, *puño* with the single neighbor *puro* (as found in the Beginning Spanish Lexicon), only the [pu-o] is reinforced – and only one time at that. Therefore, it makes sense that words with many similar sounding neighbors would have stronger representations than words with few similar sounding neighbors. Additionally, because words in a dense neighborhood, regardless of language, are said to have more similar sounding words than words from a sparse neighborhood, the influence of neighborhood density where words from a dense neighborhood are learned more accurately than words from a sparse neighborhood might be a universal mechanism.

5.2.2.1 Structure of the L2 lexicon

The present work suggests that if it is in fact easier to learn novel words from dense neighborhoods, then the structure of the L2 lexicon may be similar to the structure of the developing L1 lexicon. When a first language lexicon is developing, the structure of the lexicon appears to be more dense in nature, rather than sparse. As novel entries are integrated into the lexicon, the dense neighborhoods continue to become denser and the sparse neighborhoods, although they may add a neighbor or two, tend to stay sparse (Charles-Luce & Luce, 1990). In the present study, words from a dense neighborhood were learned more accurately than words from a sparse neighborhood. These results suggest that the structure of the learner's lexicon with L2 novel words might be similar to the structure of the L1 lexicon because it is easier to learn words from a dense neighborhood.

As the L2 learner acquires new words, the words that are integrated more accurately with stronger representations are the words from a dense neighborhood.

Words that are integrated into the lexicon less accurately with weaker representations are words from a sparse neighborhood. Words from a dense neighborhood are added to larger neighborhoods (hence, the definition of a dense neighborhood) and words from a sparse neighborhood are eventually added to smaller neighborhoods (hence, the definition of sparse neighborhood). The structure of the L2 learner's developing lexicon is thus similar to the developing L1 lexicon in that the words with stronger representations, words from a dense neighborhood, are integrated more accurately than words with weaker representations, words from a sparse neighborhood, thus; creating a lexicon that is denser in nature.

Although the developing L1 lexicon and the developing L2 lexicon appear to be similar in terms of density, an important difference is the type of representation stored in the lexicon. When children are young, they do not have the same lexical representations that adults have (Storkel, 2002). The L1 child representations tend to be more generic or holistic in nature, whereas L1 adults have finely-tuned representations with more phonetic-detail. In a second language word learning adult, the adult has already been exposed to a first language phonemic system and has had practice creating lexical representations. It is assumed that the adult L2 lexical representations have already differentiated and would not be holistic like a young child learning a second language who has not had the experience of creating a lexicon. Now, this is not to say that the L2 adult learner's lexicon will always have correct representations. To add to the difficulty in acquiring representations, the L2 phonemic system may be different than that of the L1. For example, in Spanish, the onset /p/ is not aspirated like the onset /p/ in English. So participants are most likely producing [p^hato] instead of the more correct [pato].

However, the novel representation will still be /pato/ as [p^h] and [p] are derived from the phoneme /p/ in English. The main point is that representations are still developing as they are dynamic in nature in the adult lexicon. It is possible that the adult L2 representation will still have flaws. In the present study, although the results suggest that the words from a dense neighborhood have stronger representations meaning that learner's learned these words more accurately than words from a sparse neighborhood with weaker representations; it does not mean that a strong representation is a completely correct representation. Overall language proficiency has a role to play in the developing lexicon.

It was beyond the scope of the present study to examine varying levels of proficiency of the participants and the interaction thereof with neighborhood density and word learning. However, it would be predicted, based on the present results and the presumed structure of the lexicon, that the lower proficiency speakers would have overall weaker representations than those of higher proficiency speakers. Native speakers are presumed to have correct representations, but non-native speakers who learned Spanish as an adult may never acquire the correct phonemic sound system and may therefore never have completely correct representations. The representations of a highly proficient speaker will not be holistic like a child's, but they will be phonetically differentiated although they will have mistakes. Even the representations of an adult lower proficiency speaker would be assumed to have differentiated – although the lines between neighbors would not be as distinct, the representations would not be holistic like a child's.

The participants in the present study had, on average, 5.2 years of experience in Spanish. However, the majority of the participants reported that they learned Spanish in a classroom environment and none had studied abroad. Given the current classroom Spanish being taught, students have anywhere between 3-5 hours a week during nine months out of the year of classroom exposure in Spanish. None of the participants' parents spoke Spanish in the home. The amount of exposure of an adult learning a second language is very little when compared to a child learning a second language (generally at home or in the L2 environment). Therefore, adults are most likely employing tools that they used when learning the first language to learn words in a second language as well as other cognitive strategies. It would not make sense, for example, for adults to revert to holistic representations because while learning the L1 adults had already learned to differentiate between sounds and sound groups. It would not make sense for an adult to differentiate between various stop consonants (e.g., b, p, t, g) and then suddenly, when learning a new language as an adult, group them together. (However, it would be possible to not differentiate between two phonemes in the L2 that are allophones of the same phoneme in the L1, but this is beyond the scope of the present study.) Reverting back to holistic representations would be like the adult lumping *pato* and *gato* as one representation when the adult has already differentiated between /p/ and /g/ in the L1. Therefore, for adults learning a second language, although the representations created will be weaker initially, they will still be differentiated. Additionally, because the words from a dense neighborhood have stronger representations, the neighborhoods of the developing L2 lexicon will be denser in nature while the sparse neighborhoods continue to strengthen (more slowly).

5.2.3 Pedagogical implications

The present pattern of results suggests that words from a dense neighborhood are learned and integrated into the lexicon more accurately than words from a sparse neighborhood by English speaking adults learning Spanish as a second language. These results imply that when learning a novel word, it is more helpful to have lots of words in the lexicon that sound similar to the new word and less helpful to have few words in the lexicon that sound similar to the new word. Words previously learned and stored into the lexicon appear to aid in the learning of novel words when the novel words have potential membership in the existing neighborhood. The results of the present study converge with previous research in L1 examining lexical configuration where words from a dense neighborhood were learned more accurately than words from a sparse neighborhood (Storkel, et al., 2006); however, what the present study added was the aspect of second language word learning and integration of novel words into the lexicon.

It is clear that phonological similarity influences word learning – both in the initial stage of word learning as well as second stage of word learning where words are integrated into the lexicon. The present results add to previous work in the second language acquisition word learning research in that not only do semantics influence word learning, but so does phonology. Second language teachers, when teaching vocabulary, could capitalize on teaching words similar in sound to the words that are being taught. For example, in addition to teaching words associated with going to the zoo, the teacher could also teach words that are similar sounding to the various vocabulary words associated with going to the zoo. When teaching the word *mono* in Spanish, "monkey" in

English, the teacher could also teach the words *tono*, *moto*, or *mano* given that they are phonological neighbors.

Teachers can also utilize neighborhoods to review words. For example, if the learner was learning the word *mono,* the teacher could revisit the previously learned neighborhood of which *mono* is a member. Therefore, if *mono* had many similar sounding words in its neighborhood, the students could quickly review *tono, moto,* or *mano*. The teacher would check the Beginning Spanish Lexicon to see which neighbors of *mono* that the students had already learned and then could reinforce these words. One way of reviewing the neighbors or introducing novel neighbors would be using non-communicative activities. For example, the teacher could have students do a mechanical exercise for bell-work such as a crossword puzzle where all the clues are answers from a phonological neighborhood. Or, students could do a word search where all the words to be found are neighbors of one another.

A different pedagogical interpretation of the results of the present study would be that, since dense words appear to receive an extra "boost" from their neighborhoods whereas sparse words do not have much in the way of neighborhood reinforcement, teachers should give more varied and explicit exposure to *sparse* words during classroom instruction. For example, sparse words could be highlighted in short stories, vocabulary lessons, picture stories, role playing, imagery, or other communicative activities that reinforce these words and their meanings, thereby providing an instructional boost to these less-easily learned words. The key point is that teachers have awareness of which words in their lessons are members of a dense neighborhood and which words are members of a sparse neighborhood so that they can take advantage of dense neighborhoods where they exist, and provide additional lexical support where they do not.

Essentially, the present study is not looking to replace current teaching methods, but to enhance ways of approaching word learning in a second language. It is already well-known that semantic similarity helps students learn words effectively (Barcroft, 2002, 2003; Finkbeiner & Nicol, 2003) as some Spanish text books are organized in a semantic fashion (e.g., VanPatten, et al., 2004) and now it is also known that phonological similarity aids in vocabulary learning. If teachers use phonological similarity as an additional tool in their teaching repertoire, then it is possible that word learning will become more accurate and more efficient.

As a follow up to the present study, one tool that will be created to ease use in the classroom as well as aid in additional psycholinguistic research is an online database of the Beginning Spanish Lexicon. This database will be useful in developing lesson plans that incorporate the use of phonological neighbors. Using the online lexicon, teachers will be able to search for novel words they want to teach and will be able to see the neighbors that a typical beginning Spanish learner knows. Another way to use the lexicon would be that teachers can see which words have many similar sounding words – the words that are in dense neighborhoods with stronger representations – and maybe give more time and focus the exposure to the words with fewer similar sounding words – the words that are in sparse neighborhoods with weaker representations.

Knowing that phonological similarity also influences word learning along with semantic similarity simply gives another teaching tool to second language Spanish teachers. The present results suggest that there is not a language-specific mechanism that helps word learning, but rather more of a universal learning mechanism where words with many similar sounding neighbors, or lots of support, tend to be learned more accurately than words with fewer similar sounding neighbors, or little support. Knowing that the sparse words are more difficult to learn and are learned with less accuracy, teachers could spend a little more time on these words to support a student's learning of novel vocabulary. Understanding how phonological similarity influences word learning and how the lexicon is structured will enhance vocabulary learning in Spanish second language instruction.

6. Future Research Directions

The present work has served as a jumping off point for future research directions. Due to the interdisciplinary nature of the present work, psycholinguistic theory could be combined with pedagogical application in future research. Psycholinguistic studies are generally restricted to a lab-based setting which is an excellent place to start to understand the underpinnings of a psycholinguistic model. For a future research direction, psycholinguistic models could continue to be explored as well as being examined in action, such as in a more applied setting like a classroom. The goal is to bridge the gap between psycholinguistic theory and pedagogical application.

Psycholinguistic theory has examined how words are integrated into the lexicon by first language speakers, yet, there is little research examining how words are integrated into the lexicon by second language speakers. There needs to be further research conducted to examine more in detail the *when* of lexical engagement. The present study only had two sessions, or time-points, but Gaskell and Dumay (2003) and Leach and Samuel (2007) had at least four data points and a session for participants to come back after at least a week to show what they had retained. An extension and application of the current work would be to teach students new vocabulary words in Spanish over the course of a school week and test them each day. After finishing initial testing, a researcher could return after two weeks and retest and measure what was retained. Of course, variables such as neighborhood density should be manipulated to further examine the influence of phonological similarity on word learning.

It would also be interesting to compare word learning based on semantic groupings to word learning with the additional benefit of phonological similarity. This project would take the present results and eventually apply them to word learning in the classroom. First, it would be important to establish in a laboratory-based setting that there is a difference in word learning between participants who learn semantically related words without words being similar sounding and participants learning words when phonological similarity is also incorporated during training. Second, the psycholinguistic findings would be applied to the classroom with two groups of students. One group of students, the control group, would not be exposed to phonologically similar words when learning new vocabulary. The experimental group would be exposed to phonologically similar words when learning new vocabulary. It is predicted that phonological similarity would enhance word learning – not only in laboratory settings, but also in a more applied setting: the classroom. Once it is suggested that employing phonological similarity in a classroom is beneficial, it would be possible to work with language teachers to enhance second language curricula.

Another project that would be interesting would be examining the theory of how memory improves with repeated testing. Karpicke and Roediger (2008) have shown memory performance for a list of words actually increases with additional tests of the list, even though the list was only studied briefly, and no additional study exposure occurred. This is not an intuitive finding, as it is often thought that studying is the best way to improve accuracy in memory. The authors used English-Swahili word pairs in their study to test English speaker's memories when learning the word pairs. The English speakers had never learned Swahili before the experiment. It would be interesting to expand on the theory that memory improves for increased testing and examine second language learners given real-world word pairs in their first and second language. The participants would have information stored in their lexicons about both languages, which would mean that it would be possible to examine the influence of phonological similarity in memory. After exploring this idea in a laboratory-based setting, it would be important to apply it to a classroom where different groups of students have different amounts of testing sessions versus studying sessions when learning new vocabulary. Vocabulary testing is an integral part of second language teaching and it is important to understand how testing influences the memories of student word learners.

Another study involving memory would be further investigating the von Restorff effect (von Restorff, 1933) interacting with word learning. The universal mechanism that drives word learning appears to favor words from a dense neighborhood over words from a sparse neighborhood; however, the von Restorff effect appeals to learners remembering words from a sparse neighborhood rather than words from a dense neighborhood. It would be interesting to find out if in the initial stages of word learning, lexical configuration and lexical engagement are influenced first by the universal mechanism that appears to drive word learning and then later during the retention of a learned stimulus will then be governed by the von Restorff effect.

Regarding proficiency, it would be interesting to perform a similar study to the present work with proficiency as an independent variable. In order to fully examine how the lexicon is structured and the strength of novel representations, it is important to look at various levels of learner proficiency. Lower proficiency level speakers are predicted to have overall lower accuracy rates and weaker representations, but it is still assumed that there would be some influence of neighborhood density. As speakers approach near-native proficiency levels, it is possible that reaction times will come into play. As lexical representations strengthen, the response times are predicted to diverge. Words that are responded to more accurately may also be responded to more quickly. In native speaker production and perception papers, reaction time data is significant. It is predicted that as speakers gain proficiency and become more native-like, they too will respond more quickly to words from a dense neighborhood during word learning (following the universal mechanism). However, it would be interesting to see at which point the learner possibly patterns like the native speaker (competition during production (Vitevitch & Stamer, 2006, 2009) and facilitation during recognition (Vitevitch & Rodríguez, 2005)).

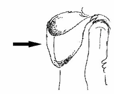
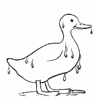
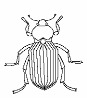
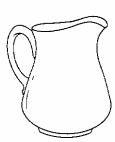
It may also be interesting to examine the manner in which words and their neighbors are presented. If a teacher or researcher were to present the neighborhood of a target word sequentially rather than all at once to a foreign language learner, the accuracy rates may be different that what was found in the present study. In other words, if the student or participant already knows the target of the neighborhood, how would there results vary if the neighbors were presented after the target is already known?

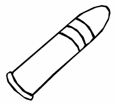
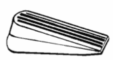
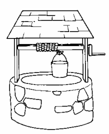
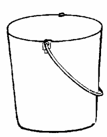
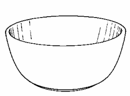
It is important to understand how lexicons are structured, how proficiency interacts with word learning, how memory interacts with neighborhood density, and the very nature of second language word learning. Word learning is a daily activity, yet second language learning adults often struggle learning words in the target language. Incorporating word learning strategies such as phonological similarity will increase accuracy in L2 vocabulary learning.

It is clear that there are factors that accelerate the initial acquisition of a word form. The majority of the research has examined how words are initially learned. However, what is less clear is how words are integrated into the lexicon. Future research indicated in the present study should answer questions about what factors influence novel word integration and about what strategies adults can employ to better learn novel words in a second language. Additionally, future research should examined strategies that teachers can use when teaching words in a second language such as using neighborhood density as suggested in this dissertation.

7. Appendices

7.1 Stimuli with Pix

Picture	*Spanish Phonology*	*Spanish Orthography*	*English Word*	*Neighborhood Density*
	/beka/	beka	hood	dense
	/bota/	bota	boot	dense
	/kuna/	cuna	crib	dense
	/pato/	pato	duck	dense
	/bitΣo/	bicho	bug	sparse
	/bule/	bule	pitcher	sparse
	/kema/	quema	fire	sparse
	/puɲo/	puño	fist	sparse

Picture	*Spanish Phonology*	*Spanish Orthography*	*English Word*	*Neighborhood Density*
	/bala/	bala	bullet	dense
	/kuɲa/	cuña	wedge	dense
	/paɲo/	paño	cloth	dense
	/poso/	pozo	well	dense
	/buke/	buque	ship	sparse
	/kubo/	cubo	bucket	sparse
	/puko/	puco	earthenware bowl	sparse
	/pote/	pote	flower pot	sparse

7.2 Questionnaire

Language History Questionnaire [adapted from (Li, et al., 2006)]

Name: ________________ e-mail: ________________ date: ________________

Please answer the following questions to the best of your knowledge.

1. Age (in years) _______
2. Sex (circle one) Male Female
3. Current year in college: Freshman Sophomore Junior Senior
4. Country of origin: _________
5. Country of residence: ______________
6. What is your native language? _________________
7. Are you fluent in any other languages? If so, which languages? Please note that fluency means that you can speak the language with ease.
8. Are you currently learning any languages other than your native langauge? If so, which languages?
9. In which Spanish class(es) are you currently enrolled? (please circle your selection)

   Span 104 Span 105 Span 108 Span 212 Span 216

   Span 324 Span 340 Span 424 Other ____________

10. What other Spanish classes have you taken at the University of Kansas?

    Span 104 Span 105 Span 108 Span 212 Span 216

    Span 324 Span 340 Span 424 Other ____________

11. How many years (to the nearest half-year) did you learn Spanish in

a. High school? _________

b. Junior high? _________

c. Elementary? _________

12. How have you learned Spanish so far? (please check the appropriate response)

a. Mainly through formal classroom instruction _____

b. Mainly through interacting with people _____

c. A mixture of both _____

d. Other (specify) _____

13. Please rate your ability in Spanish by placing a check mark in the appropriate column in the following table:

	Very poor	Poor	Fair	Functional	Good	Very Good	Native-like
	1	2	3	4	5	6	7
Reading proficiency							
Writing proficiency							
Speaking proficiency							
Fluency							
Listening ability							

14. Please provide the age when you were first exposed to each skill in Spanish:

Skill	Age
Speaking	20
Listening	20
Reading	20
Writing	20

15. Do you have a foreign accent when you speak Spanish? ________

a. If so, rate your accent on a scale from 1 (not much of an accent) to 7 (very strong accent)

16. What language do you usually speak to your mother at home? (If not applicable for any reason, write N/A)
17. What language do you usually speak to your father at home? (If not applicable for any reason, write N/A)

18. What languages can your parents speak fluently (If not applicable for any reason, write N/A)

a. Mother _______________
b. Father ________________

19. What language or languages do your parents usually speak to each other at home? (If not applicable for any reason, write N/A)

20. Estimate, in terms of percentages, how often you use your native language and other languages per day (in all daily activities combined)

Native language ______%
Second language ______%
Other languages ______% (specify: _____________________)
(Total should equal 100%)

21. Estimate, in terms of hours per day, how often you watch TV or listen to radio in your native language and other languages per day

Native language _____ (hrs)
Second language ________ (hrs)
Other languages ____________________________ (specify the languages and hrs)

22. Estimate, in terms of hours per day, how often you read newspapers, magazines, and other general reading materials in your native language and other languages per day.

Native language _____ (hrs)
Second language ________ (hrs)
Other languages ____________________________ (specify the languages and hrs)

23. Estimate, in terms of hours per day, how often you use your native language and other languages per day for work or study related activities (e.g., going to classes, writing papers, talking to colleagues, classmates, or peers).

Native language _____ (hrs)
Second language ________ (hrs)
Other languages ____________________________ (specify the languages and hrs)

24. In which languages do you usually:

a. Add, multiply, and do simple arithmetic? ______________________
b. Dream? ______________________
c. Express anger or affection? ______________________

25. When you are speaking, do you ever mix words or sentences from the two or more languages you know? (If no, skip to question 27)

26. List the languages that you mix and rate the frequency of mixing in normal conversation with the following people, on a scale from 1 (mixing is very rare) to 5 (mixing is very frequent). Write down the number in the box.

Relationship	Languages Mixed	Frequency of mixing
Spouse/family		
Friends		
Co-workers		

27. In which language (among your best two languages) do you feel you usually do better? Write the name of the language under each condition.

	At home	At work
Reading		
Writing		
Speaking		
Understanding		

28. Among the languages you know, which language is the one that you would prefer to use in these situations?

At home ______ At work ________ At a party _______ In general _______

29. If you have lived or travelled in other countries for more than three months, please indicate the names of the country or countries, your length of stay, and the languages(s) you learned or tried to learn.

30. If there is anything else you feel is interesting or important about your language background or language use, please comment below.

7.3 Examples of Experiments

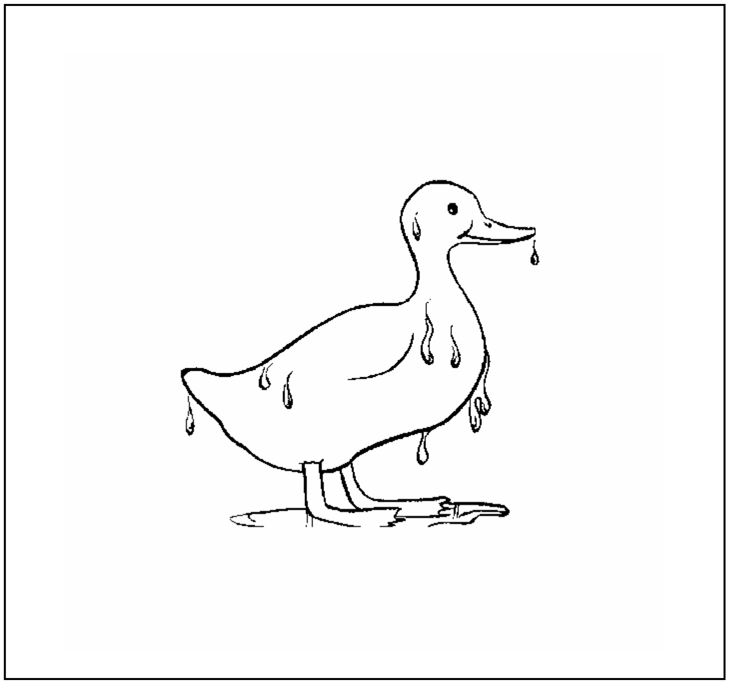
7.3.1 Picture Naming Task

The following is an example of what participants saw during the picture naming task. Participants were instructed to say, aloud, the name of the picture presented in Screen 2. Screen 1 was shown for 500 ms followed by a stimulus randomly presented in Screen 2.

Screen 1:

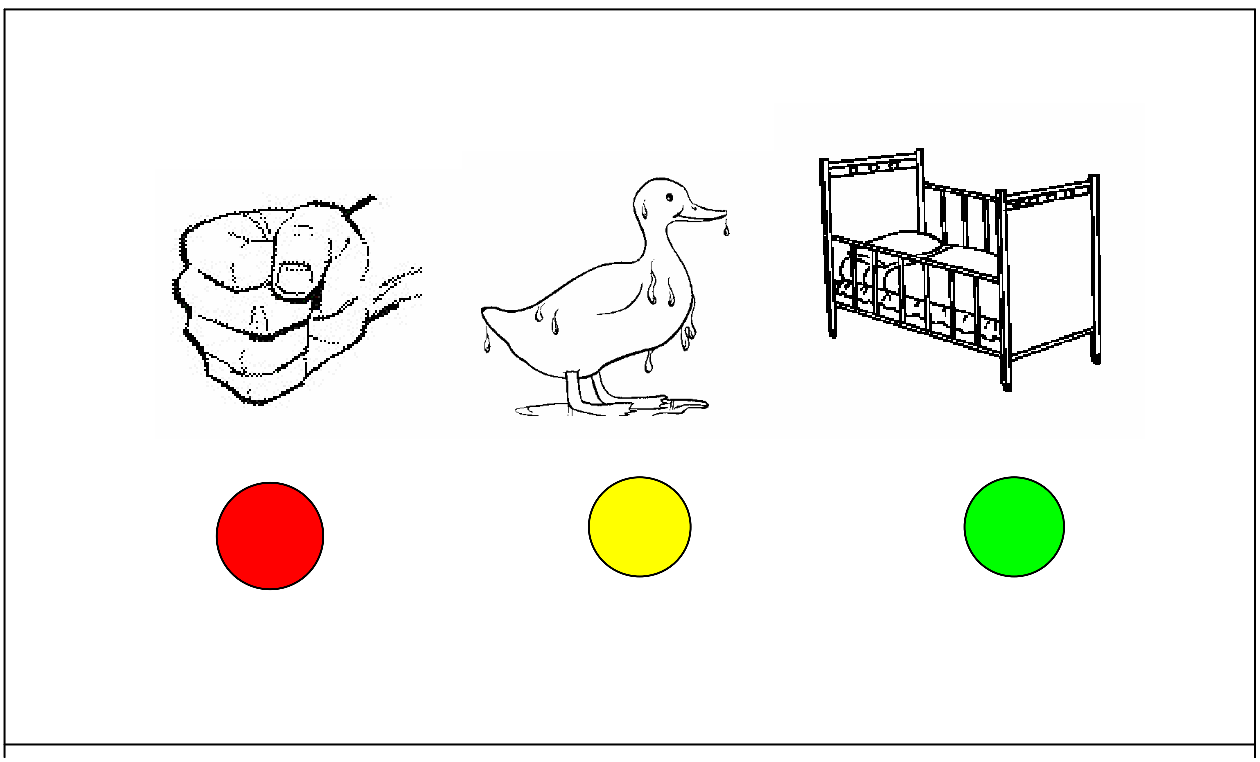
*****

Screen 2:



7.3.2 Three Alternative Forced Choice Task

The following is what participants saw during the 3AC task. Three stimulus pictures were presented side-by-side with one target word simultaneously auditorily presented. The participant was instructed to select the appropriate picture, the picture that matched the auditory stimulus, as quickly and as accurately as possible. The circle on the left was red and corresponded to the red button on the response box. The circle in the center was yellow and corresponded to the yellow button in the response box. The circle on the right was green and corresponded to the green button on the response box.



8. References

Au, T. K., & Glusman, M. (1990). The principle of mutual exclusivity in word learning: To honor or not to honor? *Child Development, 61*(5), 1474-1490.

Barcroft, J. (2002). Semantic and structural elaboration in L2 lexical acquisition. *Language Learning, 52*(2), 323-363.

Barcroft, J. (2003). Effects of Questions about Word Meaning during L2 Spanish Lexical Learning. *Modern Language Journal, 87*(4), 546-561.

Barcroft, J. (2007). Effects of Opportunities for Word Retrieval During Second Language Vocabulary Learning. *Language Learning, 57*(1), 35-56.

Birdsong, D., & Molis, M. (2001). On the Evidence for Maturational Constraints in Second-Language Acquisition. *Journal of Memory and Language, 44*(2), 235-249.

Bley-Vroman, R. (1989). What is the logical problem of foreign language learning? In S. M. Gass & J. Schachter (Eds.), *Linguistic Perspectives on Second Language Acquisition* (pp. 41-68). Cambridge: Cambridge University Press.

Burzio, L. (2002). Missing Players: Phonology and the Past-Tense Debate. *Lingua, 112*(3), 157-199.

Carlson, M. T. (2007). *The Acquisition of Probabilistic Patterns in Spanish Phonology by Adult Second Language Learners: The Case of Diphthongization.*, Pennsylvania State University.

Chambers, K. E., Onishi, K. H., & Fisher, C. (2003). Infants learn phonotactic regularities from brief auditory experiences. *Cognition, 87*(2), B69-B77.

Charles-Luce, J., & Luce, P. A. (1990). Similarity neighbourhoods of words in young children's lexicons. *Journal of Child Language, 17*(1), 205-215.

Charles-Luce, J., & Luce, P. A. (1995). An examination of similarity neighbourhoods in young children's receptive vocabularies. *Journal of Child Language, 22*(3), 727-735.

Cheung, H. (1995). Predicting pronunciation accuracy in a second language: The role of phonological awareness. *Psychologia: An International Journal of Psychology in the Orient, 38*(4), 266-274.

Cheung, H. (1996). Nonword span as a unique predictor of second-language vocabulary language. *Developmental Psychology, 32*(5), 867-873.

Chomsky, N. (1965). *Aspects of the Theory of Syntax*. Cambridge, MA: MIT Press.

Cohen, J., MacWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: An interactive graphic system for defining and controlling experiments in the psychology laboratory using Macintosh computers. *Behavior Research, Methods, Instruments, and Computers, 25*, 257-271.

Demke, T. L., Graham, S. A., & Siakaluk, P. D. (2002). The influence of exposure to phonological neighbours on preschoolers' novel word production. *Journal of Child Language, 29*(2), 379-392.

Dollaghan, C. A. (1994). Children's phonological neighbourhoods: Half empty or half full? *Journal of Child Language*, *21*(2), 257-271.

Dumay, N., & Gaskell, M. G. (2007). Sleep-Associated Changes in the Mental Representation of Spoken Words. *Psychological Science, 18*(1), 35-39.

Erickson, R. L. (1963). Relational Isolation as a means of producing the Von Restorff effect in paired-associate learning. [Peer Reviewed]. *Journal of Experimental Psychology, 66*(2), 111-119.

Erickson, R. L. (1965). Differential effects of stimulus and response isolation in paired associate learning. [Peer Reviewed]. *Journal of Experimental Psychology, 69*(3), 317-323.

Finkbeiner, M., & Nicol, J. (2003). Semantic category effects in second language word learning. *Applied Psycholinguistics, 24*(3), 369-383.

Flege, J. E. (1999). Age of learning and second language speech *Birdsong, David (1999)* (pp. Second language acquisition and the Critical Period Hypothesis. Second language acquisition research. (pp. 101-131). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers. x, 191).

Flege, J. E., Munro, M. J., & MacKay, I. R. A. (1995). Factors affecting strength of perceived foreign accent in a second language. *Journal of the Acoustical Society of America, 97*(5), 3125-3134.

Frauenfelder, U. H., Baayen, R. H., Hellwig, F. M., & Schreuder, R. (1993). Neighborhood density and frequency across languages and modalities. *Journal of Memory and Language, 32*, 781-804.

Garlock, V. M., Walley, A. C., & Metsala, J. L. (2001). Age-of-acquisition, word frequency, and neighborhood density effects on spoken word recognition by children and adults. *Journal of Memory and Language, 45*(3), 468-492.

Gaskell, M. G., & Dumay, N. (2003). Lexical competition and the acquisition of novel words. *Cognition, 89*(2), 105-132.

Gass, S. (1996). Second language acquisition and linguistic theory: The role of language transfer *Ritchie, William C.; Bhatia, Tej K* (pp. (1996). Handbook of second language acquisition. (pp. 1317-1345). San Diego, CA, US: Academic Press. xxv, 1758).

Gershkoff-Stowe, L., & Smith, L. B. (2004). Shape and the First Hundred Nouns. *Child Development*, *75*(4), 1098-1114.

Golinkoff, R. M., Hirsh-Pasek, K., Bloom, L., Smith, L. B., Woodward, A. L., Akhtar, N., et al. (2000). *Becoming a word learner: A debate on lexical acquisition*. Counterpoints: Cognition, memory, and language. New York, NY, US: Oxford University Press. (2000) vii, 208 pp.

Golinkoff, R. M., Shuff-Bailey, M., Olguin, R., & Ruan, W. (1995). Young children extend novel words at the basic level: Evidence for the principle of categorical scope. *Developmental Psychology, 31*(3), 494-507.

Govardhan, B., Sandeep, P., & Rao, G. S. (1973). The von Restorff effect in paired associate learning. [Peer-Reviewed Status-Unknown]. *Indian Journal of Experimental Psychology, 7*(1), 37-41.

Graphpad Software, I. (2002-2005). Sign and binomial test. Retrieved October 27, 2009, 2009, from http://www.graphpad.com/quickcalcs/binomial1.cfm

Hakuta, K., Bialystok, E., & Wiley, E. (2003). Critical evidence: a test of the critical-period hypothesis for second-language acquisition. *Psychological Science, 14*(1), 31-38.

Hirsh-Pasek, K., & Golinkoff, R. M. (1996). *The origins of grammar: Evidence from early language comprehension*. Cambridge, MA, US: The MIT Press. (1996) x, 230 pp.

Holmes, C. B., & Arbogast, R. (1979). An auditory von Restorff effect. [Peer Reviewed]. *Journal of General Psychology, 101*(2), 199-204.

Johnson, J. S., & Newport, E. L. (1989). Critical Period Effects in Second Language Learning: The Influence of Maturational State on the Acquisition of English as a Second Language. *Cognitive Psychology, 21*, 60-99.

Johnston, W. A., Hawley, K. J., Plewe, S. H., Elliott, J. M. G., & DeWitt, M. J. (1990). Attention capture by novel stimuli. [Peer Reviewed]. *Journal of Experimental Psychology: General*, *119*(4), 397-411.

Karpicke, J. D., & Roediger, H. L., III. (2008). The critical importance of retrieval for learning. *Science*, *319*(5865), 966-968.

Kim, K. H. S., Relkin, N. R., Lee, K.-M., & Hirsch, J. (1997). Distinct cortical areas associated with native and second languages. *Nature, 388*, 171-174.

Krashen, S. (1982). Accounting for child-adult differences in second langauge rate and attainment. In S. Krashen, R. Scarcella & M. H. Long (Eds.), *Child-Adult Differences in Second Langauge Acquisition*. Rowley, MA: Newbury House.

Leach, L., & Samuel, A. G. (2007). Lexical configuration and lexical engagement: When adults learn new words. *Cognitive Psychology, 55*(4), 306-353.

Lenneberg, E. H. (1967). *Biological foundations of language*. Oxford, England: Wiley.

Li, P., Sepanski, S., & Zhao, X. (2006). Language history questionnaire: A Web-based interface for bilingual research. *Behavior Research Methods, 38*(2), 202-210.

Lisker, L., & Abramson, A. S. (1964). A cross-language study of voicing in initial stops: Acoustical measurements. . *20*, 384-422.

Liu, J., Golinkoff, R. M., Goroff, J., & Carpenter, Q. (2001). How Do Preschool Children Acquire Superordinate Words? *Do, Anna H.-J.; DomÃ-nguez, Laura; Johansen, Aimee (2001)* (pp. Proceedings of the 25th Annual Boston University Conference on Language Development , Vols 21 and 22. (pp. 446-457). Somerville, MA, US: Cascadilla Press. 858).

Luce, P. A., & Pisoni, D. B. (1998). Recognizing spoken words: The neighborhood activation model. *Ear and Hearing, 19*(1), 1-36.

Maekawa, J. (2006). *Factors affecting word learning in second language acquisition.* Unpublished Ph.D., The University of Kansas, Lawrence, Kansas.

Markman, E. M. (1990). Constraints children place on word meanings. *Cognitive Science: A Multidisciplinary Journal, 14*(1), 57-77.

Markman, E. M. (1991). The whole-object, taxonomic, and mutual exclusivity assumptions as initial constraints on word meanings *Gelman, Susan A.; Byrnes, James P* (pp. (1991). Perspectives on language and thought: Interrelations in development. (pp. 1972-1106). New York, NY, US: Cambridge University Press. xii, 1524).

Markman, E. M. (1992). Constraints on word learning: Speculations about their nature, origins, and domain specificity *Gunnar, Megan R.; Maratsos, Michael (1992)* (pp. Modularity and constraints in language and cognition. The Minnesota symposia on child psychology, Vol. 25. (pp. 59-101). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc. x, 242).

Markman, E. M. (1999). Multiple approaches to the study of word learning in children. *Japanese Psychological Research. Special Issue: Lexical development: Evaluation of word-learning constraints, 41*(1), 79-81.

Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology, 16*(1), 1-27.

Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meaning of words. *Cognitive Psychology, 20*(2), 121-157.

Markman, E. M., Wasow, J. L., & Hansen, M. B. (2003). Use of the mutual exclusivity assumption by young word learners. *Cognitive Psychology*, *47*(3), 241-275.

Marslen-Wilson, W., & Tyler, L. K. (1980). The temporal structure of spoken language understanding. *Cognition*, *8*(1), 1-71.

McClelland, J. L., & Elman, J. L. (1986). The TRACE model of speech perception. *Cognitive Psychology, 18*(1), 1-86.

McClelland, J. L., & Patterson, K. (2002). 'Words or rules' cannot exploit the regularity in exceptions: Reply to Pinker and Ullman. *Trends in Cognitive Sciences*, *6*(11), 464-465.

McMurray, B. (2007). Defusing the childhood vocabulary explosion. *Science*, *317*(5838), 631.

Merriman, W. E., & Bowman, L. L. (1989). The mutual exclusivity bias in children's word learning. *Monographs of the Society for Research in Child Development, 54*(3-4), 130.

Mervis, C. B., Golinkoff, R. M., & Bertrand, J. (1994). Two-year-olds readily learn multiple labels for the same basic-level category. *Child Development, 65*(4), 1163-1177.

Metsala, J. L. (1999). Young children's phonological awareness and nonword repetition as a function of vocabulary development. *Journal of Educational Psychology, 91*(1), 3-19.

Morrisette, M. L. (2000). *Lexical influences on the process of sound change in phonological acquisition.* Unpublished Ph.D., Indiana University, United States Indiana.

Nation, P., & Waring, R. (1997). Vocabulary size, text coverage, and word lists. In N. Schmitt & M. McCarthy (Eds.), *Vocabulary: Description, acquisition, pedagogy* (pp. 6-19). New York: Cambridge University Press.

Norris, D. (1994). Shortlist: A connectionist model of continuous speech recognition. *Cognition, 52*(3), 189-234.

Perani, D., Paulesu, E., Galles, N. S., Dupoux, E., Dehaene, S., Bettinardi, V., et al. (1998). The bilingual brain: Proficiency and age of acquisition of the second language. *Brain: A Journal of Neurology, 121*(10), 1841-1852.

Pinker, S., & Ullman, M. T. (2002). The past and future of the past tense. *Trends in Cognitive Sciences, 6*(11), 456-463.

Quine, W. V. O. (1960). *Word and object: An inquiry into the linguistic mechanisms of objective reference*. Oxford, England: John Wiley.

Quine, W. V. O. (1964). *Word and object*. Oxford, England: M.I.T. Press. (1964).

Roodenrys, S. (2009). Explaining phonological neighbourhood effects in short-term memory *Thorn, Annabel S* (pp. C.; Page, Mike P. A. (2009). Interactions between short-term and long-term memory in the verbal domain. (pp. 2177-2197). New York, NY, US: Psychology Press. xii, 2317).

Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical Learning by 8-Month-Old Infants. *Science, 274*(5294), 1926-1928.

Sebastián Gallés, N., Martí Antonín, M. A., Carreiras Valiña, M. F., & Cuetos Vega, F. (2000). Lexesp. Léxico informatizado del español [CD-ROM]: Edicions de la Universitat de Barcelona.

Singh, L. (2008). Influences of high and low variability on infant word recognition. *Cognition, 106*(2), 833-870.

Speciale, G., Ellis, N. C., & Bywater, T. (2004). Phonological sequence learning and short-term store capacity determine second language vocabulary acquisition. *Applied Psycholinguistics, 25*(2), 293-321.

Storkel, H. L. (2001). Learning new words: Phonotactic probability in language development. *Journal of Speech, Language, and Hearing Research, 44*(6), 1321-1337.

Storkel, H. L. (2002). Restructuring of similarity neighbourhoods in the developing mental lexicon. *Journal of Child Language, 29*(2), 251-274.

Storkel, H. L. (2003). Learning New Words II: Phonotactic Probability in Verb Learning *Journal of Speech, Language, and Hearing Research, 46*, 1312-1323.

Storkel, H. L. (2004a). Do children acquire dense neighborhoods? An investigation of similarity neighborhoods in lexical acquisition. *Applied Psycholinguistics, 25*(2), 201-221.

Storkel, H. L. (2004b). The Emerging Lexicon of Children With Phonological Delays: Phonotactic Constraints and Probability in Acquisition. *Journal of Speech, Language, and Hearing Research, 47*(5), 1194-1212.

Storkel, H. L. (2006). Do children still pick and choose? The relationship between phonological knowledge and lexical acquisition beyond 50 words. *Clinical Linguistics and Phonetics*, *20*(78), 523-529.

Storkel, H. L., Armbruster, J., & Hogan, T. P. (2006). Differentiating Phonotactic Probability and Neighborhood Density in Adult Word Learning. *Journal of Speech, Language, and Hearing Research, 49*(6), 1175.

Storkel, H. L., & Maekawa, J. (2005). A comparison of homonym and novel word learning: The role of phonotactic probability and word frequency. *Journal of Child Language, 32*(4), 827853.

Storkel, H. L., & Rogers, M. A. (2000). The effect of probabilistic phonotactics on lexical acquisition. *Clinical Linguistics & Phonetics, 14*, 407–425.

Swingley, D., & Aslin, R. N. (2000). Spoken word recognition and lexical representation in very young children. *Cognition, 76*(2), 147-166.

Swingley, D., & Aslin, R. N. (2002). Lexical neighborhoods and the word-form representations of 14-month-olds. *Psychological Science, 13*(5), 480-484.

Swingley, D., & Aslin, R. N. (2007). Lexical competition in young children's word learning. *Cognitive Psychology, 54*(2), 99-132.

Treiman, R., & Breaux, A. M. (1982). Common phoneme and overall similarity relations among spoken syllables: Their use by children and adults. *Journal of Psycholinguistic Research, 11*(6), 569-598.

Trofimovich, P. (2008). What Do Second Language Listeners Know About Spoken Words? Effects of Experience and Attention in Spoken Word Processing. *Journal of Psycholinguist Research, 37*, 309-329.

Tulving, E. (2002). Episodic memory: From mind to brain. [Peer Reviewed]. *Annual Review of Psychology, 53*(1), 1-25.

VanPatten, B., Lee, J. F., & Ballman, T. L. (2004). *¿Sabías que... ?: Beginning Spanish* (4th ed.). New York: McGraw Hill Companies, Inc.

Vitevitch, M. S. (1997). The neighborhood characteristics of malopropisms. *Language and Speech, 40*(3), 211-228.

Vitevitch, M. S. (2002). The influence of phonological similarity neighborhoods on speech production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*(4), 735-747.

Vitevitch, M. S. (submitted). OBSERVATION: What do foreign neighbors say about the mental lexicon? .

Vitevitch, M. S., & Luce, P. A. (1998). When words compete: Levels of processing in perception of spoken words. *Psychological Science, 9*(4), 325-329.

Vitevitch, M. S., & Rodríguez, E. (2005). Neighborhood density effects in spoken word recognition in Spanish. *Journal of Multilingual Communication Disorders, 3*(1), 64-73.

Vitevitch, M. S., & Sommers, M. S. (2003). The facilitative influence of phonological similarity and neighborhood frequency in speech production in younger and older adults. *Memory and Cognition, 31*(4), 491504.

Vitevitch, M. S., & Stamer, M. K. (2006). The curious case of competition in Spanish speech production. *Language and Cognitive Processes, 21*(6), 760770.

Vitevitch, M. S., & Stamer, M. K. (2009). The influence of neighborhood density (and neighborhood frequency) in Spanish speech production: A follow-up report. *Spoken Language Laboratory Technical Report, 1*, 1-6.

Vitevitch, M. S., Stamer, M. K., & Sereno, J. A. (2008). Word length and lexical competition: Longer is the same as shorter. *Language and Speech 51*, 361-383.

von Restorff, H. (1933). Über die Wirkung von Bereichsbildungen im Spurenfeld (The effects of field formation in the trace field). *Psychologie Forschung, 18,* 299-334.

Werker, J. F., & Yeung, H. H. (2005). Infant speech perception bootstraps word learning. *Trends in Cognitive Sciences, 9*(11), 519-527.

White, L. (1992). Universal Grammar: Is it just a new name for old problems? In S. M. Gass & F. Selinker (Eds.), *Langauge Transfer in Language Learning* (pp. 217-232). Philadelphia: J. Benjamins.

Woodward, A. L. (1992). The role of the whole object assumption in early word learning. *Dissertation Abstracts International Vol, 53*(3-B).