THE PROCESSING OF LEXICAL STRESS BY EARLY AND LATE LEARNERS OF SPANISH

by

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ABSTRACT

The present investigation examines the processing of Spanish stress by English speakers, second language learners of Spanish, and English-Spanish early bilinguals. Some languages have lexical stress, a phonological feature that can be part of the identity of words. This is the case of English and Spanish, two languages in which stress is contrastive and, thus, it can be used to distinguish between lexical items. Despite this typological similarity, English and Spanish differ in terms of the lexical distribution of stress as well as in the number of possible stress minimal pairs. Stress in English tends to appear in the first syllable of a word in about 90% of the cases. Also, this language presents only a handful of “true” stress minimal pairs in which the segmental structure remains identical. In comparison, stress in Spanish tends to appear in the second-to-last syllable of a word and this is true for about 80% of the lexical items in this language. When it comes to the number of possible stress minimal pairs, the Spanish verbal morphology alone is highly productive in terms of creating lexical items that differ exclusively in the location of stress. Thus, when compared to English, stress in Spanish appears to be less predictable and it generates a higher number of stress minimal pairs. It is not surprising, then, that Spanish speakers make use of stress to conduct lexical searches to a greater extent than English speakers. In fact, English speakers have been found to treat the members of a stress minimal pair as homophones. When it comes to learning Spanish as a second language, English native speakers present difficulties in the processing of L2 stress contrasts. Furthermore, these processing difficulties are also found in English-Spanish bilinguals, a population that has had extended experience with both English and Spanish. To date, however, it is unknown whether the challenges that English native speakers second language learners of Spanish and English-Spanish bilinguals face stem from unsuccessful perceptual discrimination of stress contrasts, from an unstable phonological representation of stress, or a combination of both. The aim of this dissertation is twofold. The first aim is to provide data on the phonological encoding of stress in early and late learners of Spanish by probing them with stress-based contrasts in a discrimination task (Experiment 1). The findings from such a task will help us capture whether participants’ processing abilities allow them to successfully encode and access stress information in a relatively cognitively-demanding online tasks. Furthermore, this experiment will allow us to explore whether second language learners are able to develop their stress processing as they become more proficient and their experience with Spanish increases. Secondly, this dissertation addresses the perceptual discrimination of stress contrasts by second language and bilingual speakers of Spanish. Subjects participated in a discrimination task designed to test whether participants were able to perceive a difference when presented with aural productions of two nonwords that differed exclusively on the location of stress (Experiment 2). The results from Experiment 1 suggest that English speakers are challenged by stress processing when this
phonological feature is signaled exclusively through suprasegmental acoustic cues but only when they are, in theory, asked to rely on the phonological representation of lexical items. This effect is also found in early Spanish-English bilinguals, which indicates that length of exposure to and increased linguistic experience with Spanish do not guarantee the development of robust stress processing abilities. Moreover, the findings from second language learners suggest that proficiency can predict some degree of the variance found in the late learners. This provides evidence that learners with increased linguistic knowledge display a more robust representation of stress in their working-memory when compared to more novice learners. The results from Experiment 2 revealed that second language and bilingual speakers of Spanish were challenged by stress contrasts at a perceptual, low level of processing. In addition, language dominance and proficiency were found to be very modest predictors of perceptual development. Overall, it seems that the difficulties observed in English native speakers who are second language learners of Spanish and English-Spanish bilingual speakers are (at least in part) due to difficulties in the perception and phonological encoding of stress contrasts. In the case of second language learners, it appears that a development in L2 proficiency leads to more robust stress-encoding abilities, and to a very modest development in the perception of stress contrasts. Finally, the results of the present study are in line with the predictions of the lexical statistics account (Peperkamp et al., 2010), which anticipated lower stress-encoding abilities for speakers of English as a result of the higher predictability of the location of stress in this language.
CHAPTER 1: INTRODUCTION

1.1 Introduction

L2 learners often experience difficulties when perceiving nonnative phonological contrasts. One of the main reasons is that learners resort to the linguistic system of their first language (L1) to perceive nonnative sounds. In this view, linguistic experience constraints the perception of second language (L2) contrasts that diverge phonologically or phonetically from the native system (Best & Tyler, 2007). For instance, the perception of the Catalan contrast /e/-/ɛ/ is problematic for L1 Spanish speakers (Pallier et al., 1997), as is the French contrast /u/-/y/ for L1 English speakers (Levy & Strange, 2008), and the English contrast /r/-/l/ for L1 Japanese speakers (Sheldon & Strange, 1982). However, these perceptual difficulties do not only apply to segmental elements of the target language. The perception of suprasegmental features can also be challenging for second-language speakers. For example, Spanish stress appears to be difficult for native speakers of English (Beaudrie, 2007; Kim, 2015, 2016; Romanelli, Menegotto & Smyth, 2015; Romanelli & Menegotto, 2015a, 2015b; Saalfeld 2012).

In Spanish, the verb forms <paso> and <pasó> refer to two different grammatical persons and verbal tenses. Despite their segmental similarity, these two words are interpreted very differently by native speakers: /paso/ yields the interpretation “I pass” while /pa'so/ is understood as “s/he passed”. Pairs like these differ on how “prominently” each of their two syllables are realized. This distinction in prominence is located at the suprasegmental level and it is encoded in the phonological representation of the speakers as an abstract category known as stress. When learning Spanish as a second language, the successful processing of this
phonological contrast allows listeners to perceive the distinction between words. In the case of native English speakers, they have experience with similar stress minimal pairs such as <trusty> and <trustee>. Yet these types of pairs are rare in English as most of the words that differ in stress location also have different vowels (Warner and Cutler, 2017). For example, the words CONvert and conVERT differ both in the location of stress and in that the first vowel quality of the first vowel changes from /a/ to schwa. Thus, English speakers can make use of vowel reduction patterns in order to distinguish words without resorting to stress information. This fact may be behind previous findings that attest that that English native speakers are challenged by the identification and perception of Spanish stressed syllables (Beaudrie, 2007; Kim, 2015, 2016; Romanelli, Menegotto & Smyth, 2015; Romanelli & Menegotto, 2015a, 2015b; Saalfeld 2012). Moreover, speakers who grew up speaking both English and Spanish also face similar challenges with the same tasks (Beaudrie, 2017).

Cross-linguistic accounts have found that speakers of different languages process stress differently. According to this view, the degree of functionality of stress in the phonology of a given language has a direct relationship with its speakers stress-processing capabilities (Dupoux et al., 1997, 2001; Peperkamp et al., 2010). For example, speakers of Polish demonstrate more effective stress processing abilities than speakers of French, Hungarian and Finnish, but less effective capabilities when compared to Spanish speakers (Peperkamp et al., 2010). This is hypothesized to stem from the fact that the location of stress in lexical items is less predictable in Spanish than in Polish, while French, Hungarian and Finnish display no exceptions. This account suggests that speakers who have experience with a relatively unpredictable stress system are better at processing stress than speakers who are not familiar with either (1) stress as a
word-level phonological unit, or (2) the variable location of stress within a word. These processing differences are found at a phonological level at which it is speculated that listeners are required to encode speech information into their phonological memory (Dupoux et al., 1997, 2001; Peperkamp et al., 2010) and not necessarily at a more perceptual level where listeners perceive stress differences (Dupoux et al., 1997). However, whether English and Spanish speakers differ with regards to their abilities to process stress remains unknown.

In the case of late bilingualism, stress processing appears to remain relatively unaffected by proficiency in the target language in cases where learners’ first language lacks a stress system (Dupoux et al., 2008; Tremblay, 2009). Thus, when a learner does not have native experience with stress, learning to process stress in a second language becomes challenging. However, there is evidence of modest development of stress processing abilities in learners who use the target language on a daily basis (Tremblay, 2009). With regards to early bilinguals, previous research has found that contextual factors can have an effect on whether they process stress like speakers of one language or the other (Dupoux et al., 2010). Stress processing is influenced by the degree of exposure to one of the languages over the other. According to this finding, early bilinguals can behave like native speakers of only one of the languages.

1.2 Summary of Research Questions

The present study examines the stress processing abilities of three different populations: adult English speakers second language learners of Spanish, English-Spanish early bilinguals, and Spanish monolingual speakers. Specifically, the aim of the study is to uncover how speakers who have been exposed to English since infancy (either in bilingual or monolingual contexts) process
stress as compared to speakers who grew up exposed only to Spanish. More concretely, this study aims to answer the following research questions:

1. Do length and depth of experience with the Spanish language modulate participants’ likelihood to display robust stress encoding in their perceptual behavior?
2. Does a learner’s higher proficiency correlate with a higher likelihood of displaying robust patterns of stress encoding?
3. Do length and depth of experience with the Spanish language modulate participants’ perceptual discrimination abilities with regards to word-level stress?
4. Does a learner’s higher proficiency correlate with a higher accuracy in the perceptual discrimination of stress-based contrasts?

For the experiments in this dissertation, I probed early and late bilinguals as well as native speakers of Spanish with two discrimination experiments. All of the participants completed a questionnaire on their linguistic dominance and three Spanish proficiency tests. Their scores will serve to measure the impact of linguistic experience and proficiency on their stress processing abilities.

1.3 Organization of the Dissertation

The remainder of the dissertation is structured as follows. Chapter 2 provides an overview of the literature on the processing of stress from different perspectives. First, the effects of linguistic typology on listeners’ stress processing is discussed as well as the models that try to account for
this relationship. Second, the differences between English and Spanish with regards to the acoustic realization and the lexical distribution of stress is considered. Third, previous studies on the processing of second-language stress are examined, followed by the processing of stress by early bilinguals. The chapter ends with an overview of studies that look at the identification and perception of Spanish stress by early and late learners of Spanish.

Chapter 3 presents the three groups of participants that took part in this study (native speakers, early learners and late learners) as well as the proficiency and dominance tests used to gauge linguistic knowledge and experience.

Chapter 4 outlines the motivation for the first experiment and provides information about the methodology used, participant information, stimuli, procedure and analyses. The goal of Experiment 1 is to explore the phonological encoding of stress by the three different participant groups. This experiment addresses research questions 1 and 2. In order to answer these two questions the data were divided. First, the behavior of early bilinguals and the most proficient late learners is examined. Second, the potential effect of late learners’ linguistic experience and proficiency on their stress processing abilities is tested. The chapter ends with a discussion of the findings of Experiment 1.

Similarly, Chapter 5 describes the motivation and the methodology for Experiment 2. This experiment is concerned with the perceptual discrimination abilities of stress-based contrasts and addresses research questions 3 and 4. First, in order to answer research question 3, the results from the early bilinguals and the most proficient late learners is analyzed. Second, the effects of participants’ proficiency scores and year of study on perceptual discrimination are analyzed. The chapter concludes with a discussion and interpretation of the results.
Chapter 6 summarizes the findings on the phonological encoding of stress from Experiment 1, followed by the results regarding perceptual discrimination from Experiment 2. Finally, a discussion on the phonological encoding of stress is provided, followed by a conclusion.
2.1 Cross-linguistic Perception of Stress

It is commonly believed that, in order to recognize a word, listeners need to access its phonological structure (Kazanina, Bowers & Idsardi, 2018). This contains the necessary information to make this word unmistakably distinct from other non-homophone lexical items. In some languages, the phonological difference between two words can occur above the segmental structure. Thus, the information required to differentiate two words is not always limited to a sequence of segments as other non-segmental prosodic information may also be part of the phonological form of a given lexical item. These abstract units of representation can be realized and perceived as stressed syllables. Traditionally, stressed syllables have been described as being more “prominent” than unstressed syllables. This prominence allows stressed syllables to stand out from all other syllables in a word permitting the processing of this phonological component, thus, allowing access to a lexical item and inhibiting access to other lexical competitors. The efficient use of stress, for example, means that speakers are able to produce and perceive the difference between members of stress minimal pairs like TRUSty and trusTEE\(^1\). This abstract category is, however, not always exploited in the phonology of languages of the world.

Languages differ in whether they make a phonological use of stress and also the domain where this suprasegmental property applies. Stress as it concerns the present study applies at the lexical level. This means that, within a word, there is at least one syllable, the stressed one, that

\(^1\) Henceforth, I will use uppercase to indicate stressed syllables and lowercase letters to illustrate unstressed syllables, a convention used in early works on stress (Connine et al., 1987; Cutler, 1986; Cutler & Clifton, 1984).
is more prominent than others, the unstressed ones. The predictability of the location of stress in words can yield two different linguistic functions (Rietveld, 1980). In some languages, stress has a contrastive function. This is the case of free-stress languages in which stress may fall on any of the syllables within its lexical domain and its assignment is not totally predictable by rules. English and Spanish belong to this typological category. This does not mean, however, that the location of stress is completely free. While stress location is not predictable, languages typically present restrictions as to the position of stress within the word. For example, English and Spanish appear to be sensitive to a *three-syllable window* restriction (van der Hulst, 1999) that limits the syllables available to bear stress to the last three in each word. This holds true for all cases in Spanish where words do not contain clitics (*COme “eat COMMAND” – COmetelo “eat it COMMAND”*) and for underived words in English (*KNOWledge – KNOWledgeable*). In consequence, word stress in Spanish and English is also phonologically contrastive. This means that it is possible to have word pairs that differ exclusively in the syllable that carries the stress, e.g., *DIScount – disCOUNT* in English or *NUmero “number” – nuMEro “I number”* in Spanish. Thus, although the syllables in these word pairs have the same segmental structure, their acoustic realization is different. When listening to words, native speakers of both languages are able to discriminate stressed from unstressed syllables from the acoustic signal, and, thus, access the meaning intended by the speaker (Cutler, 1984; Ortega-Llebaria & Prieto, 2009).

Other languages present a predictable, fixed pattern of stress assignment. These are known as fixed-stress languages. In these languages, stress serves the linguistic function of demarcating a word’s edge. This is manifested in systematic stress assignment to a particular syllable position within its own lexical domain. This is the case of languages like Finnish,
Hungarian, and Polish (Peperkamp et al., 2010). For example, in Finnish and Hungarian stress is assigned at the lexical level and it is always found in the initial syllable of a word (Karlsson, 2013; Tompa, 1972). Polish also presents a predictable stress pattern where stress surfaces in the penultimate syllable for polysyllabic words and in monosyllabic content words (Comrie, 1976), with the exception of a few number of words that are mostly from Greek, Latin or foreign origin that show exceptional cases with antepenultimate or final stress (Peperkamp et al. 2010). Stress in these languages has a demarcative property and, unlike Spanish or English, these languages lack contrastive stress.

Contrary to what happens in languages that have phonological, lexical stress, there are languages in which the domain of prominence is not found in words but at the phrase level. This is the case of no-stress languages like French that lack lexical stress. In Standard French, stress is assigned at the phrasal level and it is found systematically in the final syllable of the phrase (Dell, 1984). In these languages, there is no possible lexical stress contrast of the type of CONvert and conVERT. Consequently, suprasegmental structure is not used by speakers of these languages to distinguish lexical items.

Cross-linguistic studies have focused on exploring how experience with the stress pattern of a given language influences listeners’ abilities to process this phonological unit. The overall finding is that speakers of languages that do not have lexical stress are challenged by stress processing. Meanwhile, speakers of languages that exploit stress lexically are able to process stress just as successfully or better than any other phonemic property (Dupoux et al. 1997; Dupoux et al. 2001). This language-specific challenge with stress processing is referred to in the literature as stress ‘deafness’. This phenomenon describes the difficulties that speakers of certain
languages have with retaining stress contrasts in working memory. If speakers of a language are said to be stress ‘deaf’, it does not mean that they lack the ability to perceive the difference between two words differing in stress. It means that, when performing highly cognitively demanding tasks, these speakers find it more difficult to recall the stress pattern of a word than its segmental structure.

This has been proven by testing listeners processing capabilities through psycholinguistic tasks that allow researchers to compare participants’ behavior with regards to stress and consonantal changes. This means that participants are tested in contrasts such as $BE_{dapi} - beD_{api}$ for stress, and $BE_{dapi} - NE_{dapi}$ for consonants. In these tasks, consonants are used as the control condition. Processing consonantal contrasts is hypothesized to be equally successful for speakers provided that these consonants are contrastive in their language. This makes consonants ideal candidates to use as controls to measure stress processing. Consonants represent a high processing ability for all listeners, regardless of their mother tongue. This comparison of stress vs consonant processing has allowed researchers to test stress processing abilities of languages that differ in the phonological relevance of stress. The language pair that has been explored the most is that of Spanish and French. This pair is interesting due to the fact that French has no stress at the word level while lexical stress is contrastive in Spanish and, therefore, it is crucial for word identity. Cross-linguistic studies have consistently shown that speakers of this language pair differ in their stress-processing abilities. Spanish speakers’ processing of stress contrasts is comparable or more successful (depending on the task used) than that of consonants. French speakers consistently perform worse with stress contrasts than with consonant contrasts. This is interpreted as a sign of stress ‘deafness’ on the part of French speakers. They appear to be
unsuccessful at processing stress contrasts at the level of consonant contrasts while speakers of Spanish do not present this difficulty.

It is important to mention that this stress ‘deafness’ effect only appears in cognitively demanding tasks. Higher cognitive load has been associated with ABX and Sequence Recall tasks in comparison to much easier AX tasks (Dupoux et al., 1997), and with increased phonetic variability (Tremblay, 2009). In a simple AX discrimination experiment, Dupoux et al. (1997) found that French speakers were not challenged by stress contrasts. For this task, participants were asked to indicate whether the two items they hear are the same or different. In this case, French speakers were able to identify changes in stress patterns as successfully as they were with consonant changes. Meanwhile, their performance in an ABX task revealed stress processing difficulties only for the stress contrasts. In this task, participants were asked to determine whether the third word they heard was identical to the first or to the second word, which appears to be a more challenging exercise than comparing two items (Tremblay, 2009). This has important implications for how we understand the concept of stress ‘deafness’. Results from Dupoux et al. (1997) demonstrate that French speakers do not present a perceptual deficit but rather a representational one. A perceptual deficit would mean that French speakers are not sensitive to the acoustic correlates of lexical stress. Their performance in a simple AX task with low phonetic variability posed no challenge for French speakers, which indicates that they are able to perceive the low-level acoustic cues used to encode stress and use this information to make decisions on the identity of word forms. A representational deficit means that, even though they are able to use stress as a phonological unit perceptually, it is at higher levels of processing when this abstract representation of stress becomes less available for them. In other words, they
are able to activate a mental representation of stress, but this representation is less robust than that of consonants. Thus, speakers of French are able to access consonantal information in their phonological buffer more successfully than they are able to recall stress information. This, however, is not the case of speakers of Spanish, who appear to have a stronger representation of stress that is more or just as accessible as that of consonants in high cognitively demanding tasks. Hereafter, I will refer to this phonological activation of abstract units in memory as ‘phonological encoding’.

Further cross-linguistic examination has also provided evidence that stress ‘deafness’ is not a binary construct. French and Spanish do not represent the only two typologically possible degrees of ‘deafness’. The successful encoding of stress in phonological memory appears to be a gradient phenomenon. This means that there are speakers of other languages that are more stress ‘deaf’ than speakers of French, but less than speakers of Spanish. For example, Peperkamp et al. (2010) tested the phonological encoding of stress in speakers of French, Finnish, Hungarian, Polish and Spanish. This linguistic sample is interesting because: French has no lexical stress, in Finnish and Hungarian the location of stress is predictable, Polish has a predictable main stress pattern with a few lexical exceptions, and Spanish also has a predictable main stress pattern but it has a large number of exceptions. The results show (1) that speakers of languages with predictable stress (Finnish, Hungarian) and speakers languages with no lexical stress (French) display a comparable degree of stress ‘deafness’; (2) that language-specific phonological distribution regularities involving stress patterns could be used to predict the degree of ‘deafness’ of speakers. According to this latter lexical statistics account, the predictability of the location of stress is in a language (i.e., the number of lexical exceptions to the main stress pattern) correlates
with the robustness of its speakers’ stress-encoding. Speakers of Polish—a language with 0.1% of lexical exceptions—appear to be less stress ‘deaf’ than speakers of French, Finnish and Hungarian—languages with no lexical exceptions—but more stress ‘deaf’ than speakers of Spanish—a language in which exceptions account for 20% of lexical items (Toro-Soto and Rodríguez-Fornells, 2007).

An earlier model to the lexical statistics account put forth by Peperkamp & Dupoux (2002) was known as the stress parameter model. This model stated that exposure to a particular stress pattern during infancy impacts the development of the processing system. In this way, infants decide during the first two years of life and based on a limited amount of information, whether stress is contrastive or not in their language and, consequently, whether or not it should be encoded in the phonological representation. However, this stress parameter model was suited to explain the results of Peperkamp & Dupoux (2002) but not those of Peperkamp et al. (2010). The fact that the first study used different methodologies to test stress ‘deafness’ in the five languages (French, Finnish and Spanish speakers were tested with different stimuli than speakers of Hungarian and Polish) caused their results to be different to those of Peperkamp et al. (2010). Peperkamp & Dupoux (2002) found that speakers of French and Finnish had a similar high degree of stress ‘deafness’, Spanish and Polish groups showed a very low degree of stress ‘deafness’ and no difference was found between the two, and Hungarian was found to be in an intermediate state. This led the authors to posit two possible explanations. First, that the stress parameter may binary (speakers can either encode or not encode stress) but the results from the Hungarian group may be due to individual differences (some set the parameters and others did not). Second, that the stress parameter may not be binary but rather gradient. This latter
explanation seems like the most plausible one as demonstrated by Peperkamp et al. (2010) who used the same methodology to test speakers of all five languages.

Overall, findings from cross-linguistic studies suggest a straightforward generalization: speakers of languages with fixed-stress or no stress systems appear to lack a robust phonological category for stress and, thus, display more processing difficulties than speakers of languages in which stress is not totally predictable. The degree of predictability of the stressed syllable would, then, modulate speakers’ stress-processing abilities. This fact may come as intuitive. Speakers with experience with predictable stress placement or the lack of a lexical stress system would not need to pay attention to stress patterns since it is not relevant to word identity. Thus, after exposure to the language, speakers of fixed-stress or no stress languages learn to ignore stress, which prevents the formation of a robust abstract representation of this phonological unit. Meanwhile, speakers of languages in which the exploitation of stress is necessary in order to distinguish between words or to parse the speech stream into words, are exposed to linguistic patterns that compel them to strengthen their phonological representation of stress in order to better process input in their native language.

2.2 Stress in Spanish and English

From a typological perspective, Spanish and English are grouped together as free stress languages. This means that the location of stress in both languages is not totally predictable by rules. Stress may occur in a random position within the word and, thus, stress must be lexically listed. However, Spanish and English differ with regards to (1) the acoustic cues used to produce
and perceive stress, and (2) their distribution of lexical stress. In what follows, I will present a review of the acoustics of Spanish and English stress, followed by the lexical distribution of stress in both languages.

2.2.1 The Phonetics of Spanish and English Stress

Early descriptions of the acoustic substance that signals word stress in Spanish directed their attention toward intensity. Navarro Tomás (1914) claimed that stressed syllables present an increase in loudness or intensity, describing Spanish stress as “intensity stress”. With time, the development of instruments that provide objective measurements of speech phenomena allowed researchers to acoustically analyze the cues of stress. Early studies (Enríquez et al., 1989; Quilis, 1971; Llisterri et al., 2003) distinguished between two levels of syllabic prominence: stressed and unstressed syllables. This means that the acoustic evidence for the cues that make up word stress up to that point came from instances where stress covaried with accent, the intonation pattern found in sentences. This means that stressed syllables in these studies were also accented and unstressed syllables were unaccented. As a result, the cues found to be correlates of stress in these studies could not be distinguished from those of accent. This confound poses a problem since stress and pitch accent, albeit interrelated phenomena, are two distinct linguistic dimensions. Stress pertains to the degree of prominence within a word while pitch is used by speakers to place focus on words in a sentence that is determined by the communicative situation (Eady & Cooper, 1986). Spanish is especially problematic in this respect since stressed syllables do not always align with the F0 peak. For example, Estebas-Vilaplana (2007) found that pre-nuclear F0 peaks are located after the offset of the accented syllable in Spanish, and the
location of the peak is affected by the distance in syllables to the end of the word. Therefore, stressed syllables are aligned with a F0 peak in nuclear position and signaled by a F0 valley in pre-nuclear position. This variation in the signaling of stressed syllables in accented contexts make it necessary to consider a third level of syllabic prominence: accented syllables.

A series of studies conducted by Ortega-Llebaria and colleagues were among the first to control for stress-accent covariation in Spanish in order to disentangle stress from accent. For instance, Ortega-Llebaria & Prieto (2007) conducted an acoustic analysis of syllables in verb forms differing in stress (deterMino “I determine” – determiNO “s/he determined”) when produced in declarative and parenthetical contexts. The latter context is naturally produced with a flat F0 intonation, which yields a flat F0 contour and, consequently, unaccented stressed syllables. The authors found that pitch was affected by context: there was an increase of F0 in the accented context but its value varied minimally between stressed and unstressed syllables in the unaccented context. The conclusions reached in this study is that pitch is an acoustic correlate of accent. Meanwhile duration, vowel quality (reduction of [o] but not [i]) and spectral tilt were cues correlated with word stress.

In a follow-up perceptual study, Ortega-Llebaria & Prieto (2009) investigated (1) whether stress can be detected in the absence of pitch-accent and vowel reduction in Spanish, and (2) which of the remaining cues are used by native speakers to perceive word stress. The results showed that, even in unaccented contexts, Spanish listeners were able to perceive a stress contrast between two syllables based on duration and overall intensity, but not spectral tilt. The authors found that duration and overall intensity act in an enhancing relationship rather than in a competing relationship, and that a heavier reliance on one cue or the other is conditioned by
vowel type. For instance, when perceiving stress in syllables containing the vowel [a], listeners were found to rely only on duration to predict stress when intensity is neutralized. For vowel [i], however, subjects relied on intensity and not on duration. Acoustic analyses of stress on vowels [a] and [i] found a similar pattern in production, where duration differences for [i] in stressed and unstressed contexts are more reduced than those of [a] (Ortega-Llebaria & Prieto, 2011). Hence, the authors claim that speakers’ deep knowledge of production patterns is reflected in their perceptual behavior since the acoustic characteristics of each of the vowels in different stress contexts appear to shape the way speakers develop reliance on one cue or another to perceive stress. Also, it seems that there are no fixed cues to stress across all vowels in Spanish, but rather context-sensitive phonetic detail that depends on experience with the language.

With regards to vowel quality changes, Spanish does not have stress-governed vowel reduction (Hualde, 2005). Consequently, Spanish speakers are expected to maintain vowel quality regardless of whether they appear in stressed or unstressed contexts. Nonetheless, some studies (Ortega-Llebaria & Prieto, 2007) did find a statistically significant F1-F2 difference (of less than one Bark) for vowel [o] in the expected direction of the reduction, while others (Ortega-Llebaria & Prieto, 2011) did not find this difference in the same vowel context. Spanish listeners appear to be sensitive to small differences in the phonetic cues used for stress in different vowels. Thus, we could anticipate that the discontinuous presence of vowel quality changes in the speech signal could lead to the unreliability of vowel quality as a cue for word stress. Nonetheless, its effects have not been tested in stress perception studies in Spanish.

In contrast to Spanish, the acoustic inquiry on English stress began much earlier. Already in the 50s, Fry (1955, 1958) explored the cues used to perceive stress by manipulating duration,
intensity and frequency parameters. Results from Fry’s studies revealed (1) that F0 changes had an overriding effect on the identification of stress in words and (2) that duration ratio is a more effective cue than intensity. These conclusions were also reached by subsequent investigations (Beckman, 1986; Bolinger, 1958; Morton & Jassem, 1965). However, these pioneering studies failed to examine stress independently from pitch accent. Thus, their results correspond to the comparison of accented stressed syllables with unaccented unstressed syllables. In view of this, Sluijter & van Heuven (1996) carried out an acoustic analysis of minimal stress pairs produced in sentences with and without focal accent in order to observe the hierarchy of cues to stress in contexts where the effects of pitch were controlled for. They discovered, on the one hand, that duration, spectral tilt, and vowel quality are respectively the first, second and third best cues of stress in the absence of pitch. Accent, on the other hand, was related to F0 and overall intensity changes.

Other authors have found fairly similar results but have come to different conclusions. Beckman and colleagues claim that duration and intensity cues are inherent elements of vowel quality change, which, in turn, acts as primary cue to stress. The first piece of evidence comes from Beckman & Edwards (1994) who examined the duration differences (among other cues) between /a/ when produced as an accented stressed (full) vowel, /a/ when produced in an unaccented, stressed context, and the reduced vowel schwa in unaccented, unstressed contexts. The differences between full and reduced vowels were larger and more consistent than those found between accented and unaccented ones. Thus, full vowels were associated with longer duration rates than reduced vowels. In a follow-up study, Campbell & Beckman (1997) looked at intensity and duration cues to stress in accent-controlled contexts in vowels [æ], [i], and [u]. The
results showed variability across different unaccented contexts on the use of duration, proving that duration has insufficient or no cue-value to identify stress. These findings support the claim that the stress contrast in English is phonologically marked by vowel quality. Thus, the duration and intensity effects that are apparent in the acoustic analyses represent articulatory consequences of vowels. For example, the full vowel \([a]\) requires a “more open vocal tract, and hence a lower jaw and larger lip displacement in going into the vowel” than its reduced counterpart (Beckman & Edwards, 1994).

Further perceptual studies have corroborated the decisive role of vowel quality in relation to other stress cues (Chrabażycz et al., 2014; Howell, 1993; Zhang & Francis, 2010). For example, Chrabażycz et al. (2014) carried out a forced-choice auditory identification task where listeners were asked to identify the location of stress in the disyllabic nonword ‘maba’ that was manipulated in pitch, duration, intensity and vowel quality. The results of the analysis show that vowel quality had a more stable connection with the identification of stress in English native speakers followed by pitch, intensity and duration. The authors argue that the fact that vowel quality is not subject to relative changes across the word may help explain these results. A schwa, regardless of the environment, indicates that a syllable is unstressed while pitch, duration and intensity values are always relative to the values of the surrounding context.

Overall, experimental research reveals a trading relationship when examining the interaction between pitch accent and the cues to word stress (Ortega-Llebaria et al., 2013). In sentences where a word carries accent (such as those with declarative intonation), pitch plays a crucial role to identify stress. Meanwhile, when processing stress in words produced in sentences with flat F0, speakers rely on other cues that are associated with lexical stress alone. Production
and perception analyses on lexical stress that differentiate between stressed and accented syllables show that there seems to be no unitary hierarchy of cues to stress across languages, but rather language-specific patterns. These patterns may differ in the number of acoustic cues as well as in the way these are used to identify stressed syllables from unstressed ones. Thus, listeners may be simultaneously exposed to multiple acoustic cues, but these cues are weighted with regards to their relevance to unravel a linguistic contrast. Consequently, listeners rely heavily on more relevant cues than on less relevant ones. This reliance on some cues over others appears to be determined by knowledge of production patterns since listeners’ perceptual behavior seems to be shaped by the acoustic characteristics of stress in different contexts. In order to successfully perceive the stressed syllable in Spanish, listeners must pay attention to different acoustic cues depending on the vowels present in the speech signal: duration for vowel [a] and intensity for vowel [i]. English stress, on the other hand, is perceived by native speakers by paying more attention to the acoustic difference between reduced and full vowels than to other suprasegmental cues.

2.2.2 Lexical Distribution of Stress in Spanish and English

Stress in both Spanish and English is generally limited to the last three syllables of a word (van der Hulst, 1999) and the location of stress within this three-syllable window appears to be flexible in both languages. However, a closer look at the lexical distribution of stress reveals cross-linguistic differences in the predictability of stress location.

In Spanish, the most common stress pattern is for stress to fall on the penultimate syllable when the word ends in a vowel (arTIsTa “artist”) and on the last syllable if the word ends in a
consonant (*paRED* “wall”). This overall stress pattern applies to 83% of the lexical items in the Spanish database of Santiago, Justicia, Palma, Huertas & Gutiérrez (1996). Other patterns occur less frequently. Hualde (2005) indicates that there is a marked pattern that includes penultimate stress in words that end in consonants (*Útil* “useful”) and antepenultimate stress in words that end in a vowel (*simPÁtico* “nice”), and an exceptional pattern of consonant-final words with antepenultimate stress (*REgimen* “regime, diet”) and vowel-final words with final stress (*jabalÍ* “boar”). Overall, in Spanish, penultimate stress is predominant as in 75% to 80% of words are stressed in the second-to-last syllable syllable (Toro-Soto and Rodriguez-Fornells, 2007). In this language, disyllabic forms are the most frequent word type, and 60% of these follow a trochaic stress pattern (Pons & Bosch, 2010). Furthermore, 70% of trisyllabic words also have penultimate stress as found on the LEXESP database (Sebastián-Gallés, Martí, Carreiras & Cuetos, 2000; Pons & Bosch, 2010). These descriptive data suggest that there are tendencies to Spanish stress assignment, yet it is not fully predictable.

In addition, stress is fully contrastive in Spanish verbal paradigms. For example, the conjugated verb forms /ˈkante/ “I sing-SUBJ” and /kanˈte/ “I sang-PAST”, or /koˈsino/ “I cook-PRES” and /kosiˈno/ “s/he cooked-PAST” differ (at the phonological level) exclusively in the location of stress, which leads to changes in terms of verb tense and/or person. Stress in Spanish verbal environments can be morphologically predictable (Oltra-Massuet & Arregi, 2005). However this prediction depends on morphemic structure, which is arguably not surface transparent but rather opaque. Nevertheless, it appears that stress in Spanish besides being unpredictable, is also highly productive in the verbal paradigm and, thus, stress minimal pairs are abundant in the Spanish lexicon.
In contrast to Spanish stress, English stress displays a strong tendency to appear in word-initial position regardless of word length (Cutler & Carter, 1987; Guion, Harada & Clark, 2004; Pons & Bosch, 2010; Suárez & Goh, 2013). Cutler & Carter (1987) found that 90% of the word items in the London-Lund Corpus of English Conversations (Svartvik & Quirk, 1980) had stressed initial syllables. Similarly to Spanish, the most common word structure in English is a disyllabic trochaic word. A total of 94% of the English disyllabic words possess initial stress (Suárez & Goh, 2013). These data suggest that syllable-initial stress is highly consistent in the English lexicon.

When it comes to stress minimal pairs, these usually involve a change in word class in such a way that stress can be used to determine whether a word is a noun or not (Romanelli et al., 2015) as exemplified by CONtent/conTENT (noun-adjective) or PERfect/perFECT (noun-verb). However, English words with opposing stress-pattern syllables may not differ exclusively on suprasegmental, prosodic dimensions. They also tend to differ vocalically. Thus, word pairs such as CONtent and conTENT, in addition to suprasegmental changes, have also a different segmental structure. Only a handful of word pairs are considered “true” stress minimal pairs in English (Cutler, 1986). This means that word pairs in which both members differ exclusively at a suprasegmental level are very limited. For example, the words FOREbear and forBEAR share the same segmental structure and differ exclusively on stress. These word pairs are rare in the English lexicon and are treated as homophones by English native speakers in cross-modal priming tasks (Cutler, 1986).

It appears that Spanish and English are similar in that, for both languages, the most common word structure is a disyllabic trochaic form. This can be observed in cognate words
such as radio, foto/photo and poni/pony which are pronounced with penultimate stress in both languages. However, this similarity appears to stem from two different facts about the lexical distribution of stress in both languages. In English, initial syllables tend to be stressed (90%) while for Spanish, penultimate stress is the most common pattern (80%). In addition, both English and Spanish present differences when it comes to the number of lexical contrasts. While both languages possess a relatively limited number of stress minimal pairs involving nouns (even considering the minimal pairs in English that differ segmentally), stress is highly contrastive in the Spanish verbal paradigm but not in English. This suggests that stress is more widely used in Spanish to indicate grammatical information when compared to English. In conclusion, stress appears to be more predictable in English when compared to Spanish and stress is more productive in Spanish than in English when it comes to marking differences between words.

2.2.3 Stress Processing

As a stress language, English has words that differ exclusively in stress. Despite this fact, word pairs such as FOREbear and forBEAR are rare (Cutler, 1986; Warner & Cutler, 2017). Words that differ at the suprasegmental level are usually realized with different vowels following a pattern that relies on phonological vowel reduction. Warner & Cutler (2017) mention two generalization in terms of this stress patterning. First, reduced vowels cannot bear stress, and second, all stressed syllables must contain a full vowel. This vowel reduction pattern is widespread in English, yielding a solid cue to word identity.

This reliability of vowel reduction patterns to distinguish words together with the lack of a sizable number of “true” stress minimal pairs (that is, word pairs that contrasts solely in stress),
appears to be behind the fact that English listeners fail to make use of suprasegmental information in lexical access. In other words, exposure to English does not provide sufficient opportunities for speakers to rely on suprasegmental information during word processing. This may be illustrated by the fact that empirical research revealed that English speakers treat stress minimal pairs as homophones (Cutler, 1986), and that mistressing a word without altering vowel quality had little adverse effects in how fast a word was recognized by the same population (Cutler & Clifton, 1984). For example, Small et al. (1988) found that word recognition was not inhibited if the misstressing of a word resulted in an existing lexical entry (INsert-inSERT). If the change in stress location resulted in a nonword (COmet-coMET), recognition was significantly inhibited.

This does not mean, however, that English speakers completely disregard stress when processing language. Stress is used in speech segmentation (Cutler & Butterfield, 1992) by native speakers of English. The relative regularity in the location of stress in the first syllable of a word leads English native speakers to treat stressed syllables as probable word onsets. Thus, English speakers do make use of stress in their speech processing routine. Only, it is not exploited in order to access words in the lexicon.

Meanwhile, Spanish speakers have been shown to make use of stress both in phonological processing (Dupoux et al., 1997; 2001; 2008; 2010; Peperkamp and Dupoux, 2002) and in lexical retrieval routines (Soto-Faraco et al., 2001). Soto-Faraco at colleagues found that the prime PRINci yielded a priming effect for the lexical item PRINcipe but an inhibitory effect for the word prinCIpio. Overall, Spanish words preceded by mismatching primes (those with a reverse stress pattern) took overall longer than those preceded by matching primes and unrelated
primes. This means that the word PRINCipe took longer to be accepted as a lexical item when preceded by prinCI than when preceded by mosQUI (an unrelated prime). Despite the similarity at the segmental level, the difference in the location of stress had adverse effects in recognition speed. These results suggest that, unlike in English, stress has a strong constraining effect on lexical access in Spanish.

2.3 L2 Stress Processing

A central assumption in L2 speech research is the influence of one’s native phonological system when learning new sounds. In light of this interaction of listeners’ languages, three main models that seek to predict degrees of success in cross-linguistic perception have been used in L2 literature: the Perceptual Assimilation Model (PAM; Best, 1995) and its application to L2 learning (PAM-L2; Best & Tyler 2007), the Speech Learning Model (SLM; Flege, 1995) and the Second Language Perception Model (L2LP; Escudero, 2005; van Leussen & Escudero, 2015).

Unlike PAM-L2 and SLM, the L2LP model takes into account different levels of representation that underlie L2 perception and learning. Figure 2.1 shows an outline of the four levels and the connections between them as found in (van Leussen & Escudero, 2015). This models aims to differentiate between pre-lexical and lexical stages of speech perception. The acoustic forms that are addressed at lower levels of representation are connected to the higher speech units by means of processing stages. At the bottom, we can find the acoustic level where speech sounds arrive into the peripheral auditory system. At this stage, listeners are able to obtain the fine phonetic detail that is in the speech signal that corresponds to a given phonological unit. The following phonetic level encodes speakers’ representation of the acoustic
information of sounds, including context-specific allophonic detail. At this stage, listeners use their linguistic experience in order to make sense of the cues perceived in the speech signal and map them to a phonological item. This level is connected to the phonemic level where the canonical forms of the phonological units are stored. Here, listeners encode phonological units in their phonological memory. They activate the abstract representation of sounds in memory that they can access after the low-level acoustic information is gone. Finally, the phonemic forms connect with possible meanings at the lexical level. Listeners make use of their phonological representation of word forms in order to conduct lexical searches (van Leussen & Escudero, 2015).

One of the advantages of this model is that in accounts for the full process of speech processing. This model allows us to locate at which level of representation speakers who are stress ‘deaf’ may present encoding difficulties, and, thus, where English L2 learners of Spanish may have difficulties with stress processing. First, the differences in the phonetic properties of stress in English and Spanish would predict difficulties at the level of ‘phonetic form’, where cue information is mapped to the low-level representation of stress. In this case, English speakers would have to be able to perceive the suprasegmental cues to stress available in Spanish speech in order to successfully process stress at higher stages. Second, at the phonemic level, learners would need to activate their abstract representation of stress in their phonological buffer. Regarding this level, there is no empirical evidence that English and Spanish speakers differ with regards to the level of stress ‘deafness’ or phonological encoding. In fact, English has not been the subject of ‘deafness’ studies, but rather, it has been used as a control group to measure other populations’ stress-encoding. However, some studies that used English speakers as the control
group found evidence that this population is challenged by stress-encoding (Lin et al., 2013; Qin et al., 2017). The Stress Parameter Model (Peperkamp & Dupoux, 2002) predicts that speakers of both languages should have comparable performance in phonological encoding. According to this model, native speakers of English and Spanish would have been exposed to the stress-assignment irregularities of their respective languages, which would have led them to activate the stress parameter. Meanwhile, the Lexical Statistics Account (Peperkamp & al., 2010) anticipates differences between both languages since Spanish has a higher number of lexical exceptions for the default stress pattern than English. This means that the lower number of lexical exceptions would have led English speakers to develop a fuzzier representation of stress in phonological memory, while Spanish speakers experience with a more unpredictable stress pattern would have caused them to produce a more robust category.

Figure 2.1: Adapted from van Leussen & Escudero’s (2015) Second Language Perception Model.
Although English speakers’ stress-encoding has not been tested in direct comparison with that of speakers of Spanish, some studies have examined how L2 English learners of different linguistic backgrounds process English stress (Altman, 2006; Lin, Wang, Idsardi & Xu, 2014; Qin, Chien & Tremblay, 2017; Tremblay, 2009). These studies aim to explore the effects of the native language in the processing of L2 stress. Some addressed this question by testing learners at an advanced/intermediate stage of their target language studies (Altman, 2006; Lin et al., 2014; Qin et al., 2017), while others look at different levels of L2 proficiency in order to explore whether learners undergo a learning process (Tremblay, 2009).

For example, Qin et al. (2017) explored whether Standard Mandarin (SM) and Taiwan Mandarin (TM) L2 speakers of English were affected by their native use of suprasegmental information when encoding English stress through a Sequence Recall task. SM is different from TM in that only speakers of the first language make use of duration in order to perceive syllabic prominence. In light of this difference, the authors aimed at elucidating whether TM speakers were able to successfully encode English stress when it was instantiated by the suprasegmental cues F0 and duration in absence of reduction patterns (/f\ñði/—/f\ñði/). In other words, they tested whether SM and TM advanced L2 speakers of English were able to use pitch and duration in order to detect stress. The prediction was that native linguistic experience with duration as a lexical cue would make SM speakers better at detecting stress than TM speakers when the stress contrast was based on non-segmental information. Their results show that when F0 and duration or F0 alone were available in the speech signal, both groups behaved comparably. They encoded stress to the same degree. However, when duration was the only cue available to perceive stress
differences, TM speakers were found to have more difficulties than SM speakers. Thus, native experience with vowel duration facilitated English stress recognition for SM speakers. This provides an example on the important association between the perception of acoustic cues available in the speech signal and stress-encoding. Thus, it is important to explore how language-specific acoustic patterns of a first language impact the low-level perceptual abilities of learners.

This study did not offer an analysis that could be used to answer the question of whether speakers of English are stress ‘deaf’. The results appear to suggest that English speakers were better at encoding consonants than at encoding stress contrasts. It appears that recalling sequences that involved consonant changes was more likely to lead to accuracy than recalling sequences with stress changes. However, this difference was not addressed in the study and the lack of a direct comparison between consonant and stress conditions does not allow us to come to any conclusion. One study that did report the behavior of English speakers’ with regards to stress and consonant encoding is Lin et al. (2014). In this study, they tested the phonological encoding of stress by English native speakers and Beijing Mandarin and Korean learners of English through a Sequence Recall task. Mandarin and Korean are two typologically different languages in that stress is lexically contrastive in Mandarin and not in Korean. This means that Mandarin speakers had native experience with processing stress from infancy while the Korean group did not. The results show that the only language group that showed not difference between the consonant and the stress conditions in the Sequence Recall was Mandarin. The English and Korean groups on the other hand were less successful at processing stress contrasts than consonant contrasts. This was expected from Korean speakers since, similarly to French
speakers, their lack of experience with stress contrasts in their native language may have led them to pay less attention to stress contrasts and, consequently, their mental representation of stress may be less robust. Regarding English speakers’ difficulty with encoding stress in their native language, the authors attributed this effect to lack of vowel reduction cues in the stress minimal pair used in this study /'mipə/—/miˈpa/. According to this explanation, the lack of segmental cues to stress may have caused English speakers to not fully perceive stress changes, which may have impacted their stress-encoding at higher levels of processing. However, it is important to note that suprasegmental changes are also part of the realization of English stress and English speakers are able to exploit suprasegmental information in order to perceive stress (Chrabaszcz et al., 2014; Qin et al., 2017). Basically, this suggests that speakers of English may display some degree of stress ‘deafness’ when segmental cues to stress are not available in the speech signal.

Another central question in L2 stress studies is that of the development of processing abilities. Some studies have focused on exploring whether language learners are able to learn to process stress by developing stronger phonological categories. In order to do so, they tested L2 learners at different stages of acquisition in order to compare their processing behavior. This is the case of studies such as Dupoux et al. (2008) and Tremblay (2009). Dupoux et al. (2008) tested French native speakers L2 learners of Spanish at a beginning, intermediate and advanced stages of L2 learning. Their main research question addressed whether the effects observed in previous stress ‘deafness’ studies were due to metalinguistic awareness. In light of this, they hypothesize that, if stress ‘deafness’ is related at some level to speakers’ metalinguistic skills, advanced L2 learners would process stress better than beginners since they would have
experience with the linguistic pertinence of stress in the Spanish language. The results from a Sequence Recall task indicate that learners do not get better at encoding stress as their proficiency increases. Even the advanced L2 learners did not perform better than naive French speakers. French speakers’ representation of stress remained constant despite being exposed to a language where the role of stress is critical for word identity. This provides evidence (1) that phonological stress ‘deafness’ is not related to speakers’ metalinguistic skills, and (2) that, even with extensive exposure and increased practice in the second language, it is difficult to strengthen the mental category of stress in phonological memory if a second language is learned later in life.

Similarly, Tremblay (2009) tested intermediate, low advanced and high advanced L2 learners of English whose L1 was French and a group of English natives as control group on their encoding of stress through an AXB task. When tested on phonetically variable stimuli in a task that, hypothetically, asked them to rely on their mental representation of stress, French native speakers produced more errors in the stress condition than in the consonant condition. English speakers were not challenged by stress contrasts. This means that they were equally accurate when retrieving consonant and stress information. Meanwhile, French speakers were able to retrieve consonant information in a more efficient manner than stress information. This study provides further evidence that French speakers’ phonological representation of stress is weaker than that of English speakers. Interestingly, daily use of the target language was a significant predictor of learner performance. Learners who used the L2 more often were found to have increased performance with regards to stress processing. Individual proficiency did not
yield any effect in the encoding of stress. Therefore, language use, but not proficiency, appears to be related to the strengthening of stress categories in L2 acquisition.

Tremblay (2009) found no evidence of phonological stress ‘deafness’ in English speakers. They displayed no difficulties in processing stress changes in the AXB task. It is worth mentioning that the stress contrasts in this study were signaled through suprasegmental information only as in ['bʊ.fn]-[bʊ.'fn]. Thus, English speakers were not challenged when asked to make decisions on words differing in stress location even when this difference included suprasegmental changes exclusively. These findings differ from other studies. Lin et al. (2014) found that native English listeners performed worse in the stress condition under identical circumstances. The difference between both studies lies in the experimental method used. Tremblay tested their participants through an AXB task while Lin et al. used a Sequence Recall task. Both tasks differ on the degree of cognitive load they impose on participants. The AXB task has been found to be less cognitively demanding than other tasks such as the ABX (Beddor & Gottfried, 1995). The Sequence Recall task has proven to be successful at unveiling stress processing difficulties as it requires participants to encode stress in working memory. It seems, then, that English speakers’ stress ‘deafness’ surfaces only when tested using tasks in which the cognitive load is significantly high. This could indicate that their phonological representation of stress is more robust than that of French speakers, but less so than that of Spanish speakers. In other words, English speakers may be less stress ‘deaf’ than French speakers, but more than Spanish speakers.
2.4 Bilingual Stress Processing

Compared to L2 stress processing, the effects of early bilingualism on stress encoding remain relatively unexplored. The overarching question on bilingual stress-encoding aims to unveil the effects of early exposure to two typologically different languages on the stress processing abilities of speakers. This question has been addressed by Dupoux et al. (2010) who looked at French-Spanish bilinguals. They tested three groups of speakers for their study: Spanish monolinguals, early French-Spanish bilinguals, and a group of French native speakers advanced late learners of Spanish. Participants completed two Sequence Recall tasks. At first, bilinguals displayed intermediate stress-processing abilities between Spanish natives and L2 learners of Spanish. This means that, as a group, bilinguals were more successful at encoding stress information than L2 learners, but less so than Spanish monolinguals. Upon closer examination, the authors find a bimodal distribution that corresponds to the behavior of the native and the L2 groups. This distribution correlated with early language exposure (country of residence between the ages of 0-2, 2-4 could significantly predict belonging to one group or another). It seems, then, that bilinguals who were raised in a Spanish-speaking context during infancy encoded stress in a Spanish-native-like manner. Meanwhile, bilinguals who were raised in a French-speaking context during infancy demonstrated stress processing abilities that were comparable to those of French native speakers. These results indicate that early exposure to one of the languages may be decisive in the development of language-specific stress-processing abilities. They also favor the interpretation that bilinguals can only process one language in a native-like manner. In this case,
early exposure to Spanish for bilinguals who were raised in French-speaking contexts did not impact their development of a strong phonological category for stress.

2.5 The Processing of Spanish Stress by English L2 Learners

A number of studies on L2 Spanish phonology have focused on Spanish stress to test English speakers’ processing abilities (Beaudrie, 2007; Kim, 2015, 2016; Ortega-Llebaria et al., 2013; Romanelli & Menegotto, 2015; Romanelli, Menegotto & Smyth, 2015a, 2015b; Saalfeld, 2012). However, these studies have not used tasks designed to test learners’ stress ‘deafness’. On the one hand, studies looking at the cue-weighting of Spanish stress by native speakers of English find that learners differ from native speakers when it comes to using suprasegmental cues to stress. On the other hand, research looking at the perception of stress without investigating learners’ cue-weighting has consistently showed that (1) stress identification is problematic in L2 contexts and that (2) identification of stress improves with exposure to the language and specific training.

The effects of cross-linguistic differences in the fine phonetic detail on the perception of stress have received little attention in the field of Spanish phonetics. The question from this perspective is whether English speakers can learn to rely on the cues Spanish speakers use to perceive and produce stress when pitch and vowel reduction are not available. In order to address this question, Ortega-Llebaria et al. (2013) conducted an identification experiment with native speakers (NS) and non-native speakers advanced learners of Spanish (NNS) where cues to stress were manipulated. They created two sets of 25 tokens from the modification of the [‘mama] – [ma’ma] contrast (both words meaning mother in Spanish). The first set resulted from crossing a
5-step duration with a 5-step pitch continua for declarative intonation and the second set was obtained from a 5-step duration with a 5-step intensity continua for flat pitch intonation. The tokens from the first set were inserted in the declarative sentence *Saluda mama contenta* ‘Mom greets happily’ and the tokens from the second set were inserted in the reporting clause *¡Hola!–saluda mama contenta* ‘Hi– greets mom happily’. Participants were instructed to determine whether the word they heard was [‘mama] or [ma’ma]. In the accented context, NNSs showed reliance on both acoustic cues: F0 and duration. They even relied on duration more strongly than native speakers did. In the unaccented context, NSs used duration to identify stress while NNSs presented difficulty perceiving stress and did not use duration or intensity cues in a consistent manner. That is, NNSs successfully perceived duration differences in declarative sentences but failed to perceive them with a flat F0 contour. Given that the co-variation of duration with F0 movement in declarative sentences is critical to interpret accent (Beckman & Edwards, 1994), the authors hypothesize that this difficulty may stem either from the absence of accent or from the differences in vowel duration ratios in English and Spanish. In both languages, stressed vowels display longer durations than unstressed ones, but their ratios differ across language with 1:6 in English and 1:3 in Spanish, meaning that stress effects on duration in English are consistently larger than those found in Spanish (Delattre, 1966). The stimuli used by Ortega-Llebaria et al. (2013) presented larger duration differences between stressed and unstressed syllables in the accented context (28 ms) than in its unaccented counterpart (21 ms). This smaller difference may have caused NNSs to fail in the perception of the duration cue. Consequently, the results of this study may derive from either learners’ inability to perceive smaller differences in duration (like those found in unaccented contexts), or from learners
associating the duration cue only with accent and not with stress. Still, these results indicate that learners are able to develop reliance on duration as a main cue to stress in declarative contexts. Thus, the fact that they can successfully use suprasegmental information in order to perceive stress contrasts indicates that their higher-level phonological encoding of stress is not hindered by lower-level processing. That is, if advanced L2 learners were to be probed on their phonological encoding of stress, the results would potentially reflect performance at the phonological level and not at the perceptual one.

Regarding stress identification, Romanelli & Menegotto (2015) looked at the perception of stress and vowels /a, e, o/ in final position by beginner-intermediate learners of Spanish by means of a pre and posttest. They tested students before and after a study abroad program in Argentina. Subjects responded to a three-alternative forced-choice perceptual identification task with nonword triplets as stimuli (seMApa – semaPA – seMApo). Their task was to identify the word they heard in the three written nonwords. They found that learners appeared to have difficulties in the perception of stress even when words are presented in isolation, with oxytone words being the most difficult to identify. After three weeks of exposure, the English speaking students performed like Spanish monolinguals in the perception of penultimate stress but not in final stress. Thus, three weeks of study appeared to be enough to develop processing abilities to identify stressed syllables of Spanish nonwords but only for paroxytone items. Similarly, Beaudrie (2007) trained intermediate Spanish learners to identify the stressed syllable of Spanish nonwords such as <cascana>. In this case, even after explicit training, learners were only able to accurately identify 63% of the stressed syllables after hearing the nonword twice. These studies suggest that learners experience difficulties in their development of stress processing. However,
the source of these difficulties remains unknown. It could be hypothesized that the stress processing difficulties found in English speakers by Lin et al. (2014) indicate a degree of stress ‘deafness’, which could be at least partially responsible for L2 learners’ challenges with Spanish stress.

Further studies have corroborated this asymmetry between oxytone and paroxytone words in the phonological encoding of L2 learners finding the same effect when words were presented in sentences with a variety of accent patterns. Kim (2016) carried out a forced-choice identification task with upper-intermediate L2 speakers. The stimuli were presented in three prosodic contexts: nuclear position, prenuclear position, and unaccented context. The items included minimal pairs of verbs that differed only in the position of lexical stress whose oxytone versions were associated with the third person singular and paroxytone versions with the first person singular, e.g., canTO ‘s/he sang’ – CANto ‘I sing’. These experimental items were produced in carrier sentences such as canto la balada ‘(I) sing the ballad’ where the subject is implicit in the verbal morphology but not explicitly stated in the sentence. The subjects’ task was to make a decision with regards to the subject of the action by paying attention to the stress structure of the verb. This task requires the ability to perceive and use stress in order to access the right meaning of the verb form. L2 learners appeared to use pitch information (F0 peak for syllables in nuclear position, F0 valley for syllables in prenuclear position) to identify paroxytone words in accented contexts. This suprasegmental information did not help to perceive oxytone syllables, whose identification was performed at chance regardless of accent condition. In the absence of pitch, accuracy rates for paroxytone words were slightly above chance. Thus, when asked to make a decision, English speakers, learners of Spanish can use pitch accent to
identify stressed syllables but not in oxytone words. These results demonstrate that, when stress can be successfully perceived, participants can make use of the phonological structure of words. Participants demonstrate that their stress processing strategies allow them to make use of suprasegmental information in order to reach differences in meaning. Furthermore, successful perception of stressed syllables is modulated by intonational contexts (accented words are easier to identify than unaccented words) and stress patterns (oxytone words are more difficult to identify than paroxytone words).

Finally, Saalfeld (2012) examined beginner-intermediate English learners of Spanish abilities to perceive stress differences in words using a Sentence Recall. Learners participated in an ABX task with sentences as stimuli. In each triad, the first two sentences (A, B) differed only in the location of verbal stress such as Para sacar una buena nota, partiClpo en clase and Para sacar una buena nota, particiPÓ en clase. The third sentence was identical to either the first one (A) or the second one (B). In this task, learners listened to three sentences and determined if X was similar to A or B. These stress changes in the verb form trigger changes in the interpretation of the verb. The form partiClpo “I participate” indicates first person singular of the present tense while the form particiPÓ “s/he participated” indicates third person singular of the preterite. This experimental design, however, adds processing load to the otherwise difficult task of perceiving and encoding a stress difference. Learners need to perceive the stress pattern of the verb, encode it, process its morphological consequences, and remember it after the three sentences have been heard. Thus, cognitive exhaustion may partially explain these results. Furthermore, this task does not provide information with regards to the retention of stress at the phonological level as (i) the processing of sentences may be very cognitively demanding, and (ii) it is not clear whether these
students already made the connection between stress change and morphological implications of person and tense.

To sum up, a study that looks at the perception of the acoustic correlates of Spanish stress by English speakers suggest that, in the presence of accent, advance learners are able to rely on suprasegmental information in order to perceive Spanish stress (Ortega-Llebaria et al., 2013). Studies that examine stress identification in L2 learners provide evidence that stress is challenging for native speakers of English. Despite these difficulties, learners appear to learn to identify stress after exposure to the language and with specific training (Beaudrie, 2007; Romanelli & Menegotto, 2015). Thus, there is evidence of L2 development of sensitivity to stress at some level during language learning. L2 learners are also challenged by some intonational contexts and stress patterns. Perceiving stress in unaccented contexts is more difficult than in accented ones; final stress is more difficult to perceive than penultimate stress (Kim, 2016). However, not much is known about the stress-encoding abilities of L2 learners of Spanish. It is unknown whether phonological processing plays a role in the results of some of the aforementioned studies.

2.6 Spanish Stress in English-Spanish Bilingual Speakers

Stress processing has also been tested on English-Spanish early bilinguals (sometimes known as heritage speakers of Spanish), however, similarly to L2 studies, these have not addressed their stress-processing abilities at the phonological level. They have focused on syllable identification (Beadurie, 2017) and low-level stress perception (Kim, 2016).
Beaudrie (2017) trained heritage speakers of Spanish to identify stressed syllables of real Spanish words. The explicit training session was carried out once a week for six weeks and student learning was assessed by means of a pre and a post-test. For each test, participants were asked to circle the stressed syllable in Spanish words such as *abrelata* “can opener”. Even after explicit training, about 32% of the participants’ error rates varied from 80% to 59%. This indicates that, despite early exposure to the language, syllable identification is not an easy task for bilingual speakers, even when they had been training for that specific task for six weeks. However, these findings do not provide information of bilingual stress-processing at a phonological level. These results shed light onto participants’ metalinguistic knowledge of stressed vs unstressed syllables. Thus, they cannot be used to argue that bilinguals are challenged by the perception of stress syllables as participants did not listen to the words, they only read them. In order to complete this task, participants need to access their mental phonological representation of the words to decide in which syllable stress is located. The results point toward the interpretation that either (1) stress is not fully encoded in lexical entries (bilinguals are able to access it easily) or (2) the connection between phonological representation of lexical items and metalinguistic knowledge is not as direct or is not yet developed in bilinguals (bilinguals have a mental representation of stress but are not able to identify it explicitly). This latter possibility seems like the most plausible one as some of the bilinguals did certainly learn to identify stressed syllables (44% of participants had a high accuracy level between 80% and 100%).

Kim (2016) also examined bilingual speakers using the aforementioned forced-choice identification task in which participants had to decide whether the subject of sentences such as as
canto la balada was yo as in “(I) sing the ballad”, or él/ella as in “s/he sang the ballad”. Bilingual participants did not differ significantly from monolingual speakers in their perception of the stress contrast. Both groups were slightly affected by unaccented contexts although in different ways. Monolingual speakers found it harder to perceive the stress pattern in oxytone words while bilingual speakers were more challenged by paroxytone words. These findings reveal a comparable perceptual performance of bilinguals when compared to monolingual speakers. Bilingual and monolingual speakers are able to perceive stress contrasts across different intonational contexts to the same extent. However, whether both groups present differences in their higher-level stress-encoding abilities remains unknown.

2.7 Conclusion

Previous research has shown that speakers of languages with no lexical stress or predictable stress are stress ‘deaf’. However, it is still unknown whether speakers of free-stress languages can also be challenged by stress contrasts at a higher phonological level. Cross-linguistic studies suggest that a language’s proportion of lexical exceptions to a main stress pattern may help predict the degree of ‘deafness’ of its speakers. According to this lexical statistics account (Peperkamp et al., 2010), English speakers’ representation of stress in phonological memory should be less robust than that of Spanish speakers. This may partially explain why English native speakers L2 learners of Spanish and bilingual speakers are challenged by stress identification. English speakers’ phonological encoding has been tested using a stress minimal pairs that differ only in suprasegmental information such as /fʌði/—/fʌði/ (Qin et al., 2017) and /mipa/—/mi’pa/ (Lin et al., 2014). It appears that recalling alternations of stress patterns was
more challenging than recalling consonantal alternations (Lin et al., 2014), which indicates a fuzzier representation of stress when compared to that of consonants. However, this ‘deafness’ effect in English has been attributed to the lack of vowel quality changes in the speech signal despite the fact that native speakers of English can use suprasegmental information in order to perceive stress contrasts (Chrabaszcz et al., 2014; Qin et al., 2017). Whether English speakers’ ‘deafness’ is due to unfamiliarity with suprasegmental cues to stress remains unexplored.

Furthermore, research on L2 processing of stress has focused on comparing languages that have word-level stress prominence (Mandarin, Spanish, English) to words that have no lexical stress (French, Korean). French speakers appear to be challenged by L2 stress-encoding (Dupoux et al., 2008; Tremblay, 2009) as are Korean speakers (Lin et al., 2014). Moreover, it appears that frequency of L2 use correlates with improved processing abilities with regards to stress (Tremblay, 2009). Therefore, it appears that a person’s degree of stress ‘deafness’ can decrease as experience processing a language in which stress is critical for word identity.

2.8 The Present Study

The present study aims to fill a gap in our understanding of L2 stress processing. Spanish and English belong to the same typological family with regards to lexical stress. However, differences in the degree of predictability of stress location as well as the co-occurrence of stress with vowel reduction patterns appear to yield differences in the phonological processing of their speakers. In order to unveil the cross-linguistic and L2 effects on stress processing, this study reports on the findings from 106 English native speakers who are second-language learners of Spanish varying in their level of proficiency, 14 early learners of Spanish who grew up exposed
to both English and Spanish, and 10 native speakers of Spanish who served as a control group. They participated in two tasks designed to unveil whether the second-language and bilingual speakers have difficulties with the processing of Spanish stress at the perceptual or phonological level.

The first experiment is an ABX task in which participants are required to encode phonological contrasts in working memory and make a decision based on their remembrance of these contrasts. We manipulated these contrasts so as to compare participants’ abilities with consonant contrasts and stress contrasts. The results from this experiment will help to unveil whether second-language learners and bilingual speakers are able to retain stress information in working memory as successfully as consonantal information, which will provide us with evidence of their phonological encoding abilities when it comes to stress.

The second experiment is an AX task designed to tap both into perceptual and into phonological processing. This experiment was designed to reveal the effects of phonological encoding in the perception of two nonword lexical items differing in either a consonant or the location of stress. The results will be useful in determining whether second-language and bilingual speakers present difficulties at the perceptual or at the phonological level.

Next, the characteristics of the participants who took part in the two experiments is discussed along with the tests used to measure their proficiency and their linguistic dominance.
CHAPTER 3: PARTICIPANTS AND PARTICIPANTS’ TESTS

3.1 Participants

A total of 130 people were recruited to participate in the study. They were all between the ages of 18 and 37 ($M = 21$, $SD = 3.8$). We recruited participants from three different populations. First, we had a group of ten native Spanish speakers with English as their second language to act as controls (native Spanish speakers, NS). Second, a group of fourteen early Spanish/English bilinguals—that is, people who, according to self-reports, grew up bilingual in these two languages (early Spanish learners, EL). And, finally, we recruited a group of 106 second language learners of Spanish of varying proficiency whose native language is English (late Spanish learners, LL).

All participants were recruited from the campus community of a large public university located in the southwestern United States. The NS group was comprised of graduate students who were raised in a Spanish-speaking country as monolingual Spanish speakers, they learned English in a school setting starting at approximately age 12, and moved to the US as adults to pursue a graduate degree. The EL group was comprised of undergraduate students who were raised in the southwestern US by Spanish-speaking or bilingual Spanish/English-speaking families. These participants learned both Spanish and English in childhood and continue to use both languages daily and fluently as adults. They use Spanish mostly with family and friends. As children, they were schooled mostly in English. At the time of the study, these participants were enrolled in intermediate or advanced Spanish classes. The LL group was comprised of undergraduate students who were raised in the US as English-speaking monolinguals. At the
time of the study, these participants were enrolled in Spanish classes in a second-language program, and their use of Spanish was mostly restricted to the school setting. Participants in the LL group were recruited from a wide range of Spanish-language courses, including first, second, and third-year Spanish classes. Since we intended to ascertain the potential role of proficiency on phonological encoding in adult second-language learners, this group is the larger of the three.

3.2 Language Dominance Test

Before participating in the experiment, all participants completed the Bilingual Language Profile (Birdsong, Gertken, & Amengual, 2012; Appendix A), available online. The Bilingual Language Profile (BLP) is a self-report questionnaire that provides data for each of the two languages of a bilingual (Spanish and English, in this case) on four different modules: language history, language use, language proficiency, and language attitudes. The answers to each of these modules yield a score of language orientation in bilingualism that is then used to calculate a total score, sometimes interpreted as an index of language dominance. A score is assigned to each of a bilingual’s two languages, and the score corresponding to a language is then subtracted from the one corresponding to the other. This makes it possible for researchers to place bilingual participants on a spectrum of language dominance based on their responses to the questionnaire. The endpoints of the spectrum are -218 and 218, which indicate a bilingual’s complete orientation towards one of their languages. Participants located closer to zero, the midpoint of the spectrum, are thought to have balanced linguistic orientations. The absolute location of participants on this spectrum is not relevant in itself. We are using the questionnaire as a tool to locate bilinguals relative to each other.
Table 3.1: Descriptive statistics of the bilingual language profile (BLP) scores and the proficiency data, which include two grammatical-proficiency cloze tests (passage cloze test, sentence cloze test) and a vocabulary size test (LexTale-Esp), for the three groups of participants: the native-speaker controls (NS; \( N = 10 \)), the early Spanish/English bilinguals (EL; \( N = 14 \)), and the late second-language learners of Spanish, who have English as their native language (LL; \( N = 106 \)).

<table>
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<tr>
<th></th>
<th>Dominance</th>
<th>Vocabulary Size Test</th>
<th>Passage Cloze Test</th>
<th>Sentence Cloze Test</th>
<th>Overall Proficiency</th>
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<tr>
<td>NS</td>
<td>-129</td>
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<td>.96</td>
<td>( (±.02) )</td>
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<tr>
<td>EL</td>
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<td>( (±47) )</td>
<td>.55</td>
<td>( (±.11) )</td>
<td>.73</td>
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<tr>
<td>LL</td>
<td>142</td>
<td>( (±27) )</td>
<td>.23</td>
<td>( (±.09) )</td>
<td>.29</td>
</tr>
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</table>

Table 3.1 shows the descriptive statistics (mean and standard deviation) of the participants’ dominance scores as a function of group. Negative values indicate preferred orientation towards (or dominance in) Spanish whereas positive values indicate preferred orientation towards (or dominance in) English. As seen in the table, the late learner (LL) group had a mean score that fell on the positive side, the early learner (EL) group had a positive mean score around 20, and the mean score of the native controls (NS) fell on the negative side of the continuum. The BLP average score of the late bilingual group reflects a prevailing dominance in English, that of the early bilingual group is suggestive of a somewhat more balanced bilingual orientation, and that of the native control group indicates dominance in Spanish. It is important to point out that the BLP scores for each participant group show no overlap among the three main groups: NS, EL, LL.
3.3 Proficiency Tests

Participants also completed a total of three Spanish proficiency tests before taking part in the experiments. The tests comprised a test of vocabulary size, the LexTale-Esp (Izura, Cuetos, & Brysbaert, 2014), and two cloze tests borrowed from Martínez García (2016), of which one was a passage cloze test and the other a cloze test with individual sentences. Therefore, proficiency in Spanish was assessed by means of two grammatical competency tests and a vocabulary size test. Table 3.1 shows the descriptive statistics (mean and standard deviation) of participants’ proficiency scores as a function of group. The scores were obtained by means of three tasks.

The LexTale-Esp is a test used to assess Spanish language proficiency through vocabulary size (Izura et al., 2014; Martínez García, 2016). In the version we used (Appendix B), this test includes 60 Spanish words and 30 nonwords in a fixed order. The nonwords are phonotactically legal in Spanish. The participants’ task is to indicate whether the word they see on the screen is a word of Spanish or not. The vocabulary-size score for each participant is calculated by subtracting 2 for each positive (“this is a Spanish word”) response to a nonword such as “terzo”, and adding 1 for each positive (“this is a Spanish word”) response to a real Spanish word such as “candado”. The maximum possible score is 60; nevertheless, we scaled the score range between 0 and 1 so that the minimum score in the data equalled 0 and the maximum score equalled 1. Higher values are indicative of a larger vocabulary size. Once again, we use this tool as a means to compare participants in our sample relative to each other.

The vocabulary size test was accompanied by two cloze tests. The two grammatical proficiency, cloze tests (Martínez García, 2016) were administered through an online form. The
first test was a passage where 20 words had been replaced with blanks (Appendix D). The second test contained 30 sentences in which one word per sentence had been replaced for a blank (Appendix C). In both tests, participants had to select an appropriate word for the context of the blank by selecting an option in a dropdown menu. For example, for the following sentence “Sus amigos pudieron haberlo salvado pero lo dejaron _____” participants had to choose between the following options: a) ganar, b) parecer, c) perecer, d) acabar. Proficiency scores were obtained by adding the correct responses, which resulted in a maximum of 20 points for the passage cloze test and a maximum 30 points for the sentence cloze test. Similarly to what we did for the vocabulary-size scores, we scaled the score ranges between 0 and 1 so that the minimum score in the data equalled 0 and the maximum score equalled 1. Therefore, higher values correspond to higher grammatical proficiency in the language. We use this tool to make comparisons between participants and participant groups in our sample. Table 3.1 shows the scaled proficiency scores resulting from each test. Scaled values are useful because they allow for comparisons across tests. In a final step, we added the three scaled proficiency scores (vocabulary size test, sentence cloze test, and passage cloze test) for each participant to obtain an overall proficiency score per participant. This score was also scaled back from 0-3 to 0-1 range. Table 3.1 shows the scaled overall proficiency score means as a function of group.

Not all of the participants completed both tasks described in the present study. Some participants completed only one of the two experiments while others completed both. Each experimental chapter includes the descriptive statistics of the subjects that participated in each particular task.
CHAPTER 4: THE PHONOLOGICAL ENCODING OF STRESS

4.1 Introduction

Previous research on the phonological processing of stress suggest that the typological structure of a language may have a direct impact on the perceptual abilities of its speakers with regards to this feature (Dupoux, Pallier, Sebastián-Gallés & Mehler, 1997; Dupoux, Peperkamp & Sebastián-Gallés, 2001; Peperkamp, Vendelin & Dupoux, 2010; Peperkamp & Dupoux, 2002). In this view, speakers of some languages appear to suffer from stress ‘deafness’, which is described in these studies as listeners’ challenges with retaining stress contrasts in working memory. ‘Deafness’ is directly related to the relevance of stress in the phonology (however this may be instantiated) of each language. This does not mean that speakers of certain languages are completely unable to perceive the difference between the two members of a stress-based minimal pair. What it means is that, when tested on cognitively demanding tasks, speakers who are stress ‘deaf’ find it more difficult to recall stress patterns than, for instance, consonantal contrasts present in their language (Dupoux et al., 1997, 2001).

In the L2LP model (van Leussen & Escudero, 2015), stress ‘deafness’ corresponds to the processing of stress at a higher level of representation where canonical forms of phonological units are stored and accessed. In the case of French speakers, their experience with their native phonological system is hypothesized to affect their long-term phonological representation of stress. In this case, the lack of functionality of stress in this language leads to a fuzzier and less accessible abstract representation of phonological categories used to retain stress. Meanwhile, at a lower processing level, French speakers are able to use the acoustic cues available in the
speech signal in order to differentiate between words differing in stress. This means that they have access to a phonetic representation of word-level stress that they can use to compare lexical items. Therefore, it is when speakers need to rely on in higher phonological memory and not on low-level phonetic processing that French speakers’ representation starts to become fuzzier or less accessible.

The present study furthers our understanding on the potential effects that linguistic typology regarding stress may have on the processing abilities of speakers. Here, we analyze and compare the performance of speakers of Spanish and English. These two languages are typologically similar in that both languages present contrastive stress. However, they are different with regards to how predictable stress location is in each language. In English, stress tends to fall on the initial syllable of a word. About 90% of words in English follow this pattern (Cutler & Carter, 1987). Meanwhile, Spanish words tend to have penultimate stress. This is the most common stress pattern found in 80% of lexical items (Toro-Soto and Rodríguez-Fornells 2007). These data suggest that stress location in English is more predictable than stress in Spanish. Therefore, the lexical statistics account predicts that English speakers’ representation of stress in phonological memory will be less detailed than that of Spanish speakers. This processing difference is suggested by studies on L2 Spanish looking at English native speakers. They consistently found that stress contrasts are challenging for learners (Beaudrie, 2007; Kim, 2015, 2016; Romanelli, Menegotto & Smyth, 2015a, 2015b; Romanelli & Menegotto, 2015; Saalfeld, 2012). Moreover, these difficulties are also found in Spanish-English early bilinguals (Beaudrie, 2017). However, it is still unknown at which level of representation early and late learners of Spanish are having difficulty with stress. This study aims at elucidating whether the
difficulties observed in early and late learners of Spanish stem (at least in part) from stress-encoding performance at a higher phonological level. In other words, it seeks to find whether these two populations have some degree of stress ‘deafness’.

4.1.1 Cross-linguistic Studies

Cross-linguistic research have focused on comparing stress processing in languages that differ significantly in their lexical use of stress such as French and Spanish (Dupoux et al., 1997, 2001), and in languages that differ in the regularity of stress patterns in their lexicon such as Finnish, Hungarian, and Polish (Peperkamp et al., 2010). By testing more than one language using the same experimental design, Peperkamp and colleagues (2010) were able to test the degree of stress ‘deafness’ for speakers of different languages. They found that the predictability of stress location (measured as lexical exceptions to the most common stress pattern) in a given language appears to have a direct relationship with the successful phonological encoding of stress. This lexical statistics account posits that speakers of languages that present a higher rate of lexical exceptions (Spanish) demonstrate increased stress processing abilities relative to speakers of languages with no lexical exceptions (French, Hungarian, Finnish). However, this appears not to be a binary construct, but rather a continuous one. When comparing two languages that present lexical exceptions to the main stress pattern such as Polish and Spanish, Peperkamp et al. (2010) found that Spanish speakers were significantly more successful at recalling stress patterns than Polish speakers. At the same time, when compared to speakers of French, Hungarian and Finnish, Polish speakers were significantly more accurate in processing stress changes. The reason behind this difference lays in the percentage of lexical exceptions that
each language demonstrates. For Spanish, lexical exceptions to the main stress pattern account for 20% of lexical items. Meanwhile, lexical exceptions in Polish account for 0.1% of its vocabulary. Therefore, these results suggest that the higher the number of lexical exceptions in a language, the more skillful its speakers will be in encoding stress.

Previous cross-linguistic studies have demonstrated the direct relationship between the phonological typology of a language regarding stress use and speakers’ abilities in stress-encoding. The present study is different in that it tests two languages that are very similar in regards to stress use, English and Spanish. In both languages, stress is contrastive and its location within the word is not fully predicted by rules. Nonetheless, the lexical statistics account (Peperkamp et al., 2010) predicts that speakers of Spanish should be more skillful than speakers of English in encoding stress in phonological memory due to an asymmetry in the number of lexical exceptions to the main stress pattern (10% for English; 20% for Spanish). This model also predicts that, relative to Polish speakers, we would expect English speakers to have more solid stress-encoding abilities. The present experiment makes use of the ABX paradigm (similarly to Dupoux et al., 1997) in order to explore the robustness of the phonological representation of stress in English and Spanish speakers. The results from this study will allow us to provide further evidence of the continuous nature of stress ‘deafness’. If we are able to capture a stress-processing difference, it would match the predictions made by the lexical statistics account, and would, thus, support its theory. Meanwhile, if stress-encoding poses no challenge for English speakers, the results would question the predictions made by the lexical statistics account.
4.1.2 Stress Processing in Early and Late Bilingualism

Stress processing has also been examined through the lenses of second language acquisition. Within this field, the studies address (1) whether learners are able to identify/encode stress like native speakers of the target language, and (2) whether learners develop their stress-processing abilities with exposure to the L2 and/or with increased L2 proficiency. Most of these studies have tested learners at an advanced/intermediate stage of their target language studies (Altman, 2006; Lin et al., 2014; Qin et al., 2017), while others have looked at L2 learners of various proficiencies (Dupoux et al., 2008; Tremblay, 2009).

For example, Altman (2006) tested advanced L2 learners of English of a variety of native languages: Korean, Japanese, Chinese, Spanish, French, Turkish, and Arabic. For this study, participants were asked to hear a nonword twice and to indicate which syllable was the stressed one. In order to make their decision, they were asked to select the stressed syllable in a computer screen that displayed the syllables that made up the word participants just heard. For example, if they heard the nonword /tu.ri/, they were presented with the orthographic representation of the syllables <too> and <ree> on the screen. The results showed that speakers of languages where stress is not contrastive (Korean) and speakers of languages with unpredictable stress (Spanish, Chinese, Japanese) performed close to ceiling. Meanwhile, speakers of languages categorized in this study as having predictable stress (Arabic, Turkish, French) displayed more errors in the identification of stressed syllables. There are two remarks that should be made about this study. First, French in this study is categorized as a language with predictable stress. This conflicts with previous studies that consider stress in French a suprasegmental property at the phrase level
(Dupoux et al., 2010). Second, this study tests participants' abilities to indicate the stressed syllable of a word. Thus, it cannot be used to answer questions that address participants’ phonological encoding of stress.

Other studies have been carried out using more sensitive tasks that provide a window into phonological processing without the influence of metalinguistic knowledge. For example, Lin, Wang, Idsardi & Xu (2014) looked at the phonological encoding of stress by English native speakers and Beijing Mandarin and Korean learners of English through a Sequence Recall task. Mandarin and Korean are two interesting languages from a typological standpoint. On the one hand, Mandarin is a language where stress is lexically contrastive (Lin et al., 2014); it possesses full and light syllables that can be equated to stressed and unstressed syllables in English (Duanmu, 2007). Moreover, stress in Mandarin and English appear to be realized using the same acoustic cues. On the other hand, Korean does not have contrastive lexical stress. Participants were tested with the phoneme minimal pair /'kuti/—/'kupi/ and in the minimal stress pair /'mipa/—/mi'pa/ produced by a native English speaker and appearing in sequences of 2, 3, 4, 5 and 6 items long. The results from the sequence recall show that Korean speakers had a less efficient stress-encoding mechanism than Mandarin speakers. The Korean group was less successful at recalling sequences where the stress contrast was involved than sequences of the phoneme minimal pair. Meanwhile, Mandarin speakers’ performance in the phoneme contrast was not significantly different from the stress contrast. But the most relevant finding to the present study is the one regarding the English group. English speakers’ stress-encoding abilities were not significantly different than those of the Korean group. This means that they were able to recall sequences more successfully if the sequences involved a phoneme minimal pair than if
they were tested on the stress minimal pair. The authors attributed these results to the lack of vowel reduction cues in the stress minimal pair /mipa/—/mi'pa/. This explanation resorts to English speakers’ lack of experience with suprasegmental cues to stress. However, in addition to vowel reduction, stress in English is also signaled through duration cues, which can be exploited by native English speakers in order to perceive stress contrasts (Qin et al., 2017).

From this study, we can highlight two important messages that are relevant to the present experiment. First, high proficiency in an L2 does not necessarily lead to native-like phonological processing of the target language when it comes to stress. Phonological sensitivity to stress appears to be difficult to alter although not impossible (Dupoux et al., 2008; Tremblay, 2009). Second, English speakers may also suffer from some degree of stress ‘deafness’.

With regards to early bilingualism, researchers became interested on whether experience with two languages like French and Spanish from birth leads to any degree of stress ‘deafness’ or to Spanish-like abilities in the processing of stress. Dupoux et al. (2010) tested a group of French-Spanish bilinguals using a Sequence Recall with a stress (/mipa/—/mi'pa/) and a consonant (/kuti/—/kupi/) contrast, and compared their performance to a control group of Spanish native speakers and a group of French speakers advanced L2 learners of Spanish. A first analysis revealed that the stress encoding abilities of the early bilingual group were intermediate to those of the L2 and the native control group. However, upon further examination, the authors found that the behavior of the bilingual group could be further explained by means of a binomial distribution that corresponded to the behavior to the native and the late learner groups. It appeared that early language exposure (country of residence between the ages of 0-2, 2-4) could significantly predict belonging to one group or another. Thus, being raised in a Spanish-speaking
country up to the age of 4 with the resulting extensive exposure to Spanish led early French-Spanish bilinguals to develop stress-encoding abilities comparable to those of Spanish monolinguals. Meanwhile, being raised in a French-speaking country correlated with participants’ less successful encoding of stress.

The present study is different from Altman (2006) in that we make use of the ABX paradigm in order to obtain results that provide evidence of participants’ phonological encoding of stress without the interference of metalinguistic knowledge. It also adds to the literature on L2 stress by testing the effects of linguistic experience and proficiency in the processing of stress by English speakers learners of Spanish.

4.1.3 Stress in English-Spanish Bilingualism

In the field of English-Spanish bilingualism, the processing of stress has received substantial attention due to the fact that late learners of Spanish appear to be challenged by stress identification (Beaudrie, 2007; Romanelli & Menegotto, 2015; Romanelli, Menegotto & Smyth, 2015a, 2015b) and the lexical use of Spanish stress (Kim, 2015, 2016; Saalfeld, 2012). Meanwhile, results from early learners are not as consistent as those of late learners. In some studies, early bilinguals were found to perform similar to monolingual speakers (Kim, 2015, 2016); other studies find that early bilinguals find it difficult to identify stressed syllables even after explicit training (Beaudrie, 2017). Stress perception is crucial to successfully represent orthographic stress. Stressed syllables in words that differ in stress in Spanish are orthographically represented by the absence or the presence of accent marks following Spanish accentuation rules, e.g.: <círulo> (circle), <ciculó> (I circulate), <ciculó> (s/he circulated).
This is different from the case of English in which stress is either orthographically represented through segmental orthography (such as in <trusty> and <trustee>) or signaled by word class (n. <object> and v. <object>). The general finding is that both early and late learners have trouble in identifying stressed syllables when learning the accentuation rules (Beaudrie, 2007; 2017). For this reason, researchers have looked at the identification of stressed syllables and processing of stress using different paradigms in order to explore why early and late bilinguals struggle with stress.

For example, Beaudrie (2007) trained intermediate late learners of Spanish to identify the stressed syllable of words and to correctly use the accent mark in Spanish nonwords. The effects of the training sessions were measured by means of a perceptual task and two accentuation tasks. In the perceptual task, participants listened to one trisyllabic Spanish nonword twice and were asked to identify the stressed syllable on a worksheet. For the accentuation tasks, students had to rewrite Spanish nonwords using the accent mark when needed (following the accentuation rules). The difference between the first and the second accentuation task is that in the first one, the stressed syllable was underlined in the worksheet. Meanwhile, in the second accentuation task, participants heard the nonword pronounced by a native speaker; so the stressed syllable was not highlighted in the orthographic representation of the word. The results show that the training session only had a positive, significant effect in the accentuation task where the stressed syllable was already orthographically underlined for the learners (pre-test 51% vs post-test 93% accuracy). Even after training, learners were only able to reach 64% accuracy in the perceptual task, and 58% accuracy in the accentuation task that required participants to make a decision based on what they heard. Thus, learners were more challenged by the two tasks that required
them to perceive stress in speech. These results indicate that learners have trouble identifying stressed syllables. However, it is still unclear whether this could be partly due to their phonological processing or to their metalinguistic skills.

In a different study, Beaudrie (2017) trained early learners, heritage speakers of Spanish to identify stressed syllables. She conducted a pre and post-test in order to measure the learning of the students. The training consisted on explicit instruction on how to identify stress categories and learning the accentuation rules followed by three practice weekly activities: a stressed syllable identification task in sentences, a stressed syllable identification task in isolated words, and a word identification task. Similarly to the late learners in other studies some bilingual speakers were challenged by the identification of stressed syllables. 14% of the students obtained an accuracy rate between .20 and .40, and 18% of the students obtained an accuracy rate between .41 and .60. These results indicate that early exposure to the language does not have an effect on stress identification. Notice that these results happened after a 6-week training.

In both studies, participants were asked to perform on tasks that target their metalinguistic abilities. The results may suggest that late learners and some of early learners are not able to hear the difference between members of a stress minimal pair. However, the fact that they need to rely on metalinguistic knowledge in order to complete this task raises questions about where exactly do their difficulties lie. It could be the case that participants can hear stress differences but are unable to identify the stressed from the unstressed syllables when asked explicitly.

The present experiment is different from previous studies on the perception of stress by early and late learners of Spanish in that we test the phonological encoding of stress directly; we
carry out a task that does not allow the intervention of metalinguistic skills. This will allow us to contribute to the growing body of literature on L2 Spanish stress by capturing whether or not late learners present difficulties in the encoding of stress at a higher phonological level. Furthermore, we tested a total of 84 late learners at three different learning stages, which will allow us to explore whether learners are able to modify their behavior with increased experience with Spanish.

4.2 Experiment 1: ABX

Research has found that stress ‘deafness’ is directly related to the stress typology of each language. The lexical statistics accounts predicts that speakers of Spanish should be more skillful than speakers of English in encoding stress in phonological memory due to an asymmetry in the number of lexical exceptions to the main stress pattern (10% for English; 20% for Spanish). The stress encoding of Spanish speakers been compared to that of speakers of Standard French (Dupoux, et al., 1997; Dupoux, et al., 2001; Peperkamp et al., 2010), Southeastern French, Finnish, Hungarian and Polish (Peperkamp et al., 2010). The encoding of stress in English natives has been compared to that of speakers of French (Tremblay, 2008), Beijing Mandarin (Qin et al., 2017; Lin e tal., 2014) and Korean (Lin et al., 2014). Both English and Spanish have not been tested using the same methodology. Furthermore, the results from a Sequence Recall in Lin et al. (2014) suggest that recalling sequences involving a stress minimal pair is not as automatic as recalling sequences of a consonant minimal pair for English speakers. This less successful processing of stress is theorized by the authors as coming from the fact that the materials used in the task did not include segmental cues to stress. In the following experiment,
we test English natives that are learners of Spanish. This population should be familiar with the lack of vowel reduction patterns in stress contrasts. Note that English speakers are able to use suprasegmental cues to perceive English stress (Qin et al., 2017). Thus, the present experiment will provide us with information not only of the case of English learners of Spanish processing stress in the target language, but also of the stress-encoding abilities of English listeners in general.

We also seek to explore whether late learners of Spanish are able to develop higher sensitivity to stress contrasts with increased exposure to the target language. Previous studies have found that L2 daily use was a significant predictor in learner performance (Tremblay, 2009). Thus, late learners who use the target language more often were more prone to improvement in their stress-encoding abilities. We included 84 second language learners of different proficiencies in this study, which should allow us to capture any potential development in the phonological abilities of late learners of Spanish.

Finally, we are interested in the stress processing skills of English-Spanish early bilinguals. Early bilinguals appear to be challenged by stress in stressed syllable identification as well as by the Spanish accentuation rules (Beaudrie, 2017). However, it is still unknown if this could be (at least partially) due to a less accessible representation of stress in phonological memory. The present experiment will allow us to locate the stress processing abilities of early bilinguals with respect to the behavior of Spanish speakers who have been raised monolinguals and English natives late learners of Spanish.

The two main research questions addressed in this study are the following: (1) Does length and depth of experience with the Spanish language modulate participants’ likelihood of
displaying robust stress encoding in their perceptual behavior? (2) Does a learner’s higher grammatical and lexical proficiency—i.e., higher competency due to further experience with the language—correlate with a higher likelihood of displaying robust patterns of stress encoding?

In order to answer these questions, we adapted Experiment 3 from Dupoux et al. (1997) and carried out an ABX discrimination task in which participants were tested on a stress, a consonant and a redundant condition (stress+consonant change). Participants heard three items in each trial. Each item was produced by a different Spanish native speaker. Items A and B were produced by two different male speakers and item X was produced by a female speaker. In this task, participants had to indicate whether the third item X was identical to the first A item or to the second B item by pressing a button in a response box. Our present experiment is different from Experiment 3 in Dupoux et al. (1997) in that our A and B items were recorded from two different speakers instead of the same speaker. Such a change in the phonetic variability of the task is expected to increase the difficulty of the task for people who do not possess a robust mental representation of stress (Tremblay, 2009).

For this task, the prediction is that, if English speakers are challenged by stress encoding at a phonological level, we will be able to capture a difference between the stress and the consonant conditions. Spanish speakers are expected to perform equally successfully in the stress and consonant conditions. This would mean that the phonological representation of stress in English natives is not as detailed and not as accessible as that of Spanish speakers. Moreover, if learners undergo a learning process in the encoding of stress contrasts in Spanish, we will be able to observe a development from poor performance in early stages of acquisition to improved/optimal performance in later stages in the stress condition. This would mean that
learners are challenged by the processing of stress when they are first exposed to the language and develop their encoding abilities it as their experience with Spanish increases.

Table 4.1: Descriptive statistics of the bilingual language profile (BLP) scores and the proficiency data, which include two grammatical-proficiency cloze tests (passage cloze test, sentence cloze test) and a vocabulary size test (LexTale-Esp), for the three groups of participants: the native-speaker controls (NS; $N = 10$), the early Spanish/English bilinguals (EL; $N = 10$), and the late second-language learners of Spanish, who have English as their native language (LL; $N = 84$) and are further divided as a function of their year of college Spanish.

<table>
<thead>
<tr>
<th></th>
<th>Dominance</th>
<th>Vocabulary Size Test</th>
<th>Passage Cloze Test</th>
<th>Sentence Cloze Test</th>
<th>Overall Proficiency</th>
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<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
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<tr>
<td>NS</td>
<td>-129 (±18)</td>
<td>.96 (±.02)</td>
<td>.93 (±.04)</td>
<td>.96 (±.03)</td>
<td>.97 (±.01)</td>
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<tr>
<td>EL</td>
<td>3.4 (±42)</td>
<td>.58 (±.08)</td>
<td>.78 (±.11)</td>
<td>.87 (±.08)</td>
<td>.74 (±.08)</td>
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<tr>
<td>LL 1st</td>
<td>164 (±18)</td>
<td>.19 (±.08)</td>
<td>.26 (±.09)</td>
<td>.17 (±.08)</td>
<td>.14 (±.06)</td>
</tr>
<tr>
<td>LL 2nd</td>
<td>144 (±22)</td>
<td>.22 (±.07)</td>
<td>.27 (±.13)</td>
<td>.24 (±.12)</td>
<td>.18 (±.08)</td>
</tr>
<tr>
<td>LL 3rd</td>
<td>124 (±18)</td>
<td>.26 (±.07)</td>
<td>.32 (±.14)</td>
<td>.36 (±.13)</td>
<td>.25 (±.09)</td>
</tr>
</tbody>
</table>

4.3 Participants

A total of 104 people participated in the perceptual experiment. The participant pool represented the three different populations of interest. The first group is comprised of ten native Spanish speakers with English as their second language to act as controls (native Spanish speakers, NS). The second group is made up of ten early Spanish/English bilinguals who reported growing up bilingual in both languages (early Spanish learners, EL). And, finally, the third group was comprised of eighty four second language learners of Spanish of varying proficiency whose
native language is English (late Spanish learners, LL). This last group was further divided into three subgroups that corresponded to the level of the Spanish-class in which participants were enrolled at the time of testing. We had a first-year student group with 27 participants, a second-year student group with 27 participants and a third-year student group with 30 participants.

4.4 Stimuli and Procedure

To investigate the phonological encoding of stress we fundamentally replicated the design of one of the experiments reported in Dupoux, Pallier, Sebastián-Gallés, and Mehler (1997). In particular, we conducted an ABX discrimination task that made use of 12 CVCVCV nonword quadruplets that differed in three possible contrast conditions: consonant condition, stress condition, and redundant condition. In the consonant condition, stimuli in a trial differed as a function of a consonantal contrast shared by both Spanish and English, such as the /b/-/n/ contrast. For instance, the forms bédapi and nédapi, phonotactically-legal nonwords in both Spanish and English, differ only in the use of consonants /b/ and /n/ in word-initial position. This condition is expected to be easily discriminable by all groups of participants. Contrasting consonants were located in different places in the nonwords, not only in word-initial position. In the stress condition, stimuli in a trial differed as a function of the location of stress in any of the three syllables of the nonword stimuli. For instance, the forms bédapi and bedápi, phonotactically-legal nonwords in both languages, differ only in the location of stress, word-initial in bédapi (/bédapi/) but word-medial in bedápi (/beˈdapi/). This condition is expected to be more difficult than the consonant condition for at least some of our learner
participants. In other words, the stress condition constitutes the target condition, and the consonant condition constitutes the main control condition. Finally, the redundant condition provides a condition against which to measure the other two. In this third condition, stimuli in a trial differ as a function of both a consonantal contrast and the location of stress. For instance, the forms *bédapi* and *nedápi*, differ in both the location of stress, word-initial in *bédapi* but word-medial in *nedápi*, and a segmental contrast shared by the two languages, */b/-/n/*. For people who encode both stress and consonant contrasts phonologically, this is expected to be an easy condition. However, for people who encode consonant contrasts, but not lexical stress, phonologically, it is difficult to make a clear prediction.

The stimuli were presented in the form of three auditory items per trial—a triad. The first and second items (A, B) were always different nonwords which contrasted as a function of one of the three key contrast conditions: stress, consonant, redundant. The third item in the trial (X) was always phonologically identical to either the first (A) or the second (B) item. In all trials, participants were asked to indicate by pressing a button whether the last item was like the first (ABA, BAB) or, rather, like the second (ABB, BAA) item in the trial. Order of presentation was included as a factor. Trials in which targets resembled the first stimulus were assigned to the primacy condition and trials in which they resembled the second stimulus were assigned to the recency condition. Comparisons in the primacy condition are expected to be more challenging than those in the recency condition, particularly in cases in which phonological encoding is not available, as stimuli are more distant in time and an additional auditory stimulus is played between the two compared items, the B stimulus (Best, McRoberts, & Sithole, 1988).
The auditory stimuli were produced by three Spanish-speaking talkers, two men and one woman. The three talkers were native speakers of Spanish who grew up speaking only that language as children and who learnt English only as adults. They currently reside in North America and use Spanish and English on a daily basis, but continue to be dominant in Spanish. Recordings were made with a Marantz PMD660 digital recorder and a Shure SM10A head-mounted, dynamic microphone. The recordings were digitized at a sampling rate of 44.1 kHz and 16-bit quantization. Talker order was kept constant throughout the experiment. The stimuli from the two male speakers were assigned to the first and second items (A, B) and the stimuli from the female talker was always played as the third item (X); this means that the stimuli recorded by the female talker always acted as the target. This ensured that identical nonwords were acoustically different as they were produced by different speakers. Thus, auditory comparisons had to be based on phonological comparisons rather than acoustic-phonetic ones. From the recorded stimuli, 288 experimental trials were designed. Trials were counterbalanced so that each of the items in the quadruplets appeared as the first item (A) three times, one for every possible contrast found in the second item (B): stress, consonant, redundant. This resulted in 12 possible combinations for each quadruplet (4 nonwords × 3 contrasts). Since the third item, the target, could be identical to either the first one (A) or the second one (B), all of the 12 possible AB combinations of each quadruplet appeared twice, one for every possible correct order (primacy condition [ABA, BAB], and recency condition [ABB, BAA]). The final experimental design was as follows: 12 quadruplets × 12 combinations × 2 correct orders = 288 trials. All experimental items were randomized and participants were given the option to take a break every 24 trials. The interstimulus interval (ISI) was set constant at 500 ms.
The participants completed the task using MDR-7502 Sony headphones in a sound-attenuated booth in front of a computer running the experiment from a Python script, which had been written with PsychoPy (Peirce, 2007). The desktop computer was connected to a Cedrus RB-834 response pad. The participants were told that they would listen to three Spanish nonwords and were instructed to decide, as quickly as possible and without making mistakes, whether the last nonword in the triad was like the first or like the second one. They were asked to respond by pressing one of two activated keys on the response pad. Responses were coded as a function of their accuracy (correct vs. incorrect identification) and timing (measured from the onset of the third, target auditory stimulus). The experiment was preceded by a practice session of 10 trials with items under identical conditions as the experimental trials but with different nonwords.

4.5 Data and Analyses

The present experiment investigates whether participants’ experience with the Spanish language affects their likelihood of displaying robust stress-encoding patterns in a perceptual discrimination task. Our exploration is conducted by means of two separate analyses, which address research questions 1 and 2. On the one hand, we compare both early Spanish/English bilinguals (early learners) and adult second-language learners of Spanish whose native language is English (late learners) with participants who grew up speaking only Spanish in childhood (native controls). The main research question addressed by this analysis has to do with whether early and late learners differ in their stress-encoding abilities. This first research question does not concern age of acquisition exclusively. In our sample, the early and late learners present
differences not only in their age at onset of Spanish exposure, but also on length of exposure and language proficiency. Therefore the first research question could be laid down as follows: Does length and depth of experience with the Spanish language modulate participants’ likelihood of displaying robust stress encoding in their perceptual behavior? To address this research question, we compared ten participants per group: ten native-speaker controls, ten early learners of Spanish, and the ten most proficient late learners of the language in our sample. The selection of the data for this analysis is explained below.

The second question addressed in our study concerns the role of proficiency in late second-language learners of Spanish. This question focuses exclusively on the second-language learners, and may be laid down as follows: Does a learner’s higher grammatical and lexical proficiency—i.e., higher competency due to further experience with the language—correlate with a higher likelihood of displaying robust patterns of stress encoding? Proficiency, in our sample, is correlated with other variables, such as length of study. To address this question, we analyze the behavior of all 84 late learners, but exclude from the analyses the native-speaker controls and the early bilinguals. The selection of the data for this analysis is explained below.

Data wrangling and analyses for both studies were conducted with a collection of R scripts (R Core Team, 2018), with packages tidyverse (Wickham, 2017), afex (Singman, Bolker, Westfall, & Aust, 2018), and emmeans (Lenth, 2018).

4.5.1 Study 1

The first comparison was carried out on a total of 30 participants categorized in three groups as a function of their linguistic experience. There were ten participants in each group: (i) native
speakers of Spanish with English as their second language to act as controls (NS); (ii) Spanish/English bilinguals who learned both languages during childhood (early learners, EL); (iii) second-language learners of Spanish with English as their native language (late learners, LL). The ten late learners selected for this analysis were the ten most proficient participants from the group of second-language learners. To select the ten participants, we used the scaled overall proficiency score assigned to each of the 84 participants in our LL sample (see Table 3.1). The scaled overall proficiency score results from adding the three scaled scores corresponding to the vocabulary size, the sentence cloze test, and the passage cloze test scores. The result of this addition is then scaled back between 0 and 1.

The statistical exploration of this particular data set consists of analyses of accuracy rates and response times as a function of two experimental conditions: (i) contrast (stress condition, consonant condition, redundant condition), and (ii) stimuli order (i.e., whether the target item matches the first item in the triad [ABA, BAB: primacy] or the second [ABB, BAA: recency]). For each of the 30 participants in this dataset, accuracy rates (proportion-correct scores) and response times (ms) are obtained for each of the experimental conditions. In the analyses of the latency data, we only include response times in triads that were responded to correctly. This results in six accuracy scores and six response-time scores per participant, a total of 180 observations in the accuracy dataset (6 scores × 30 participants) and 180 total observations in the response-time dataset (6 scores × 30 participants). Proportion-correct scores, which derive from categorical data (correct vs. incorrect response), are submitted to an arcsine transformation prior to statistical analyses. Bound data, such as proportion scores, are typically transformed to increase the normality of the data and to make them amenable to parametric statistical
explorations (Cochran, 1940; Gotelli & Ellison, 2004; but see Warton & Hui, 2011; Winer, Brown, & Michels, 1971).

The dominance and proficiency scores corresponding to the ten native-speaker controls and the ten early Spanish/English bilinguals are reported in Table 3.1. However, Table 3.1 shows the dominance and proficiency scores of the entire group of second-language learners of Spanish ($N = 84$). For reference, the data corresponding to the ten most advanced Spanish speakers in the group—i.e., the subset of late learners included in this study—are as follows: BLP ($M = 113; SD = 17$), sentence cloze test ($M = .49; SD = .08$), passage cloze test ($M = .45; SD = .1$), LexTale-Esp test ($M = .32; SD = .06$). A series of $t$-tests confirmed that each group differed from the other two groups in terms of both dominance (NS-EL: $t(12.25) = -9.12, p < .0001$; NS-LL: $t(17.93) = -30.53, p < .0001$; EL-LL: $t(11.90) = -7.59, p < .0001$) and proficiency (NS-EL: $t(10) = -8.72, p < .0001$; NS-LL: $t(14.97) = -50.65, p < .0001$, EL-LL: $t(11.61) = -13.01, p < .0001$). Of the ten participants in this subsample, nine were in their third year of college Spanish and one was in her second year.

4.5.2 Study 2

The second statistical exploration is conducted on the entire second-language learners’ dataset ($N = 84$). Participants in this group differed in their experience with Spanish, which translates to differences in vocabulary size and grammatical proficiency. First, we investigate whether the length of time they had been taking college Spanish courses affects their phonological encoding patterns. For this, we compare three groups of second-language learners as a function of their course year: first-, second-, or third-year college Spanish. The three groups, in addition to
differing with regards to the course in which they were enrolled at the time of testing, also differ in dominance, as determined by the BLP scores (first-second: $t(50.05) = 3.58, p < .016 [.0007]$; second-third: $t(49.83) = 3.69, p < .016 [.0005]$; first-third: $t(54.12) = 8.29, p < .0001$), as well as in overall proficiency, as determined by the added and scaled language proficiency measures (first-second: $t(49.29) = -1.78, p > .016 [.08]$; second-third: $t(54.97) = -3.13, p < .016 [.002]$; first-third: $t(51.77) = -5.15, p < .0001$). Note that, in terms of overall proficiency, the third-year group differs from the other two, but the first- and the second-year groups are not significantly different from each other.

Subsequently, we investigate whether an increase in proficiency—as measured by lexical and grammar tests—correlates with their phonological encoding patterns. A linear-regression analysis with continuous proficiency measures as predictors constitute the basis of this exploration. The proficiency measures are the scaled scores obtained by means of the two grammatical-proficiency tests (the passage cloze test and the sentence cloze test) and the vocabulary-size test.

4.6 Results

4.6.1 Study 1: The Role of Linguistic Experience

The first statistical exploration focuses on a subset of 30 participants: the 10 native speakers (NS), the 10 early bilinguals (EL), and a subsample of 10 subjects from the late learner group (LL). The 10 late learners were the most advanced learners in the sample of 84 learners, according to their scores on grammatical proficiency and vocabulary size. In this analysis, we investigate the role of linguistic experience on phonological encoding. In particular, we analyze
the potential role of age of acquisition (early vs. late learners of Spanish) or of length and depth of experience (life-long experience vs. recent, adulthood-only experience with Spanish) on the phonological encoding of lexical stress.

Table 4.2 shows the descriptive statistics for both response accuracy and timing as a function of participant group (NS, EB, LL), type of contrast (stress, consonant, redundant), and stimuli order (primacy [ABA, BAB], recency [ABB, BAA]). In the table, accuracy is presented in proportion-correct scores and timing is shown in milliseconds. Inferential statistics, however, are conducted over transformed observations; that is, accuracy values are arcsine-transformed and response times are log-transformed.

Table 4.2: Descriptive statistics (mean and standard deviation) for both accuracy (proportion-correct scores) and timing (response times in milliseconds for correct responses only) as function of contrast (consonant, redundant, stress), order (primacy, recency), and group (NS, EL, LL).

<table>
<thead>
<tr>
<th></th>
<th>Accuracy (prop. correct)</th>
<th>RT (ms.)</th>
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<tbody>
<tr>
<td></td>
<td>conson.</td>
<td>redund.</td>
</tr>
<tr>
<td>NS</td>
<td></td>
<td></td>
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<tr>
<td>primacy</td>
<td>.97</td>
<td>.98</td>
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<tr>
<td></td>
<td>(±.04)</td>
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<tr>
<td>recency</td>
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<td>EL</td>
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<td>.96</td>
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<td>(±.04)</td>
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4.6.1.1 Response Times

Log-transformed response times for all correct responses are submitted to a mixed-design $3 \times (3) \times (2)$ analysis of variance (ANOVA) with contrast and order as within-subjects factors, and group as a between-subjects factor. The ANOVA yields main effects of contrast, $F(1.56, 42.04) = 44.98; p < .0001; \eta^2 = .06$, and order, $F(1, 27) = 35.32; p < .0001; \eta^2 = .06$, but no main effect of group, $F(2, 27) = 1.85; p > .05 [.18]; \eta^2 = .11$. Only one of the interactions is significant, the two-way contrast by order interaction, $F(1.74, 46.89) = 5.62; p < .05 [.009]; \eta^2 = .006$. (Note that the degrees of freedom are Greenhouse-Geisser corrected when sphericity is found to be violated. This is done throughout the study.)

To explore the interaction, we conduct pairwise comparisons using estimated marginal means and obtain effect sizes for each comparison (Searle, Speed, & Milliken, 1980). In pairwise comparisons, $p$ values are corrected using the Tukey method for comparing a family of three estimates—this is done throughout the study, when appropriate. In the primacy condition, all contrast types differ from each other (consonant-redundant: $t(27) = 4.98; p < .016 [.0001]; \beta = .008$; consonant-stress: $t(27) = -4.50; p < .016 [.0003]; \beta = .014$; redundant-stress: $t(27) = -7.14; p < .0001; \beta = .015$. Meanwhile, in the recency condition, the redundant contrast differs from the other two (consonant-redundant: $t(27) = 5.49; p < .0001; \beta = .009$; redundant-stress: $t(27) = -6.29; p < .0001; \beta = .010$) but stress and consonant contrasts do not (consonant-stress: $t(27) = -1.06; p > .05 [.54]; \beta = .013$). This explains the interaction.

In other words, in the recency condition, participants’ responses in redundant contrasts are found to be faster than those in consonant- and stress-based contrasts, whereas consonant and stress trials are not found to differ from each other. In the primacy condition, on the other hand,
responses in redundant trials are significantly faster than those in the other two conditions and responses in stress trials are significantly slower than those in the other three conditions. Note that, interestingly, an analysis of response latencies suggests that experimental conditions affect similarly the three participant groups.

4.6.1.2 Response Accuracy

Arcsine-transformed proportion-correct scores are similarly explored with a $3 \times (3) \times (2)$ ANOVA with contrast and order as within-subjects factors, and with group as a between-subjects factor. The ANOVA reveals significant main effects of group, $F(2, 27) = 8.97; p < .001; \eta^2 = .23$, contrast, $F(1.76, 47.45) = 19.28; p < .0001; \eta^2 = .14$, and order, $F(1, 27) = 15.32; p < .0001; \eta^2 = .08$. All two-way interactions are also found to be significant: group by contrast, $F(3.51, 47.45) = 5.28; p < .05 [.002]; \eta^2 = .08$, group by order, $F(2, 27) = 4.24; p < .05 [.03]; \eta^2 = .05$, and contrast by order, $F(1.88, 50.74) = 12.87; p < .0001; \eta^2 = .08$. Finally, the three way interaction is also revealed to be significant, $F(3.76, 50.74) = 5.27; p < .05 [.002]; \eta^2 = .06$.

In order to explore the three-way interaction, we investigate the potential effects of both contrast and group, as well as their interaction, for each participant group, separately. Hence, each ANOVA has a $(3) \times (2)$ repeated-measures design with contrast and group as within-subjects factors. The ANOVA corresponding to the NS group does not produce any significant findings: contrast, $F(1.30, 11.67) = .18; p > .05 [.74]; \eta^2 = .004$, order, $F(1, 9) = .01; p > .05 [.92]; \eta^2 = .0001$, and contrast by order interaction, $F(1.83, 16.47) = .29; p > .05 [.73]; \eta^2 = .006$. In other words, NS participants are found to be equally (highly) accurate in all three
contrast conditions and in both trial orders, regardless of whether the matching stimulus is adjacent or nonadjacent. This may be seen in the descriptive statistics in Table 4.2.

The ANOVA to which we submit the EL data reveals significant main effects of contrast, \(F(1.36, 12.20) = 15.71; p < .05 [\ .001]; \eta^2 = .37\), and of order, \(F(1, 9) = 9.25; p < .05 [\ .01]; \eta^2 = .19\), as well as a significant interaction between the two predictors, \(F(1.65, 14.82) = 18.79; p < .0001; \eta^2 = .28\). To explore the interaction, pairwise comparisons are conducted across contrast types in the two trial orders separately. In recency trials, in which the target and matching stimuli are adjacent, none of the contrast conditions are found to differ significantly from each other (consonant-redundant: \(t(9) = -1.15; p > .016 [\ .50]; \beta = -.03\); consonant-stress: \(t(9) = .44; p > .016 [.89]; \beta = .01\); redundant-stress: \(t(9) = 1.31; p > .016 [.42]; \beta = .05\)). In primacy trials, on the other hand, the stress condition is revealed to differ significantly from both the redundant (\(t(9) = 5.86; p < .016 [.0006]; \beta = .35\)) and the consonant (\(t(9) = 4.80; p < .016 [.002]; \beta = .34\)) conditions, but the redundant and the consonant conditions do not differ from each other (\(t(9) = -0.19; p > .016 [.97]; \beta = -.009\)). In sum, in trials in which the target and matching stimuli are adjacent, the EL participants are highly accurate across contrast types, just like the NS participants. On the other hand, in trials in which the target and matching stimuli are nonadjacent, the EL participants are accurate only when trials differ exclusively in consonant or consonant and stress identity. When trials differ exclusively in stress location, on the other hand, EL participants tend to be less accurate.

Finally, the ANOVA exploring the LL data yields significant main effects of both contrast, \(F(1.34, 12.03) = 7.39; p < .05 [\ .01]; \eta^2 = .11\), and order, \(F(1, 9) = 9.77; p < .05 [\ .01]; \eta^2 = .13\), but there is no significant interaction between the two, \(F(1.98, 17.79) = 1.71; p > .05 [.21];\)
\( \eta^2 = .03 \). The effects of order are due to participants demonstrating higher accuracy in the recency condition than in the primacy condition, \( t(9) = -3.12; \ p < .016 \ [.012]; \ \beta = -.09 \). In other words, trials in which the matching stimulus is not adjacent are more likely to yield erroneous responses. More importantly, however, the contrast effects seem to be due to these participants’ difficulties with the stress condition in particular, as they tend to be slightly less accurate in the stress condition than in the two other conditions (consonant-stress: \( t(9) = 3.23; \ p > .016 \ [.025]; \ \beta = .078 \); redundant-stress: \( t(9) = 2.82; \ p > .016 \ [.047]; \ \beta = .101 \), while they are similarly accurate in the consonant and the redundant conditions, \( t(9) = -1.14; \ p > .016 \ [.51]; \ \beta = -.023 \). Yet these differences appear to be marginal.

To summarize, participants in the NS group are highly accurate across conditions, regardless of whether trials change as a function of a consonant contrast, the location of lexical stress or both. They are also unaffected by whether the matching stimulus is adjacent or nonadjacent to the target. These findings are in line with those in Dupoux et al. (1997). Participants in the EL group are similarly accurate across contrasts, but only in triads in which the target and matching stimuli are adjacent. In triads in which the matching stimuli are not adjacent, on the other hand, they are less accurate in conditions involving a change in stress location than one in consonant identity. Surprisingly, EL participants are also less accurate in the redundant condition than in the consonant condition in primacy trials. Finally, the findings pertaining to the LL group suggest that trials involving exclusively a change in the location of stress—but not when both consonant identity and stress location change—are slightly more difficult for these participants, especially when the matching stimuli are not adjacent.
It seems that only the primacy condition reveals differences between the NS group and both the EL and LL groups. In these particular trials, changes involving the location of stress lead to more erroneous responses for the participants in the experimental groups than for those in the control group. Note, however, that we have not ascertained this specific statement, since we analyzed the effects of the two within-subject factors for the three groups of participants separately after finding a three-way interaction in the omnibus ANOVA. Therefore, in order to obtain an explicit, direct finding pertaining to these particular facts, we change the terms of the follow-up analysis by focusing exclusively on the participants’ responses to primacy trials, in which the target and matching stimuli are not adjacent. We employ a mixed-design ANOVA with transformed accuracy scores as the dependent variable, group (NS, EL, LL) as a between-subjects factor, and contrast (consonant, stress, redundant) as a within-subjects factor to analyze a data frame in which only primacy trials are included. The ANOVA finds significant effects of group, $F(2, 27) = 9.13; p < .001; \eta^2 = .31$, and contrast, $F(1.82, 49.03) = 28.25; p < .0001; \eta^2 = .26$, and a significant interaction between the two, $F(3.63, 49.03) = 9.03; p < .0001; \eta^2 = .18$. In turn, follow-up pairwise comparisons yielded no significant differences between any of the three participant groups in the consonant condition (EL-NS: $t(27) = -1.97; p > .016 [.138]; \beta = -.11$; LL-NS: $t(27) = -2.18; p > .016 [.091]; \beta = -.12$; EL-LL: $t(27) = .21; p > .016 [.975]; \beta = .012$), as expected. In the stress condition, the EL group’s accuracy differs from that of the controls, $t(27) = -5.57; p < .0001; \beta = -.421$, but the difference between the LL group’s accuracy and that of the controls is only marginal, $t(27) = -2.86; p > .016 [.021]; \beta = -.216$. There is also a marginal difference between the EL group’s accuracy and that of the LL group, $t(27) = -2.71; p > .016 [.029]; \beta = -.205$. It appears that, in the stress condition, the accuracy of the EL group is the
lowest, and that of the LL group stands somewhere in between that of the other two groups and differs from each of them only marginally. In the redundant condition, the three groups do not differ from one another (EL-NS: $t(27) = -1.79; p > .1; \beta = -.095$; EL-LL: $t(27) = 0.57; p > .8; \beta = .030$; LL-NS: $t(27) = -2.39; p > .06; \beta = -.125$).

Figure 4.1. Boxplots of accuracy by group as a function of order and contrast
In sum, while, in primacy trials, all three groups of participants are similarly accurate when stimuli differ solely as a function of the identity of their consonants, when stress differences are involved the two experimental groups turn out to be less accurate than the native controls—although this difference is only reliable for the early learners. Taking into account only the trials in the primacy order condition, an exploration of the individual by-condition means shows that, in the stress contrast condition, eight of the ten EL participants’ values are situated beyond two standard deviations from the NS mean and, in the redundant contrast condition, all of them stand beyond that threshold. On the other hand, only four of the LL participants’ values in the stress contrast condition are found beyond two standard deviations from the mean of the NS group, and two of them are found beyond that threshold in the redundant condition.

Taking into account only the trials in the primacy order condition, an exploration of the individual by-condition means shows that, in the stress contrast condition, eight of the ten EL participants’ values are situated beyond two standard deviations from the NS mean and, in the redundant contrast condition, all of them stand beyond that threshold. However, only four of the LL participants’ values in the stress contrast condition are found beyond two standard deviations from the mean of the NS group, and two of them are found beyond that threshold in the redundant condition.

4.6.2 Study 2: The Role of Proficiency in Late Learners

The second statistical exploration focuses on a subsample of 84 participants. These are all the second language learners that participated in this experiment. The 10 late bilinguals included in Study 1 were the most advanced learners in the group; therefore, the remaining 74 participants
whose behavior we investigate here are less proficient. In Study 2, we investigate the role of experience—determined by length of study and independent scores of grammatical proficiency and vocabulary size—on the phonological encoding of lexical stress. We conduct two analyses, one in which participants are classified by their level in the Spanish language program in which they are enrolled (first, second, and third-year college Spanish) and one in which we use continuous predictors: grammatical proficiency and vocabulary size as determined by the BLP and grammar tests explained in the Method section.

Table 4.3: Descriptive statistics (mean and standard deviation) for both accuracy (proportion-correct scores) and timing (response times in milliseconds for correct responses only) as function of contrast (consonant, redundant, stress), order (primacy, recency), and participant year-of-study (first-, second-, third-year college Spanish) in Study 2.

<table>
<thead>
<tr>
<th></th>
<th>Accuracy (prop. correct)</th>
<th>RT (ms.)</th>
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<tbody>
<tr>
<td></td>
<td>conson.</td>
<td>redund.</td>
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<tr>
<td>First year</td>
<td></td>
<td></td>
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<tr>
<td>primacy</td>
<td>.94</td>
<td>.95</td>
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<tr>
<td></td>
<td>(±.05)</td>
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<tr>
<td>recency</td>
<td>.96</td>
<td>.97</td>
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<td></td>
<td>(±.04)</td>
<td>(±.03)</td>
</tr>
<tr>
<td>Second year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>primacy</td>
<td>.92</td>
<td>.94</td>
</tr>
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<td></td>
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<tr>
<td>recency</td>
<td>.93</td>
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<td>Third year</td>
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<td>primacy</td>
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<td>recency</td>
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<td>(±.04)</td>
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</table>
Table 4.3 shows the descriptive statistics for both response accuracy and timing as a function of participant year (first-, second-, and third-year college Spanish), type of contrast (stress, consonant, redundant), and stimuli order (primacy [ABA, BAB], recency [ABB, BAA]). In the table, accuracy is presented in proportion-correct scores and timing is shown in milliseconds. Inferential statistics are conducted over transformed observations.

4.6.2.1 Response Times

Log-transformed response times for all correct responses are submitted to a mixed-design \(3 \times (3) \times (2)\) analysis of variance (ANOVA) with contrast and order as within-subjects factors, and group as a between-subjects factor. The three groups correspond to the second-language learners of Spanish organized by course year: first- \((N = 27)\), second- \((N = 27)\), and third-year \((N = 30)\). The ANOVA yields main effects of contrast, \(F(1.53, 124.11) = 123.91; p < .0001; \eta^2 = .09\), and order, \(F(1, 81) = 163.89; p < .0001; \eta^2 = .08\), but no main effect of group, \(F(2, 81) = .48; p > .05\) \([.62]\); \(\eta^2 = .10\). Only one of the interactions is significant, the two-way contrast by order interaction, \(F(1.91, 155.05) = 16.93; p < .0001; \eta^2 = .010\). The interaction is analyzed by exploring the effects of order for each contrast type, separately. Pairwise comparisons are obtained by means of estimated marginal means. Whereas participants are faster at responding to trials in the recency condition than to those in the primacy condition across all contrast types, the size of the effect is found to be largest in the stress condition \((t(81) = 11.06; p < .0001; \beta = .115)\), smaller in the redundant condition \((t(81) = 9.40; p < .0001; \beta = .065)\), and smallest in the consonant condition \((t(81) = 6.18; p < .0001; \beta = .055)\). In sum, length of study does not appear to impact response-latency patterns in this task.
4.6.2.2 Response Accuracy

Arcsine-transformed proportion-correct scores are similarly explored with a $3 \times (3) \times (2)$ ANOVA with contrast and order as within-subjects factors, and with group as a between-subjects factor. The ANOVA reveals significant main effects of contrast, $F(1.54, 125.04) = 134.54; p < .0001; \eta^2 = .30$, and order, $F(1, 81) = 112.69; p < .0001; \eta^2 = .18$, but no main effects of group, $F(2, 81) = .62; p > .05 [.54]; \eta^2 = .007$. Only the contrast by order interaction is found to be significant, $F(1.82, 147.30) = 93.92; p < .0001; \eta^2 = .15$. Interestingly, group does not interact with any other factor. The interaction between contrast and order is due to the fact that, in primacy trials, accuracy differs for all contrast types (consonant-redundant: $t(81) = -3.30; p < .016 [.004]; \beta = -.039$; consonant-stress: $t(81) = 12.83; p < .0001; \beta = .300$; redundant-stress: $t(81) = 14.49; p < .0001; \beta = .339$), whereas in recency trials it is only the redundant contrast condition that differs from the other two (consonant-redundant: $t(81) = -4.68; p < .0001; \beta = -.068$; redundant-stress: $t(81) = 6.99; p < .0001; \beta = .097$), as the consonant and stress conditions do not differ from each other (consonant-stress: $t(81) = 2.01; p > .016 [.115], \beta = .029$). Effect sizes are larger in the primacy trials than in the recency trials. In general, participants are more accurate in the redundant contrast condition than in the other two, and they are most prone to error in the stress-only contrast condition, particularly in primacy trials, where the target and matching stimuli are not adjacent. This pattern is comparable to the one found in Study 1 for the ten participants in the late learner (LL) group. Importantly, it does not seem that the level of the course year in which a participant is enrolled affects their behavior in this perceptual discrimination task.
Figure 4.2. Boxplots of accuracy by group as a function of order and contrast.

Taking into account only the trials in the primacy order condition, which are the ones that prove to be difficult for these learners, an exploration of the individual by-condition means shows that, in the stress contrast condition, 22 of the 27 first-year participants (81%) are situated beyond two standard deviations from the mean of the native controls for this particular condition (see Study 1), also 22 of the 27 second-year participant’s (81%) are found beyond this threshold, and 23 of the 30 third-year participants (77%) are found beyond the threshold. This suggests that this particular experimental condition—in which stimuli differ exclusively in the location of
stress and where the target and matching stimuli are not adjacent—are particularly difficult for second-language learners of Spanish whose first language is English. Interestingly, trials of this type remain difficult across the course levels included in our study.

4.6.2.3 Predicting Response Accuracy from Proficiency

The null finding on the effects of group does not necessarily imply that grammatical proficiency and vocabulary size (or both) do not predict phonological encoding patterns in second-language learners. The null finding only means that categorizing participants by their course year does not appear to provide any insight into the development of stress encoding abilities in English-speaking second-language learners of Spanish. These results could stem from the fact that participants in these three groups may have different knowledge of their L2 which, in turn, may translate into varying levels of linguistic ability when it comes to phonological encoding. Thus, it could be the case that unbalanced proficiency levels in each group may be masking the results. In order to test that, instead of investigating accuracy as a function of course year in a between-subjects factorial design, we set out to predict accuracy rates as a function of the attribute data we gathered from each of the 84 second-language learners in our sample. Here, we focus on participants’ behavior in the condition that appears to be the most difficult for these learners, the stress-only contrast condition in the primacy trials—i.e., the trials whose stimuli differ exclusively in the location of stress and where the matching and target stimuli are not adjacent.

First, a linear regression model with arcsine-transformed accuracy as response and dominance—i.e., the scores obtained with the Bilingual Language Profile questionnaire—as predictor fails to produce a significant finding, $\beta = -.0002$, $t = -.268$, $p > .05$ [.79], $R^2 = -.011$. It
can be concluded that dominance scores do not predict the stress encoding capabilities of this participant sample, perhaps because the profile questionnaire we employed is not sensitive enough to detect differences in proficiency within a sample of late learners that are very similar to each other in terms of experience with their second language.

Second, we regress arcsine-transformed accuracy with overall proficiency scores as predictor. Recall that such scores are obtained by adding the three scaled proficiency scores—passage cloze test, sentence cloze test, and vocabulary-size test—and scaling the result back between 0 and 1. This time, the regression model produces a significant finding, $\beta = .981$, $t = 4.225$, $p < .0001$, $R^2 = -.168$, one that explains 16% of the variance. Therefore, an increase in linguistic proficiency correlates with an increase in response accuracy; in other words, more proficient learners appear to be more likely to display accurate stress-encoding abilities than less proficient learners. As adult second-language learners of Spanish improve on their linguistic skills, they also develop stronger representations of word-level stress. Nevertheless, it is possible that more proficient learners are simply more likely than less proficient ones to carry out this particular perceptual task more successfully. If this were the case, overall proficiency would predict accuracy rates across contrast conditions, not only the stress condition. To rule out this possibility, we subtract each subject’s accuracy score in the stress condition from their accuracy score in the consonant condition (in primacy trials exclusively), our control contrast (see also Dupoux et al., 1997, 2001; Peperkamp & Dupoux, 2002). This difference score is then regressed with overall proficiency as predictor, which produces a significant finding, $\beta = -.739$, $t = -3.33$, $p < .05 [0.0013]$, $R^2 = -.108$. In particular, we find that more proficient learners have a smaller difference score than less proficient ones. As learners become more proficient, the difference in
accuracy between their stress encoding abilities and their consonant encoding ones becomes smaller. This analysis confirms that with an increase in grammatical proficiency comes an increase in the ability to encode stress phonologically. Second-language learners of Spanish appear to become more likely to represent stress phonologically as they become more proficient.

Our overall proficiency score results from adding three separate measures of linguistic proficiency. In order to further assess the proficiency effects we see above, we regress accuracy scores in the stress-primacy condition using each of these proficiency scores as predictor, separately. First, when using vocabulary-size scores—obtained through the LexTale-Esp task (Izura et al., 2014; Martínez García, 2016)—as predictor, we obtain a null finding, $\beta = .299, t = 1.007, p > .05 [.317], R^2 = .0001$. Vocabulary size does not explain the variance in accuracy from our sample. Interestingly, the proficiency effect comes exclusively from the grammatical cloze tests. Both the sentence ($\beta = .621, t = 3.72, p < .05 [.0004], R^2 = .134$) and the passage ($\beta = .677, t = 3.72, p < .05 [.0004], R^2 = .134$) versions of the test (Martínez García, 2016). In fact, both tests yield similar findings, as each explains about 13% of the variance. However, the best fit is obtained by using both cloze-test scores as predictors in a single linear model. A linear model with two predictors is found to be significantly better than a model with only one of the predictors, $F(1, 81) = 7.76, p < .05 [.006]$, and it explains about 20% of the variance.

In sum, the data suggest that second-language learners of Spanish whose native language is English have difficulties processing word-level stress contrasts in their second language. These difficulties are revealed in discrimination triads in which nonword stimuli differ solely as a function of the location of stress and only in the primacy condition (where the matching and target stimuli are not adjacent). In these cases, participants in the experimental groups obtain
about 71% correct responses. In trials in which nonword stimuli differ in the identity of one of their consonantal segments, they average about 93% correct responses. Native Spanish speakers who grew up monolingual do not demonstrate this asymmetry in their behavior. Moreover, participants' accuracy in two grammatical-proficiency cloze tests are able to predict, to some extent, their success in the stress-based triads in this perceptual discrimination task. We conclude that, as they become more proficient in terms of grammatical knowledge, and perhaps their vocabulary, they also develop stronger representations of word-level stress.

4.7 Interim Discussion

4.7.1 Summary of Findings

In this experiment, we had native speakers of Spanish, early Spanish-English bilinguals and English native speakers late learners of Spanish participate in an ABX task. This task was able to reveal stress processing difficulties in a previous study that looked at the phonological encoding of stress in French and Spanish (Dupoux et al., 1997). This task required participants to make a decision based on three auditory items: A, B and X. The hypothetical complexity of this task lies in the fact that participants need to rely on a phonological representation of (perhaps some of) the items in order to compare them. They need to hold at least item A in short-term memory while they hear item B and compare it to item X. This retention of item A, most likely, forces participants to rely on an abstract representation of the item rather than a low level phonetic remembrance of it. The aim of the present study was to test the robustness of this abstract representation with regards to stress. We manipulated the experimental items in such a way that we were able to compare this abstract phonological representation of stress to that of consonants.
Consonants are expected to be encoded at ceiling as the consonants included in the stimuli are present in the phonological inventory of the languages being tested. Thus, participants responses to the consonant condition provide a baseline to which the responses to the stress condition can be compared. We performed two different analyses in order to answer the two research questions we set for this experiment.

The first question addressed whether length and depth of experience with the Spanish language modulate participants’ likelihood of displaying robust stress encoding in their perceptual behavior. Our results indicate that the early and late learner groups were challenged by the stress contrast. The group of late learners and the 10 early learners with the highest proficiency scores displayed a similar accuracy rate when they were asked to recall differences in stress. Both groups were significantly less accurate in the stress condition than in the consonant condition. Thus, it appears that, for the late learners, high target language proficiency does not lead to native-like performance in the discrimination of stress contrasts. Similarly, early experience with Spanish, in the case of the early learners, did not lead to higher stress-encoding abilities.

The second research questions related to whether learner’s higher grammatical and lexical proficiency—i.e., higher competency due to further experience with the language—correlated with a higher likelihood of displaying robust patterns of stress encoding. Findings from the second study indicate that year of study does not have an effect on stress perception. However, late learners’ proficiency (as measured by the composite score of their accuracy in the sentence and passage cloze tests) was found to be a significant predictor of their performance with the stress contrast. The model was able to predict about 20% of the variance.
Thus, late learners show a significant development in their stress-encoding abilities with increased proficiency.

4.7.2 Interpretation and Implications

The results of the present experiment shed light onto the phonological processing abilities of late and early learners of Spanish. We tested participants using the ABX paradigm, which had previously been used to reveal processing differences between French and Spanish (Dupoux et al., 1997). We modified Experiment 3 from Dupoux et al. (1997) to incorporate higher phonetic variability (each of the three items of the ABX was produced by a different speaker), and a higher number of experimental triads (288 instead of 144). The results suggest that EL and LL participants were challenged when asked to recall the stress pattern of the first item A. In other words, we found a primacy effect for the stress condition only. This effect was not found for the consonant condition. This means that EL and LL participants struggled to access stress information when it had been stored in short-term memory. But when it came to recalling consonant information, they were successful in remembering the identity of nonwords.

The present study provides evidence that English speakers present some degree of stress ‘deafness’. This means that, when asked to rely on their phonological representation, they have limited access to stress information. This was successfully predicted by the lexical statistics account (Peperkamp et al., 2010) as it posited that the lower number of lexical exceptions in English (10%) when compared to Spanish (20%) should render poorer encoding of stress in phonological memory. This means that, despite their typological similarities (like stress being contrastive in both languages), the ways speakers of English and Spanish phonologically exploit
stress is quantitatively different. The lexical statistics account would locate English between Polish (0.1% of lexical exceptions) and Spanish, thus, supporting the claim made by Peperkamp et al. (2010) that there might be languages with intermediate stress ‘deafness’ between Polish and Spanish. Further studies could corroborate this theory by comparing stress-encoding in speakers of Polish and in speakers of English.

These results align with previous accounts on stress-encoding in English such as those in Lin et al. (2014). In their Sequence Recall involving the contrasts /'mipa/—/'mi'pa/ and /'kup/—/'kuti/, English speakers’ stress-encoding abilities were not significantly different than those of speakers of Korean (a language with no lexical stress). This means that they were able to recall sequences more successfully if the sequences involved a consonant minimal pair than if they were tested on the stress minimal pair. The authors attributed these results to the lack of vowel reduction cues in the stress minimal pair. The present study provides evidence that English speakers present a persistent stress ‘deafness’ when stress is signaled exclusively by suprasegmental cues. Participants in our late learner group (that included the most proficient late learners) had been extensively exposed to the language-specific acoustic cues to Spanish stress. Still, their L2 experience with suprasegmentals did not lead to comparable behavior in the stress and in the consonant conditions. They were still challenged by stress contrasts. This means that the results found by Lin et al. (2014) could be due (at least in part) to stress ‘deafness’.

From the standpoint of second language acquisition, our results point towards the interpretation that the phonological processing of stress is not static. Late learners’ proficiency scores from the sentence and passage cloze tests could significantly predict about 20% of the variance in the learners’ stress encoding accuracy. This means that, increased proficiency (and
perhaps the consequent exposure to the language) has a direct effect on the stress-encoding abilities of learners. Thus, advanced learners are more likely to display more robust processing skills. The present results differ from those in Tremblay (2009) in that our analyses reveal a significant effect of proficiency. Tremblay (2009) found daily target language use, but not proficiency, was a significant predictor to higher accuracy increments. This could be due to differences in the tools used to measure proficiency. Despite this difference, findings from both studies are relevant in that they provide evidence that experience with a second language (whether this is measured by proficiency or by daily language use) leads to a development of stress-encoding abilities.

The limited number of participants in our EL group do not allow us to draw conclusions regarding the effects of linguistic experience on the phonological processing of stress. Previous research on French-Spanish bilinguals suggested that bilingual’s stress-encoding was modulated by early language exposure—country of residence between the ages of 0-2, 2-4 could significantly predict belonging to one group or another (Dupoux et al., 2010). Thus, it appears that those bilinguals who were raised in a Spanish-speaking country during their first years of life, performed like Spanish monolinguals. Meanwhile, bilinguals who were raised in a French-speaking country behaved like late learners with regards to stress-encoding. The authors’ interpretation is that early bilinguals can process only one language in a native-like manner, and that the quality and quantity of early exposure to each of the languages can be decisive in the development of language-specific phonological parsing abilities. Our group showed stress-encoding abilities that were only slightly different from the LL group. According to the finding in Dupoux et al. (2010), it may well be that most of our EL participants had had more
significant experience with English than with Spanish during infancy. Upon closer examination, we found that all of them had been born in an English-speaking country, but the limited number of participants do not allow us to draw conclusions. In order to find whether the findings of Dupoux et al. (2010) hold true for English-Spanish bilinguals, we will need to test a larger pool of early bilinguals.

Finally, the present experiment helps to further understand the challenges that EL and LL face when dealing with stress identification and accentuation rules. It appears that, at a phonological level, both groups display limited stress-representation abilities. This means that their processing of stress contrasts is not as automatic as that of speakers who grew up speaking only Spanish. This could help to partially explain why the late learners in Beaudrie (2007), Romanelli, Menegotto & Smyth (2015a, 2015b), and Romanelli & Menegotto (2015) and the early learners in Beaudrie (2017) had difficulties with identifying stressed syllables. We provide evidence that the obstacle to successful stress identification is, at least in part, related to listeners’ perceptual abilities. Our results also help to explain why the effects explicit instruction on learners metalinguistic awareness are somewhat limited. Training studies target learners’ metalinguistic skills, perhaps ignoring that there are processing limitations that limit their encoding and retrieval of stress information. Therefore, our study complements those studies on heritage and L2 perception by providing evidence that, at a purely phonological level, stress contrasts are challenging for these populations.

In sum, the present study provides significant results that are relevant to the study of stress from the standpoints of cross-linguistic differences, second language acquisition and bilingualism. We found that, as predicted by the lexical statistics account (Peperkamp et al.,
English native speakers learners of Spanish are relatively stress ‘deaf’. This ‘deafness’ is further modulated by Spanish proficiency for the late learners in such a way that more proficient learners are more likely to demonstrate more successful stress-encoding abilities. These results also help to understand studies on L2 Spanish that expose how challenging Spanish stress is for English speakers (Beaudrie, 2007; Kim, 2015, 2016; Romanelli, Menegotto & Smyth, 2015a, 2015b; Romanelli & Menegotto, 2015; Saalfeld, 2012). Finally, the results indicate that early bilinguals also present difficulties when asked to retrieve stress information in a cognitively demanding task, which leads to the conclusion that early experience with Spanish does not correlate with the development of native-like stress-encoding abilities.

4.7.3 Conclusion

In this experiment, we had early Spanish-English bilinguals, second language learners of Spanish and Spanish natives perform an ABX discrimination task. In this task, participants were asked to indicate whether the third nonword they heard was identical to the first one or to the second one. We tested subjects in three conditions: a consonant condition, a stress condition, and a redundant (stress+consonant change) condition. Our results show that early and late learners performed at ceiling when asked to recall consonant patterns across the board, but they were challenged when asked to recall the stress pattern of the first item in the triads. This means that their abstract representation of stress is somewhat less robust than that of consonants and is, therefore, less available in working memory. More proficient late learners were found to display more successful stress-encoding abilities when compared to less proficient learners. This indicates that experience with Spanish leads to a modest development of stress-processing abilities at the
One of the main implications of the study lies in the finding that English speakers show some degree of stress ‘deafness’. These findings complement studies on the processing of stress from a cross-linguistic perspective in that it situates English in relation to Spanish. Spanish speakers continue to behave at ceiling in stress-processing tasks, while English speakers appear to be challenged by stress contrasts. Moreover, English speakers’ ‘deafness’ helps us to further understand why L2 learners have trouble with syllable identification and orthographic accentuation in Spanish (Beaudrie, 2007; Romanelli & Menegotto, 2015; Romanelli, Menegotto & Smyth, 2015a, 2015b).
CHAPTER 5: THE PERCEPTION OF STRESS

5.1 Introduction

The results from Experiment 1 (ABX) indicate that English-Spanish bilinguals and language learners whose first language is English have difficulty with encoding lexical stress at a higher phonological level. In the L2LP model (van Leussen & Escudero, 2015), these results correspond to the processing of stress at a prelexical level where canonical forms of phonological units are stored and accessed. For these two populations, their experience with the English phonological system is hypothesized to affect their long-term phonological representation of word-level stress in such a way that abstract categories used to retain stress information appear to be less accessible than those used to signal consonants. Still, this phonological level is directly dependent on perceptual performance. In order to be mapped onto an existing phonological category for stress, a stressed syllable must first be perceived as prominent in relation to adjacent unstressed syllables. This prominence is signaled by a set of acoustic cues that allow listeners to perceive the differences between stressed and unstressed syllables that have to do with stress and not with other phonological units (vowels, consonants). Without the perception of this prominence, the phonological representation of stress would not be activated, and, thus, could not be accessed and exploited in long-term memory. Experiment 2 aims to elucidate on this low-level perception of lexical stress in order to determine whether EL and LL speakers are able to hear the phonetic differences between Spanish stressed and unstressed syllables.

In order to successfully perceive prominence differences, listeners need to concentrate on the acoustic information that is used to signal stress. Research has shown that there is not one
single hierarchy of cues to stress that applies to all languages. Rather, each language can display a set of language-specific patterns. In the case of English and Spanish, the acoustic correlates listeners pay attention to in order to perceive stress are different for each language. Stress in Spanish is signaled by suprasegmental acoustic cues. Spanish listeners pay attention to duration and intensity cues in order to perceive differences in prominence (Ortega-Llebaria & Prieto, 2009, 2011). Meanwhile, English speakers use segmental information in order to differentiate between stressed and unstressed syllables. In this language, vowel quality patterns appear to be the primary acoustic cue exploited by listeners (Chrabaszcz et al., 2014; Howell, 1993; Zhang & Francis, 2010).

In the context of second language acquisition, learners transfer their linguistic knowledge into the perception of new contrasts (Iverson et al., 2003). They bring their language-specific perceptual processing and, thus, pay attention to the cues to stress they have experience with, which may not be relevant to perceive differences in the L2. At this point, learners would need to reassess the relevance of the acoustic cues they are using to perceive an L2 contrast and learn to perceive new dimensions that are not informative in their native language. In the case of second-language Spanish, vowel reduction cues do not represent informative cues to L2 stress. Therefore, English speakers’ attention must adjust to the new suprasegmental cues (duration, intensity) in order to successfully decode the L2 speech signal and perceive prominence.
5.1.1 Cross-linguistic Studies on Stress

Up to now, cross-linguistic stress-encoding studies had not tested English and Spanish using the same experimental design. The behavior of Spanish speakers has been compared to that of speakers of Standard French (Dupoux, et al., 1997; Dupoux, et al., 2001; Peperkamp et al., 2010), Southeastern French, Finnish, Hungarian and Polish (Peperkamp et al., 2010). These studies used short-term experiments in which participants were exposed to a cognitively demanding tasks: ABX and Sequence Recall tasks. Both tasks require listeners to rely on their high-level phonological processing abilities rather than their lower-level perceptual system. In these studies, the processing of stress contrasts was examined from a typological perspective in order to establish a linguistically-based criterion that accounted for stress ‘deafness’ across languages. The main underlying assumption is that stress-encoding abilities correlate with how useful these may be in parsing speech in a particular language. Thus, speakers of languages in which stress information is critical for word identity will display higher degree of stress encoding than speakers of languages in which the role of stress is relevant to access lexical information. However, stress ‘deafness’ appears to be a gradient phenomenon rather than a binary one. Peperkamp et al. (2010) found that language-specific phonological distribution regularities involving stress could predict the degree of ‘deafness’ of speakers. According to this lexical statistics account, the predictability of stress location (as measured by the number of lexical exceptions to the most common stress pattern) in a given language will have a direct effect on the processing of stress. On the one hand, the results from Peperkamp et al. (2010) indicate that speakers of Polish—a language with 0.1% of lexical exceptions—are able to encode stress in a
more efficient manner than speakers of French, Finnish and Hungarian—languages with no lexical exceptions—but less efficiently than speakers of Spanish—a language in which exceptions account for 20% of lexical items. On the other hand, these results cannot help support any account that establishes that native lexical use of acoustic cues provides an advantage to perceive stress when stress is instantiated through suprasegmental information. This means that speakers of languages like Hungarian and Finnish—languages that display contrastive vowel length—are not better at encoding stress than speakers of French or Polish—languages with no lexical use of vowel duration. Thus, the fact that speakers of Polish performed better than speakers of French, Hungarian and Finnish provides evidence that the use of cues to stress in one’s native language does not correlate with better processing of stress.

One cross-linguistic study that targeted a more basic perceptual sensitivity to stress was carried out with native speakers of French and Spanish (Dupoux et al., 1997). French is different from both Spanish and English in that it does not possess stress at the lexical level. Therefore, when parsing speech, French speakers do not need to pay attention to cues to stress in order to make the right lexical decision. When tested with a simple AX discrimination task with low phonetic variability (“same” A and X items were phonetically identical), French speakers’ responses to minimal pairs differing in the position of stress were no different than responses to minimal pairs involving a consonantal contrast. Therefore, French speakers seem to perceive the low-level phonetic differences between stressed and unstressed Spanish syllables even when they have no linguistic experience with Spanish nor do they use duration lexically in their native language. In this scenario, naive French speakers are able to perceive differences in the speech signal that allow them to discriminate between Spanish nonwords even when they do not seek
these or any other cues to perceive stress when parsing their native language. The results from this task appear to indicate that French speakers are not challenged by the acoustic correlates of accent when there is low phonetic variability. However, difficulties arise when they are asked to perform on cognitively more demanding tasks (Dupoux et al., 1997; Dupoux et al., 2008) and with higher phonetic variability (Tremblay, 2009) which points towards the interpretation that their limited remembrance of lexical stress lays in the encoding of stress in their phonological representation.

The present study differs from the majority of previous cross-linguistic studies in that it focuses both on the low-level perceptual abilities of speakers and on the phonological encoding of stress in the same experiment. Furthermore, it tests English and Spanish, two languages that present contrastive stress. In these two languages, stress is phonetically produced in different ways. English stress is signaled through both suprasegmental and segmental cues while Spanish stress involves changes at the suprasegmental level. This is different from the cross-linguistic study carried out by Peperkamp et al. (2010) in which the languages tested either presented no word-level stress system or their lexical stress that was signaled through suprasegmental cues (F0, intensity, duration). Thus, the case of English speakers learners of Spanish is somewhat different. English speakers’ familiarity with vowel reduction leads them to pay attention to this cue when parsing speech. When exposed to Spanish, they would need to readjust to perceive cues that are informative and relevant to the perception of Spanish word stress. Therefore, it may be the case that adjusting to the acoustic cues to Spanish stress may require an adaptation process through which learners learn to perceive the acoustic dimensions that are relevant to the L2 (Ortega-Llebaria et al., 2013). Regarding English-Spanish bilinguals, their native experience
with Spanish stress contrasts presumes that they will have no issues in perceiving the acoustic cues to stress.

5.1.2 Stress Processing in L2 and Bilingualism

In the field of L2 acquisition, studies have concentrated on exploring the effects of the native language in the processing of L2 stress. This overarching question was approached through different methodologies by testing different linguistic backgrounds and target languages. Most of these studies have tested learners at an advanced/intermediate stage of their target language studies (Altman, 2006; Lin et al., 2014; Qin et al., 2017), while others have looked at L2 learners of various proficiencies (Dupoux et al., 2008; Tremblay, 2009). For example, Qin et al. (2017) looked at the effects of L1 experience with suprasegmental cues in the perception of L2 stress in English nonwords. L2 learners of English whose native languages were Standard Mandarin and Taiwan Mandarin participated in the study along with native speakers of English, who acted as controls. Taiwan and Standard Mandarin differ in their lexical use of duration. Only Standard mandarin uses duration as a cue to perceive syllabic prominence. The authors aimed at elucidating whether native experience with an acoustic cue to stress yielded an advantage over speakers of languages in which that cue was not exploited lexically. The participants of this study took part in two Sequence Recall experiments. The first one consisted on recalling sequences of nonword pairs that differed either in the location of stress or in a consonant. In this task, stress changes did not yield vowel reduction patterns (/fʌði/—/fʌði/). In the second Sequence recall task, the same nonword pairs were manipulated in such a way that the phonetic
difference between the stressed and the unstressed syllables was signaled only through differences in either F0, duration or conflicting F0 and duration. Their results indicate that, only in the condition where duration was the only acoustic cue available, speakers of Standard Mandarin were able to use duration as a cue to perceiving English stress, which led them to recall stress patterns more efficiently than speakers of Taiwanese Mandarin. This means that the native use of duration had only positive L2 encoding outcomes in the condition where duration was the only available cue. However, in the presence of F0 and duration, there was no difference among the three groups. In this case, speakers of Taiwan and Standard Mandarin were able to transfer their F0 processing abilities from their native use of tones. Thus, it appears that stress encoding is highly associated with the perception of acoustic cues available in the speech signal. The successful perception of these acoustic cues is a *sine qua non* condition to attain phonological encoding; thus the importance of exploring how language-specific acoustic patterns of a first language impact the low-level perceptual abilities of learners.

A relevant finding of the cross-sectional L2 study by Tremblay (2009) relates to whether or not learners are able to further their stress-encoding abilities with increased proficiency in the L2. Tremblay (2009) tested intermediate, low advanced and high advanced L2 learners of English whose L1 was French and a group of English natives as control group on their processing of stress using an AXB task. In this task, participants need to indicate whether the second item X is identical to the first one A or to the third one B. Unlike in the ABX task, participants do not need to retain item A in memory when processing item B, but rather compare the first item to the second (AX) and the second to the third (XB) which imposes a low degree of memory load when compared to the ABX task (Beddor & Gottfried, 1995, as cited in Tremblay,
2009). Participants were tested on nonwords differing in stress and consonant contrasts as well as on phonetic variability. Experimental nonwords were designed in such a way that stress minimal pairs involved changes at the suprasegmental level. No minimal pair differed with regards to vowel quality in this experimental condition. In order to test phonetic variability, two conditions were introduced. First, for the low variability condition, each trial included the three items—A, X, B—produced by the same speaker, and the two identical items were two instances of the same production. Second, for the high variability condition, each trial involved three items that were produced by different speakers. The results manifest an effect of phonetic variability—higher variability in the signal led to more errors—and daily use of English for the L2 group. In the low variability condition, L2 learners’ responses to segmental changes were just as accurate as responses to stress contrasts. However, when presented with trials in the high variability condition, learners were significantly less accurate in the stress condition than in the consonant condition. This means that learners were able to encode stress acoustically in short-term memory. Meanwhile, when asked to rely on their mental representation of stress, learners produced more errors, which indicates that they were not always able to retrieve stress information. Furthermore, L2 daily use was a significant predictor in learner performance. Individual proficiency did not appear to yield any effect in the encoding of stress. Students who reported using English more on a daily basis were more likely to develop increased stress processing performance. Therefore, it appears that L2 exposure and use, but not language proficiency, can predict improvement in stress-encoding abilities. This may be behind the results of Dupoux et al. (2008). In their study, three groups of French native speakers learners of Spanish (beginner, intermediate, advanced) and a control group of Spanish natives were tested
using a Sequence Recall task. They were tested using a consonant contrast /fiku/—/fìtu/ and a stress contrast /númi/—/numí/. The results show, not only that recalling sequences involving stress changes was more challenging than sequences with consonant changes, but also that there was no sign of stress-encoding development across proficiency level. Bear in mind that these results are no different from those in Tremblay (2008).

Thus, it appears that (1) the ability to perceive L2 cues that are used to signal stress directly impact the higher phonological processing of stress, and (2) stress-encoding may be an ability that can be further developed in L2 acquisition with increased experience with the language. The present experiment aims at unveiling the relationship between these two findings by using a task that can potentially tap onto the relationship between low-level perception of stress contrasts and the encoding of stress in phonological memory. This study is different from previous L2 accounts in that it tests perceptual discrimination of stress in a very simple manner that does not impose a high cognitive load when compared to the Sequence Recall or the ABX tasks. Yet, it aims at gathering information at both levels of processing (perception, encoding) within the same experimental design. This is different from Qin et al.’s (2017) study in that the present study tests low-level perceptual abilities of L2 learners instead of examining its effects in a phonological encoding task. In their study, TM speakers are tested in naturally produced and also with manipulated stress minimal pairs. The comparison of the results of the TM group between the natural and the synthesized stimuli is what allowed the authors to make the claim about their inability to use duration as a cue for stress. Also, only advanced learners were tested, which did not allow for an analysis on the effects of L2 experience. Here, we test the perception of stress in a more direct way. Instead of testing learners’ phonological encoding in order to
observe how/if they exploit the acoustic cues that are relevant to Spanish stress, we have them participate in a task that directly addresses their perceptual discrimination abilities.

From the perspective of bilingualism, the question becomes: how does early experience with two languages affect the processing of stress? This question remains relatively unexplored when compared to the case of second language acquisition. Dupoux et al. (2010) recruited three groups of speakers for their study: Spanish monolinguals, early French-Spanish bilinguals, and a group of French native speakers advanced late learners of Spanish. They participated in two Sequence Recall tasks using consonant and stress contrasts. Both tasks differed in phonetic variability and inter-stimulus interval. In the first Sequence recall, each item in a sequence was separated from the previous one by 80 ms of silence. Also, the items used were all phonetically different among them but they had been recorded from the same speaker. In the second Sequence recall, items were separated by 50 ms of silence and each of the words in each sequence had been recorded from a different person. Thus, the second task appeared to be more cognitively demanding as items in each trial appeared faster and each one of them was produced by a different person, which required participants to perceive stress patterns across different speakers. A first analysis indicates that early Spanish-English bilinguals’ encoding abilities fall between those of Spanish natives and advanced L2 Spanish speakers. This means that their accuracy rates were lower than those of natives and higher than the late learners. Upon closer examination, the authors find a bimodal distribution that corresponds to the behavior of the native and the late learner groups. This distribution correlated with early language exposure (country of residence between the ages of 0-2, 2-4 could significantly predict belonging to one group or another). Thus, it appears that those bilinguals who were raised in a Spanish-speaking country during their
first years of life, performed like Spanish monolinguals. Meanwhile, bilinguals who were raised in a French-speaking country behaved like late learners with regards to stress-encoding. According to the authors, these results point toward the interpretation that early bilinguals can process only one language in a native-like manner, and that the quality and quantity of early exposure to each of the languages can be decisive in the development of language-specific phonological parsing abilities.

The present study is different from the one carried out by Dupoux et al. (2010) in that we focus on the low-level perceptual abilities of bilinguals. While experience with two languages is predicted to have an effect at the phonological level (Dupoux et al., 2010), not much is known about the successful perception of stress contrasts in bilinguals. In order to successfully access stress information in their abstract phonological representation, listeners must be able to perceive the acoustic information that makes up stress. Therefore, it is of great importance to rule out the possibility that late learners’ encoding difficulties displayed in the ABX task were motivated by the unsuccessful perception of stress contrasts.

5.1.3 Stress in Spanish-English Bilingualism

In the case of English-Spanish bilingualism, the processing of stress has received substantial attention due to the fact that late learners of Spanish appear to be challenged by stress identification (Beaudrie, 2007; Romanelli & Menegotto, 2015; Romanelli, Menegotto & Smyth, 2015a, 2015b) and the lexical use of Spanish stress (Kim, 2015, 2016; Saalfeld, 2012). Stress identification is important when learning Spanish in formal contexts since the correct placement of accent marks directly depends on which syllable is the stressed one. For this reason,
Researchers have focused on exploring the effects of L2 exposure and training on stress identification.

Romanelli & Menegotto (2015) looked at the perception of stress in isolated words by beginner-intermediate learners of Spanish. They tested students before and after a study abroad program in Argentina. Subjects responded to a three-alternative forced-choice perceptual identification task with nonword triplets as stimuli (seMApa – semaPA – seMApo). For this task, participants were instructed to indicate which of the three orthographic representations on the test sheet corresponded to the nonword they heard. They found that learners appeared to have difficulties in the perception of stress in nonwords presented in isolation, with oxytone words being the most difficult to identify. After three weeks of exposure, the English speaking students performed like Spanish monolinguals in the perception of penultimate stress but not in final stress. Thus, three weeks of study appeared to be enough to develop sensitivity to suprasegmental cues available in the Spanish nonwords but only for paroxytone items. This study, however, relied on the metalinguistic abilities of learners rather than testing the perception of stress. Participants were asked to make a decision by choosing an orthographic representation of the words they heard. Therefore, it is unknown whether the findings result from challenges at the perceptual/encoding level or from participants’ metalinguistic abilities.

Similarly, Beaudrie (2017) trained early learners, heritage speakers of Spanish to identify stressed syllables. She conducted a pre and post-test in order to measure the learning of the students. The training consisted of explicit instruction with regards to stress categories and accentuation rules followed by three practice weekly activities: a stressed syllable identification task in sentences, a stressed syllable identification task in isolated words, and a word
identification task. The training program lasted six weeks. The pre and post-tests consisted of two tasks. In the first one, students had to circle the stressed syllable of a series of Spanish words. In the second one, students had to follow the orthographic rules for accentuation and rewrite a series of Spanish words with its corresponding orthographic representation taking stress into account. The results of the study suggest that, even after training, some early learners still present difficulties in the identification of stressed syllables, with 14% of the students obtaining an accuracy rate between .20 and .40, 18% of the students obtained an accuracy rate between .41 and .60. Thus, it appears that, despite their exposure to the language from a very young age, early learners are also challenged by the explicit identification of stressed syllables, even when they had been training specifically for this task during 6 weeks. However, this task targets the metalinguistic abilities of bilingual speakers. The results may suggest that some of these heritage speakers are not able to hear the difference between members of a stress minimal pair, but the fact that they need to rely on metalinguistic knowledge in order to complete this task makes this claim difficult to sustain. It could be the case that early bilinguals can hear stress differences but are unable to identify the stressed from the unstressed syllables when asked explicitly.

At a phonetic level, Ortega-Llebaria et al. (2013) conducted an identification experiment with Spanish native speakers and English speakers L2 learners of Spanish in which cues to stress were manipulated. The aim of the study was to test whether advanced late learners were able to use duration as a cue to stress as successfully as native speakers. They modified the ['mama] – [ma’ma] word pair (both words meaning mother in Spanish) and obtained experimental items to test participants’ use of: (1) duration and pitch in an accented environment; and (2) duration and intensity in an unaccented environment with flat pitch. The accented tokens were inserted in
the declarative sentence *Saluda mama contenta* ‘Mom greets happily’, while the unaccented tokens were inserted in the reporting clause ¡*Hola!– saluda mama contenta* ‘Hi– greets mom happily’. Participants were instructed to determine whether the word they heard was [‘mama] or [ma’ma]. In the accented context, late learners showed reliance on both acoustic cues: F0 and duration. They even relied on duration more strongly than native speakers did. In the unaccented context, natives used duration to identify stress while late learners had difficulties perceiving stress and did not use duration or intensity cues in a consistent manner. That is, learners successfully perceived duration differences in declarative sentences but failed to perceive them with a flat F0 contour. Authors hypothesize that these results could stem from either the absence of accent or the smaller duration differences between stressed and unstressed syllables found in the items that belonged to the unaccented condition when compared to those of the accented condition. Regarding this latter hypothesis, it is worth noting that, in both languages stressed vowels display longer durations than unstressed ones, but their ratios differ across language with 1:6 in English and 1:3 in Spanish, meaning that stress effects on duration in English are consistently larger than those found in Spanish (Delattre, 1966). This duration difference may have caused learners to fail in the perception of the duration cue in the unaccented context. Consequently, the results of this study may derive from either learners’ inability to perceive smaller differences in duration (like those found in unaccented contexts), or from learners associating the duration cue only with accent and not with stress. Nevertheless, the results from this study demonstrate that the absence of vowel reduction patterns in the L2 speech signal does not prevent stress perception in the case of late learners of Spanish. Moreover, it provides evidence that, at least in the accented context, advanced learners are able to use duration as a
main cue to stress, which would make perceiving Spanish stress relatively easy in this intonational context.

The present experiment is different from previous studies on stress identification (Beaudrie, 2007; Romanelli, Menegotto & Smyth, 2015a, 2015b; Romanelli & Menegotto, 2015), use of stress in lexical decisions (Kim, 2015, 2016), sentence recall (Saalfeld, 2012) and the use of duration as a cue to stress (Ortega-Llebaria et al., 2013) in that it focuses on the low-level perception of Spanish stress contrasts with no cue manipulation. In this simple task, participants are asked to make a decision based on the two words they hear. Unlike in some previous studies (Beaudrie, 2007; Romanelli et al., 2015a, 2015b, 2015c), early and late learners are not required to resort to their metalinguistic abilities to complete the task. That means that this task measures whether or not they hear a stress difference, and not whether or not participants are able to interpret the stress pattern of a word by marking it on its orthographic representation. This study is also different from Saalfeld (2012) in that it focuses on words in isolation rather than words embedded in sentences. This will make the task easier for participants at the same time that reveals effects of stress purely at the word level with no intervention of sentence or morphological parsing. Following Romanelli, Menegotto & Smyth (2015a, 2015b), the present experiment also differs from Beaudrie (2017), Kim (2016, 2017), Ortega-Llebaria et al. (2013), and Saalfeld (2012) in that we use nonwords as experimental items. This allows us to control for word knowledge. Familiarity with some real Spanish words and not others could yield an effect, which may skew the results. By using nonwords we test beginning and advanced learners of Spanish under the identical condition as neither of them can rely on their lexical representation of Spanish words. Finally, this experiment is different from that of
Ortega-Llebaria et al. (2013) in that it tests the perceptual discrimination of stress by early and late learners of Spanish by using stimuli that is naturally produced and, thus, contains the acoustic cues that listeners are exposed to in their natural context. This will allow us to observe whether these populations can perceive stress by using all of the acoustic cues available in the speech signal.

5.2 Experiment 2: AX

Results from Experiment 1 suggest that speakers who grew up exposed only to English, or to both English and Spanish appear to be challenged by stress contrasts in a task that uses high memory load and high phonetic variability. However, its results do not allow us to observe whether second-language learners undergo a learning process in which they develop perceptual sensitivity to stress contrasts. Learners need to learn to pay attention to the suprasegmental cues that are relevant to decode Spanish stress rather than transferring their perceptual knowledge from English—which would not yield any perceptual productivity. Therefore, we are interested in knowing if learners are able to perceive prominence differences between two words differing in stress from the beginning of their language instruction, or if they learn to perceive stress contrasts only after exposure to Spanish. Experiment 2 addresses this issue by exploring how NS, EL and LL participants are able to perceive low-level differences in stress. With this experiment, we intend to capture the learning process of L2 language-specific acoustic patterns.

The two main research questions addressed in this study are the following: (1) Do length and depth of experience with Spanish (native monolingual, native bilingual, late learner) modulate participants’ perceptual discrimination abilities with regards to word-level stress? (2)
Does a learner’s higher grammatical and lexical proficiency—i.e., higher competency due to further experience with the language—and/or linguistic experience correlate with a higher accuracy in the perceptual discrimination of stress-based contrasts?

In order to explore this issue, we adapted Experiment 4 from Dupoux et al. (1997) and carried out a simple AX experiment in which subjects had to discriminate only between two items spoken by two different speakers. Participants heard the two items separated by a tone of varying duration and had to make a decision on whether the two items were (1) two instances of the same nonword (‘same’ condition) or (2) two different nonwords (‘different’ condition).

Subjects were tested on two ‘different’ conditions, one involving a consonantal change (bédapi — nédapi), and another one in which stimuli differed only in the location of stress (bédapi — bedápi). In the ‘same’ condition, subjects heard the same nonword twice.

In this experiment, we inserted either a short or a long tone in between the two experimental items. The length of this tone is intended to test the effects of echoic memory in the perceptual categorization of stress. A long tone (2200ms) could tamper with phonetic memory and, by hypothesis, make the acoustic trace of nonwords less accessible to participants, who, in turn, would presumably need to rely on their phonological representation of the items to make a decision (Dupoux et al., 1997). A short tone (200ms) is expected to yield virtually no effect (or a very small one) and would allow participants to rely on low-level acoustic remembrance of nonwords in order to discriminate between both items. Therefore, we expect that, participants will be challenged in the short-tone condition if they have difficulties with perceiving the difference between words differing in stress (bédapi — bedápi). This would mean that they do not possess the early processing mechanisms to perceive the acoustic correlates of stress.
Meanwhile, if participants’ difficulties lay at a higher, phonological stage, we expect them to be challenged by the long-tone condition and not the short-tone condition as their difficulties arise only when they need to rely their phonological representation and not in the low-level perception of stress.

For this task, the prediction is that, if learners undergo a learning process in the perception of stress contrasts in Spanish, we will be able to capture a development from poor performance in early stages of acquisition to improved/optimal performance in later stages in the short-tone condition. This would mean that learners are challenged by the perception of Spanish stress when they are first exposed to the language and learn to perceive it as their experience with Spanish increases. If learners are able to perceive Spanish stress from the beginning, we expect them to be challenged only by the long tone. The long tone would alter their remembrance of the acoustic form of items which would force them to rely on their phonological structure. Regarding early Spanish learners (EL) and Spanish dominant speakers (NS), in Experiment 1 EL but not NS appeared to have difficulties with the encoding of stress at the phonological level. Therefore, we expect the short-tone condition not to be challenging for either group, while the long-tone condition is expected to be challenging only for the EL group, providing further evidence that their access to the abstract representation of stress is weaker than that of Spanish dominants.

5.3 Participants

A total of 116 participants were recruited to participate in the discrimination task. Similarly to the previous experiment, participants in this task belonged to three different populations. First, a
group of ten Spanish dominant speakers with English as their second language to act as controls (Spanish natives, NS). Second, a group of eleven early Spanish/English bilinguals—that is, people who, according to self-reports, grew up bilingual in these two languages (early Spanish learners, EL). Finally, a group of ninety five second-language learners of Spanish of varying proficiency whose native language is English (late Spanish learners, LL). This last group was further divided into three subgroups that corresponded to the level of the Spanish-class in which participants were enrolled at the time of testing. We had a first-year student group with 27 participants, a second-year student group with 27 participants and a third-year student group with 30 participants.

Before exploring the dataset, we isolated participants’ responses to the consonant condition and excluded those participants whose error rates were above 25% in this condition. Responses in the consonant condition are intended to provide a baseline to determine how difficult it is for participants to make a decision on the stress condition. This means that the consonant condition is expected to be the ‘easy’ one for our experimental groups. The degree to which each participant finds it difficult to make a decision on a stress contrast is relative to their performance on this ‘easy’ condition. The fact that some participants display error rates above 25% in consonantal contrasts suggests (to us) that they may have been distracted and not fully engaged in the task. The excluded participants involved one early learner and 15 late learners. This resulted in a total sample of 100 participants: ten Spanish natives, ten early learners and eighty language learners. Participants in the LL group varied in their L2 experience. The LL group was comprised of students enrolled in first \((N = 22)\), second \((N = 24)\), and third-year \((N = 34)\) Spanish classes.
Table 5.1 contains the orientation scores’ descriptive statistics of participants included in the study (those whose error rates in the consonant condition were less than 25%). The data have been divided as a function of participant group, with the LL data further divided as a function of course year (whether they are enrolled in first, second, or third-year college Spanish courses). The descriptive statistics of the participants’ include dominance and proficiency. The scores shown in Table 5.1 are converted to 0-1 values as a means to compare participants in our sample relative to each other, not across experiments or research studies.

Table 5.1: Descriptive statistics of the bilingual language profile (BLP) scores and the proficiency data, which include two grammatical-proficiency cloze tests (passage cloze test, sentence cloze test) and a vocabulary size test (LexTale-Esp), for the three groups of participants: the native-speaker controls (NS; N = 10), the early Spanish/English bilinguals (EL; N = 10), and the late second-language learners of Spanish, who have English as their native language (LL; N = 80) and are further divided as a function of their year of college Spanish.

<table>
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<th>Passage Cloze Test</th>
<th>Sentence Cloze Test</th>
<th>Overall Proficiency</th>
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</thead>
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<td></td>
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<td>M</td>
<td>(SD)</td>
<td>M</td>
</tr>
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<td>(±.02)</td>
<td>.93</td>
</tr>
<tr>
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<td>.55</td>
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<td>.71</td>
</tr>
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<td>(±22)</td>
<td>.26</td>
<td>(±.11)</td>
</tr>
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</table>

5.4 Stimuli and Procedure

In order to explore the effects of echoic memory in the perception of stress contrasts, we adapted the design of experiment 4 in Dupoux, Pallier, Sebastián-Gallés, and Mehler (1997). We made
use of 12 experimental CVCVCV nonword quadruplets (e.g., bédapi, bedápi, nédapi, nedápi) in order to create a total of 144 experimental trials. Each trial was comprised of two auditory stimuli (A, X). In 48 of the 144 trials (or 33.3%), participants heard two acoustic renderings of the same nonword (bédapi, bédapi)—these are referred to as “same” trials because the word forms, although acoustically distinct, are phonologically identical. In 96 of the 144 trials (or 66.6%), participants were presented with two acoustic renderings of different nonwords, which differed in two possible phonological conditions—these are referred to as “different” trials because the word forms are acoustically and phonologically distinct. In 48 trials (or 50% of the “different” trials) the two nonwords differed solely in the location of stress (e.g., bédapi-bedápi). In the remaining 48 trials (the other 50% of the “different” trials), the two nonwords differed on a consonantal contrast shared by both English and Spanish (e.g., bédapi-nédapi). This creates two “different” conditions, a stress-based condition and a consonant-based condition. Remember that the stress-based condition is our experimental condition, the consonant-based condition is our control one, as we anticipate all our participants to be very accurate in their responses to the consonant-based condition. The four members of each nonword quadruplet appeared in the first position in the pair (A) three times, one for every possible combination under the aforementioned conditions. This yielded 12 possible combinations per quadruplet (4 × 3), and a total of 144 trials (12 × 12). In sum, a third of the trials were “same” trials, a third were “different-stress” trials, and a third were “different-consonant” trials.

In addition to manipulating the phonological identity of the stimuli being presented in the trials, we manipulated the length of the interval between the two stimuli. Each AX combination appeared in two stimulus interval conditions, a long one and a short one. Rather than controlling
for the exact time of the interval, we manipulated the time lag between the onsets of the two critical stimuli; thus, we created two stimulus onset asynchronies (SOAs). In both SOAs conditions, stimuli were separated by a violin sound playing a flat constant note. In the short condition, nonwords were separated by a 200 ms violin note (short SOA); and, in the long condition, they were separated by a 2.2 s violin note (long SOA). This resulted in a total of 288 trials to be presented to each participant: 144 trials in the long SOA condition, and 144 trials in the short SOA condition. Trials were presented in two blocks, with trials divided as a function of their SOA condition. The order of SOA conditions was counterbalanced, so that some participants responded to the trials with the long SOA first and short SOA second, and others to the short SOA first and the long SOA second.

The stimuli were recorded by two native speakers of Spanish, a man and a woman, who grew up speaking only Spanish and learned English as adults. Recordings were made in a sound-attenuated booth with a Marantz PMD660 digital recorder, a Sound Devices MM-1 microphone pre-amplifier, and a Shure SM10A head-mounted, dynamic microphone. The recordings were digitized at a sampling rate of 44.1 kHz and 16-bit quantization. Talker order was kept constant throughout the experiment. The stimuli from the male speaker were assigned to the first item (A) and the stimuli from the female speaker were assigned to the second item (X). This ensured that items in any given trial were acoustically distinct, as they were produced by different speakers. (In other words, the “same” trials included two different acoustic tokens of the same nonword and not the exact same sound file. The “different” trials were acoustically and phonologically distinct.) The participants completed the task using MDR-7502 Sony headphones in a sound-attenuated booth in front of a computer running the experiment from a Python script,
which had been written with PsychoPy (Peirce, 2007). The desktop computer was connected to a Cedrus RB-834 response pad, which was responsible for capturing response times.

Each trial consisted of the first nonword stimulus (A), a violin sound (varying in length as a function of SOA condition), and the second nonword stimulus (X). Participants were told that they would listen to two nonwords separated by a tone and were instructed to make a decision, as fast and accurately as possible, on whether the two nonwords were the same or different nonwords. They were instructed to press the left key on the response pad to indicate that they believed the two nonwords to be the same nonword (A = X), and the right key to indicate that they believed the two nonwords to be different (A ≠ X). The words same and different appeared in the lower left and right side, respectively, of the screen when the second auditory stimulus was being played. After participants pressed a response key, a fixation cross appeared on the screen for 500 ms before the new trial began. Participants had a break every 24 trials in each block.

The participants completed 10 practice trials with two quadruplets that were not included in the experiment (fälupo-falúpo-fátupo-fatúpo; tídoca-tídóca-tímoca-timóca). After practice, participants were presented with 12 experimental blocks, 6 in each SOA condition. Response times were measured from the onset of the second stimulus to the pressing of the response button.

5.5 Data and Analyses

In the present study, we divide the data into two separate sets to conduct different analyses, which address different questions. On the one hand, we compare native speakers of Spanish who were raised monolingual (native controls) with early Spanish/English bilinguals who grew up in
an environment in which English was the dominant societal language (early learners) and with adult second-language learners of Spanish whose native language was English (late learners). The main research question addressed in this analysis is as follows: Does length and depth of experience with Spanish (native monolingual, native bilingual, late learner) modulate participants’ perceptual discrimination abilities with regards to word-level stress? In this data subset, we made use of the observations of ten participants per group, for a total of 30 participants. This included the ten native-speaker controls, the ten early learners of Spanish, and the ten most proficient late learners in our sample of 80 late learners.

The second question addressed in our study concerns the role of proficiency in late second-language learners of Spanish. This question may be laid down as follows: Does a learner’s higher grammatical and lexical proficiency—i.e., higher competency due to further experience with the language—correlate with a higher accuracy in the perceptual discrimination of stress-based contrasts? To address this question, we excluded the data from the Spanish dominant controls and the early bilinguals and focus exclusively on the responses of the 80 late learners.

Data wrangling and analyses for both studies were conducted with a collection of R scripts (R Core Team, 2018), with packages tidyverse (Wickham, 2017) and afex (Singman, Bolker, Westfall, & Aust, 2018). When reporting the results of inferential statistics, we provide effect sizes, such as eta-squared ($\eta^2$) and 95% confidence intervals (c.i.). Exact $p$-values are also reported, except when they are below 1/1000.
5.5.1 Study 1

The first comparison was carried out on a total of 30 participants divided in three groups based on their linguistic experience: ten native controls, ten early learners, and the ten most proficient late learners. In order to select the ten most proficient late learners, we made use of the scaled overall proficiency score assigned to each of the participants (see Table 4.1). In other words, we selected the ten late learners with the highest scaled overall proficiency.

The statistical exploration of this data set consists of analyses of accuracy rates and response times as a function of two experimental conditions: (i) type of contrast in the different trials (stress condition, consonant condition), and (ii) duration of the interstimulus interval (short, long). Accuracy rates and response times (ms) are obtained for each experimental condition. In the analyses of the latency data, we only include response times in trials responded to correctly. The analysis of the accuracy rates is done by exploring two different scores: proportion of hits (trials with two phonologically distinct stimuli that the participant correctly identified as being “different”) and proportion of false alarms (trials with two phonologically identical stimuli which the participant incorrectly identified as “different”). In other words, we analyzed the proportion of times participants responded “different” either correctly (hits) or incorrectly (false alarms).

The accuracy data scores, which derive from categorical data (correct vs. incorrect response) and are converted to proportion counts, are submitted to an arcsine transformation prior to statistical analyses. Bound data, such as proportion counts, are typically transformed to increase the normality of the data and to make them amenable to parametric statistical
explorations (Cochran, 1940; Gotelli & Ellison, 2004; but see Warton & Hui, 2011; Winer, Brown, & Michels, 1971).

Table 4.1 shows the dominance and proficiency data of the ten native controls and the ten early Spanish/English bilinguals. Note that the late-learner data belong to the entire group of 80 subjects. The attributes corresponding to the ten most advanced late learners are as follows: BLP ($M = 111; SD = 26$), sentence cloze test ($M = .52; SD = .17$), passage cloze test ($M = .52; SD = .15$), LexTale-Esp test ($M = .37; SD = .13$). Their overall proficiency scores were as follows: $M = .43, SD = .15$. A series of $t$-tests confirmed that each group differed from the other two groups in terms of both dominance (NS-EL: $t(11.5) = -9.1, p < .0001$; NS-LL: $t(15.87) = -23.38, p < .0001$; EL-LL: $t(14.03) = -5.18, p < .0001$) and overall proficiency (NS-EL: $t(9.23) = 5.43, p < 0.016 [.0003]$; NS-LL: $t(9.28) = 11.11, p < .0001$, EL-LL: $t(17.83) = 3.46, p < .016 [.002]$). Of the ten participants in this subsample, nine were in their third year of college Spanish and one was in her second year.

5.5.2 Study 2

The second statistical exploration was conducted on the entire second-language learners’ dataset ($N = 80$). Participants in this group differed on their experience with Spanish, which can be observed in differences in vocabulary size and grammatical proficiency. First, we investigate whether the length of time they had been taking Spanish courses affects their phonological encoding patterns. For this, we compare three groups of second-language learners as a function of their course year: first, second, or third-year Spanish. The three groups differ in dominance, as determined by the BLP scores (first-second: $t(43.72) = 3.68, p < .016 [.0006]$; second-third:
\( t(53.13) = 3.91, \ p < .016 \ [0.0002]; \) first-third: \( t(52.79) = 7.95, \ p < .0001 \), but not all groups differed from each other in overall proficiency, as determined by the added and scaled language proficiency measures (first-second: \( t(43.07) = -1.62, \ p > .016 \ [.11] \); second-third: \( t(55.95) = -1.97, \ p > .016 \ [.05] \); first-third: \( t(52.55) = -3.53, \ p < .016 \ [.0008] \)). In terms of overall proficiency, the third-year group differs from the first-year group, but the second-year group does not differ significantly from either of the other two groups.

Then, we investigate whether an increase in proficiency—as measured by lexical and grammatical-knowledge tests—correlates with their perceptual discrimination patterns as they pertain to word-level stress. A linear-regression analysis with continuous proficiency measures as predictors constitute the basis of this exploration. The proficiency measures used as predictors are the scaled scores obtained by means of the two grammatical-proficiency tests (the passage cloze test and the sentence cloze test) and the vocabulary-size test.

5.6 Results

5.6.1 Study 1: The Role of Linguistic Experience

The first study focuses on a subset of 30 participants: ten native speaker controls (NS), ten early bilinguals (EL), and a subsample of ten participants selected from the late learner group (LL). The ten late learners in this sample were the most proficient second-language learners of Spanish in the group of 80 late learners. In this analysis, we investigate the role of linguistic experience on the perceptual discrimination of stress contrasts. We analyze the potential role of age of acquisition (early vs. late learners of Spanish) or of length and depth of experience (life-long experience vs. recent, adulthood-only experience with Spanish).
In this study, we explore both response accuracy and response times. Accuracy is measured in two steps. First, we investigate whether the three groups differ in their false alarm rate. We obtain and compare the proportion-correct scores in “same” trials. This metric is referred to as response bias. If participant groups differ in terms of their response biases, the remaining accuracy metric needs to be interpreted with extreme caution. Second, we investigate whether the three groups differ in their hit rate. For this metric, we obtain and compare the proportion-correct scores in “different” trials. This metric is referred to as response accuracy. The accuracy metrics are analyzed as a function of the factors available in the design: Response bias is assessed as a function of SOA length, whereas response accuracy is assessed as a function of both SOA length and contrast type. The response times we study are restricted to those collected from the participants’ correct responses to “different” trials. Table 5.2 shows the descriptive statistics for both response accuracy and timing divided by participant group (NS, EB, LL), type of contrast (stress, consonant), and SOA length (long SOA, short SOA). Response bias is not shown in the table. In the table, accuracy is presented in proportion-correct scores and timing is shown in milliseconds. Inferential statistics are conducted over transformed observations. Accuracy values are arcsine-transformed and response times are log-transformed.

5.6.1.1 Accuracy

First, response bias is examined by investigating false alarm rates. Arcsine-transformed proportion-correct scores to “same” trials are analyzed by means of a 3 × (2) ANOVA with SOA length as a within-subjects factor and with group as a between-subjects factor. The ANOVA did not produce any significant findings: there were no main effects of group, $F(2, 27) = .27, \eta^2 = .01, p > .05 [.77]$, no main effects of SOA length, $F(1, 27) = .04, \eta^2 = .0006, p > .05 [.85]$, and no
interaction between the two, $F(2, 27) = 1.61, \eta^2 = .05, p > .05 [.22]$. Thus, these results suggest that response bias throughout the task was comparable across groups, which would indicate that response accuracy to “different” trials can be interpreted without the need to control for bias.

Table 5.2: Descriptive statistics (means and standard deviations) for both accuracy (proportion-correct scores in “different” trials, or hits) and timing (response times in seconds for correct responses only) as function of type of contrast (consonant, stress), SOA length (long, short), and group (NS, EL, LL) in Study 1.

<table>
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<tr>
<th></th>
<th>Accuracy (prop. correct)</th>
<th>RT (s)</th>
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<tr>
<td></td>
<td>conson.</td>
<td>stress</td>
</tr>
<tr>
<td>EL</td>
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<tr>
<td>long</td>
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</table>

Figure 5.1. Boxplots of accuracy by group as a function of SOA Length and contrast
Second, we investigate response accuracy. Arcsine-transformed proportion-correct scores to “different” trials are analyzed by means of a $3 \times (2) \times (2)$ ANOVA with SOA length and contrast type as within-subjects factors, and with group as a between-subjects factor. This time,
the ANOVA yielded significant main effects of group, $F(2, 27) = 6.76, \eta^2 = .20, p > .05 [0.04]$, and contrast, $F(1, 27) = 19.07, \eta^2 = .22, p < .05 [0.002]$, but not of SOA length, $F(1, 27) = .51, \eta^2 = .001, p > .05 [0.48]$. SOA length did not interact with any of the other two factors so that the only significant two-way interaction was that between group and contrast type, $F(2, 27) = 5.58, \eta^2 = .14, p < .05 [0.009]$. The three-way interaction was not significant, $F(2, 27) = 1.52, \eta^2 = .003, p > .05 [0.24]$. The two-way interaction was explored in two ways. First, we divided the data set into two subsets as a function of contrast type in order to investigate the effects of group for the two types of contrast separately, and then we divided the data set into three subsets as a function of group in order to investigate the potential effects of contrast type separately for each group.

A one-way ANOVA with group as the only predictor failed to produce any significant effects in the consonant condition, $F(2, 27) = 1.49, \eta^2 = .10, p > .05 [0.24]$. This means that participants were similarly accurate when responding to “different” trials whose stimuli were distinguished by means of a consonantal contrast. A one-way ANOVA with accuracy as response and group as a between-subjects factor in the stress condition did reveal a significant finding, $F(2, 27) = 6.54, \eta^2 = .33, p < .05 [0.005]$. These effects are due to the fact that the NS group is found to be more accurate in this condition than both the EL and the LL groups, as indicated by a set of Welch t-tests (NS-EL: $t(9.42) = 3.39, p < .016 [0.007], 95\% \text{ c.i.} = [0.182, 0.895]$; NS-LL: $t(9.46) = 3.78, p < .016 [0.003], 95\% \text{ c.i.} = [0.234, 0.918]$), whereas the two latter groups do not differ from each other in terms of their response accuracy in the stress condition (EL-LL: $t(17.96) = .17, p > .016 [0.86], 95\% \text{ c.i.} = [-0.419, 0.493]$). Three separate paired t-tests confirmed that both the EL and LL groups were more accurate in the consonant condition than in the stress condition (EL: $t(9) = 3.23, p < .016 [0.0102], 95\% \text{ c.i.} = [0.138, 0.781]$; LL: $t(9) = 3.18, p
< .016 [.0111], 95% c.i. = [.138, .819]), whereas the NS group was similarly accurate across conditions (NS: \( t(9) = -.797, p > .016 \), 95% c.i. = [−.095, .045]).

To sum up, all three groups were similarly accurate in correctly responding “different” in trials whose stimuli involved a consonantal contrast. On the other hand, both the LL and the EL groups were less accurate than the NS participants in trials involving a stress contrast. Whereas the LL and the EL groups were more accurate in the consonant condition than in the stress condition, the NS controls were similarly accurate across conditions. The length of the stimulus onset asynchrony (SOA) did not affect accuracy in any condition or group. In the stress condition, only three of the ten participants in the EL group and three of the ten participants in the LL group obtained response accuracies within two standard deviations of the mean of the NS group.

5.6.1.2 Response Times

Response latencies to correct responses in “different” trials were log-transformed and analyzed with a \( 3 \times (2) \times (2) \) ANOVA with \textit{SOA length} and \textit{contrast type} as within-subjects factors, and with \textit{group} as a between-subjects factor. The ANOVA revealed a main effect of \textit{group}, \( F(2, 27) = 7.68, \eta^2 = .28, p < .05 \), and of \textit{contrast}, \( F(1, 27) = 9.70, \eta^2 = .04, p < .05 \), but no effect of \textit{SOA length}, \( F(1, 27) = .40, \eta^2 = .002, p > .05 \). The model yielded no significant interactions.

The effects of contrast were due to the fact that participants were faster to respond in the consonant condition than they were in the stress condition, \( t(29) = 2.75, p < .05 \), 95% c.i. = [.024, .168]. The effects of contrast were based on the fact that the NS participants were faster than both the EL and the LL groups (NS-EL: \( t(13.7) = -4.19, p < .016 \), 95% c.i. = [−.468, .
whereas the EL and LL participants did not differ from each other in overall response latencies ($t(17.3) = .181, p > .016 [.85], 95\% \text{ c.i.} = [-.198, .235]$). NS participants were more likely to be accurate in the stress condition than the participants in the other two groups. This means that the latency comparisons are based on unbalanced datasets, with fewer observations for the EL and the LL participants than for the NS ones.

5.6.2 Study 2: The Role of Proficiency in Late Learners

The second study analyzes the behavior of 80 participants, the full sample of late second-language learners who participated in this experiment. This analysis includes the data from the ten advanced late learners examined in Study 1, but it investigates these data alongside those of the remaining 70 late learners in the study. In Study 2, we investigate the potential role of language competency—determined by length of study as well as by independent measures of grammatical proficiency and vocabulary size—on the perceptual discrimination of lexical stress.

We conduct two sets of analyses, one of which takes into account participants’ year of study (first, second, and third-year college Spanish) and one in which we use a set of continuous predictors based on their language competency.

Table 5.3 shows the descriptive statistics for both response accuracy and timing as a function of participant year (first-, second-, and third-year college Spanish), type of contrast (stress, consonant), and SOA length (long, short). In the table, accuracy is presented in proportion-correct scores and timing is shown in milliseconds. Inferential statistics are conducted on transformed observations.
Table 5.3: Descriptive statistics (means and standard deviations) for both accuracy (proportion-correct scores in “different” trials, or hits) and timing (response times in milliseconds for correct responses only) as function of contrast (consonant, stress), SOA length (long, short), and participant year-of-study (first-, second-, third-year college Spanish) in Study 2.

<table>
<thead>
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<th>Accuracy (prop. correct)</th>
<th>RT (ms.)</th>
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<td>conson.</td>
<td>stress</td>
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<td>1st</td>
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5.6.2.1 Accuracy

First, we examined accuracy rates as a function of the participant’s year of enrollment (first, second, and third-year college Spanish). After investigating whether people were affected by some type of response bias (which we do by analyzing accuracy rates in the “same” trials), we explore accuracy rates in the “different” trials, which are the ones that vary in terms of controlling consonant or stress distinctions. Arcsine-transformed proportion-correct scores in “same” trials are analyzed by means of a $3 \times (2)$ ANOVA with SOA length as a within-subjects factor and with year-of-enrollment as a between-subjects factor. The ANOVA yielded significant
main effects of SOA length, $F(1, 77) = 20.6, \eta^2 = .06, p < .0001$, but no main effects of year, $F(2, 77) = .36, \eta^2 = .007, p > .05$ [.70], and no interaction between the two, $F(2, 77) = .52, \eta^2 = .003, p > .05$ [.60]. These results suggest that response bias throughout the task was comparable across groups and that, overall, learners were less likely to be accurate in the long SOA condition. In other words, relative to trials in which the time separation between the two stimuli was short, trials in which such separation was long led participants to be, on average, more likely to respond “different” even though the two stimuli were phonologically identical.

The second analysis focuses on the “different” trials. Arcsine-transformed proportion-correct scores in “different” trials are investigated by means of a $3 \times (2) \times (2)$ ANOVA with year-of-enrollment as a between-subjects factor and with contrast type and SOA length as within-subjects factors. The ANOVA reveals significant main effects of year, $F(2, 77) = 5.31, \eta^2 = .07, p < .05$ [.007], and contrast, $F(1, 77) = 246.78, \eta^2 = .55, p < .0001$, as well as a marginally significant interaction between the two, $F(2, 77) = 3.42, \eta^2 = .03, p < .05$ [.04]. There are no main effects or interactions in the model. The interaction is due to the fact that participant groups do not differ from each other in their response patterns to the consonant condition, $F(2, 77) = 2.19, \eta^2 = .05, p > .05$ [.12], while they do in the stress condition, $F(2, 77) = 4.70, \eta^2 = .11, p < .05$ [.01]. In pairwise comparisons, we find that the only meaningful difference is that between the third- and second-year groups, $t(56) = 3.41, p < .016$ [.001], 95% c.i. = [.124, .447]. All three participant groups were more likely to be accurate in the consonant than in the stress condition (Y1: $t(21) = 7.87, p < .0001$, 95% c.i. = [.467, .803]; Y2: $t(23) = 12.59, p < .0001$, 95% c.i. = [.625, .871]; Y3: $t(33) = 7.88, p < .0001$, 95% c.i. = [.374, .635]).

Figure 5.2. Boxplots of accuracy by year of study as a function of SOA Length and contrast
While the participant groups differ in their accuracy rates in the stress (but not the consonant) condition, there is no clear improvement of stress discrimination with increased
proficiency. In other words, whereas the third-year group is the one with the smallest average difference in accuracy between the consonant and the stress conditions, the group with the greatest difference is the second-year group, not the first-year group. A more sensitive or fine-grained analysis may reveal a relation between perceptual discrimination of lexical stress and grammatical proficiency in Spanish second-language learners, but the current analysis cannot be used to argue for this a relation. Six of the 34 third-year learners’ accuracy rate fell within two standard deviations of the NS (control) group (17%), two of the 24 first-year students (8%) and none of the 22 second-year students did. There may be a relation between grammatical proficiency and stress discrimination in this sample, but such relation is, if at all, very modest.

5.6.2.2 Response Times

Log-transformed response times to correct responses in “different” trials are analyzed with a $3 \times (2) \times (2)$ ANOVA with SOA length and contrast type as within-subjects factors, and with year-of-enrollment as a between-subjects factor. The ANOVA yields only main effects of contrast type, $F(1, 77) = 92.19, \eta^2 = .11, p < .0001$, and a marginally significant interaction between year-of-enrollment and SOA length, $F(2, 77) = 3.32, \eta^2 = .01, p < .05 [.04]$. No other main effects or interactions are revealed by this model. The main effects of contrast are due to the fact that participants are, on average, much faster at making (correct) decisions in the consonant condition than in the stress condition, $t(79) = 9.82, p < .0001, 95\%$ c.i. = [.136, .205]. The marginal interaction between SOA length and year may be because there are no effects of SOA length for groups Y1 ($t(21) = 1.13, p > .016 [.26], 95\%$ c.i. = [.030, .105]) and Y2 ($t(23) = -1.70, p > .016 [.101], 95\%$ c.i. = [.103, .009]) whereas, in group Y3, such effects might approach (but not reach) significance, $t(33) = 2.01, p > .016 [.05], 95\%$ c.i. = [.0007, .147]. It
appears that there are no clear effects of overall proficiency, and the robust effects of contrast type affect the three groups of participants.

5.6.2.3 Predicting Response Accuracy from Proficiency

The null finding from the year of enrollment in college Spanish does not necessarily imply that grammatical proficiency or vocabulary size (or both) do not predict perceptual discrimination patterns with regards to word-level stress in second language learners. It might simply be that classifying learners by their year of enrollment is not a good indicator of linguistic proficiency. This may explain the lack of a relation between stress perception and “proficiency”. In order to better assess whether such a relation exists, we focus on participants’ behavior in the condition that seems to be most difficult for these learners, the stress-only condition in the “different” trials. Furthermore, rather than operationalizing proficiency as a function of year of enrollment, we aim to predict accuracy rates as a function of the linguistic scores we gathered from each of the 80 second language learners in our sample: their language dominance data and the three grammatical and vocabulary proficiency tests.

A linear regression model with arcsine-transformed accuracy as response and dominance—i.e., the scores obtained with the Bilingual Language Profile questionnaire—as predictor yields a modestly significant effect, $\beta = -.003$, $t = -2.05$, $p < .05$ [.043], $R^2 = .039$. Thus, an increase in English dominance leads to an apparent decrease in accuracy rate in stress discrimination. On the other hand, a linear regression with arcsine-transformed accuracy as response and overall proficiency—i.e., the score obtained by averaging the scores corresponding to the three proficiency tests—as predictor does not produce a significant finding, $\beta = .629$, $t = 1.77$, $p > .05$ [.079]. Lastly, we ran regression models with each of the test scores as predictors:
sentence-based cloze test ($\beta = .559, t = 2.03, p < .05 [.045], R^2 = .038$), passage-based cloze test ($\beta = .192, t = .62, p > .05 [.53]$), and vocabulary size ($\beta = .661, t = 1.62, p > .05 [.109]$). In sum, only one of these models yields a marginally positive finding.

To sum up, there is some modest evidence that linguistic experience and proficiency, as measured by language dominance questionnaire and a sentence-based cloze test, predict perceptual discrimination accuracy of stress-based contrasts in second-language learners of Spanish whose first language is English. This evidence is, at most, modest because the relevant models predict only about 3% of the variance and this effect is not found when other measures of linguistic proficiency, such as a passage-based cloze test and a vocabulary-size test, are used as predictors.

5.7 Interim Discussion

5.7.1 Summary of Findings

In this experiment, we had subjects participate in an AX discrimination task involving nonwords differing in either a consonantal or a stress contrast. The two items (A,X) were separated by two stimulus onset asynchrony (SOA) conditions (short and long) in order to explore whether the unavailability of the acoustic information played a role in the discrimination of the stimuli. We hypothesized that the short tone would have no effect (or a very small one) in that it would allow participants to use their acoustic remembrance of the first item in order to make a decision. For the long tone condition, however, we expected participants to rely on their central representation of the nonwords as the tone could tamper with their acoustic representation of the first item. We performed two different analyses in order to address the two research questions we set for this
experiment. The first research question addressed whether length and depth of experience with Spanish modulates perceptual discrimination abilities of word-level stress. The results from the first study indicate that native speakers, early learners and late learners were not affected by the SOA manipulation in any of the experimental conditions. Furthermore, the LL and EL participants were less accurate in the stress condition than in the consonant condition while NS controls were equally accurate in both conditions. Thus, it appears that higher proficiency and more extensive experience with Spanish do not lead to native-like performance in the discrimination of stress contrasts. The EL group and the 10 LL speakers with the highest proficiency scores displayed a similar tendency to accept words contrasting in stress as being the ‘same’. Meanwhile, their performance in the consonant condition exhibit a ceiling effect, which indicates that they had no problems in the perception of consonantal changes. Furthermore, the manipulation of the SOA did not yield any differences in accuracy. This means that the identity of the experimental items was available for the EL and LL participants whether they were heard with a long or a short tone. Thus, early and late learners did not rely on their phonetic acoustic memory in order to identify words in any condition.

The second research question concerns the effects of second-language learners’ proficiency and linguistic profile in the perceptual discrimination of Spanish stress. Findings from the second study indicate that year of study does not have an effect on stress perception. Meanwhile, proficiency (as measured in sentence-based cloze test) and language dominance (language dominance questionnaire) appear to be significant predictors of stress accuracy, but can only modestly predict (3% of the variance of) second-language speakers’ performance. Thus, late learners do not show a robust effect of L2 experience in the development of their
discrimination abilities. Results point toward the interpretation that perceiving differences in stress minimal pairs is just as difficult for beginners as it is for advanced learners.

5.7.2 Interpretation and Implications

The results from the present experiment shed light on the low-level perceptual abilities of early and late learners of Spanish. Experiment 1 looked at the encoding abilities of participants by testing them in a task that was cognitively more demanding than the AX. The two tasks (Experiment 1, Experiment 2) are similar in that both incorporate phonetic variability into their design. Each of the three items of the ABX was produced by a different speaker (male, male, female), and each of the two items of the AX was produced by a different speaker (male, female) as well. The results suggest that EL and LL participants were challenged by the two types of paradigms. Despite the relative simplicity of the AX with respect to the ABX, this task also allowed us to observe processing difficulties with regards to stress. This contrasts with the case of French naive listeners in Dupoux et al. (1997) who were not challenged by the stress condition in the AX task. Remember that the ABX requires participants to hold the first item (A) in memory while they process the second (B) and third item (X). Meanwhile, in the AX task, participants only need to retain identity information of the first item (A) until they finish hearing the second item (X). We can offer two explanations that can account for these outcomes.

First, it may be the case that, despite our efforts to design this experiment as a means to tap into the phonetic and phonological levels of stress processing, the presence of phonetic variability in the task required participants to rely on their abstract representation of the nonwords. Comparing items by two talkers, then, may have prevented subjects from using
acoustic information which led to a higher error index in the stress condition. These results would be in line with previous studies (Dupoux et al., 2008; Tremblay, 2009) that confirm the defining role of phonetic variability in the perception of stress. Also, this could help explain why our EL and LL groups were challenged by this task while the French speakers in Dupoux et al. (1997) were not. The stimuli in their design presented low phonetic variability; both items were produced by the same speaker. As a consequence, the cognitive abilities required to complete the ABX were no different from those required to complete our AX task. This explanation would also account for the fact that SOA manipulation did not yield any results. If participants were required to access their phonological representation of the nonwords in order to complete this task, then meddling with their acoustic remembrance of stress would, of course, not have any effect in their performance. Thus, hearing a long or short tone in between the two items, did not impact their short-term encoding of stress, which led to no significant differences between the SOA conditions.

A second possible explanation is related to participants metalinguistic awareness with regards to how critical stress is for word identity in Spanish. In the ABX task, participants are required to make a decision based solely on their perception/encoding of the phonological form of the items. For that purpose, they need to rely on their processing abilities to determine which item is the one that is identical to the target. Meanwhile, in the AX task, participants are not asked only to perceive whether item A and item X are different. The task required that participants indicate whether the two items they heard were the ‘same’ word or ‘different’ words. The nature of this experimental paradigm requires that subjects consciously assess whether any given difference between A and X is significant enough to make them two potentially distinct
lexical items. In other words, when hearing the triplet *nédapi* — *nedápi* — *nedápi* in the ABX task, participants need to rely exclusively on perceiving and retaining the differences between the three words in order to make a decision. But when they hear the pair *nédapi* — *nedápi* in the AX task, they need to make a further decision on whether the stress difference between both items makes them two different nonwords. In light of this, it could be the case that, despite their experience with Spanish minimal pairs such as */ˈpasə/-/ˈpaso/, EL and LL participants are unsure of the decisive role of stress in word identity in Spanish. Thus, the higher rate of errors in the stress condition in the AX task when compared to the ABX experiment may lie in this metalinguistic choice. According to this explanation, it would be challenging for EL and LL participants to decide whether the stress difference between *nédapi* and *nedápi* means that they are different nonwords. Another factor that may have contributed to this outcome may lie in their training session, which was different from the one in Dupoux et al. (1997). In our experiment, participants did not receive feedback on whether their responses in the practice session were correct or not. This may have had an effect as participants were not explicitly told that a difference in a stress contrast meant (for this experiment) that the two items were different.

The interpretation that making a same-different decision on stress contrasts is challenging for these populations could be further supported by evidence from lexical access. Previous studies have shown that words differing on word-level stress exclusively (with no segmental differences) are treated as homophones in cross-modal priming tasks by English natives (Cutler, 1986). This means that, for example, for a minimal pair involving a stress contrast with no reduction of vowels such as *trusty* — *trustee*, when hearing the word *trusty*, native speakers of English are able to access the meaning of the word *trustee*, which indicates that they treat both
lexical items as homophones. This may stem from the fact that “true” stress minimal pairs are rare in English (Warner and Cutler, 2017). Only a handful of these pairs exist in this language. Thus, listeners who have early experience with English, a language in which stress changes alone appear to have little relevance, may learn to ignore stress differences when discriminating words, which (we hypothesize) may have caused EL and LL participants to be confused when asked to consider whether words like nédapi and nedápi are different or identical. In light of this explanation, it is worth mentioning that participants were aware that this experiment was conducted to test their perception of Spanish sounds and that it involved Spanish nonwords (as it was explained in both the consent form and the instructions of the experiments). For that reason, we would like to highlight that participants with more experience with the Spanish language and Spanish language instruction (EL and LL in their second and third year) still display rates between 57% and 62% accuracy in the stress condition. Even after having been exposed to the lexical relevance of stress (either from exposure or in a learning context), their perceptual discrimination is not very different from that of learners in their first year of Spanish classes who still have limited experience with the lexical consequences of word-level stress changes.

Whichever the explanation may be, the present experiment adds to the growing body of literature dealing with cross-linguistic stress processing by testing English and Spanish—two languages that have contrastive stress—using the same methodology. It provides evidence that languages with typologically similar stressed systems may display different degrees of ‘deafness’. In this case, it seems that English speakers are more stress ‘deaf” than Spanish speakers. This finding is predicted by the lexical statistics account put forth by Peperkamp et al. (2010). According to this model, the predictability of stress location (as measured by the number
of lexical exceptions to the most common stress pattern) in a given language will have a direct effect on the processing of stress. The results from Peperkamp et al. (2010) indicate that speakers of Polish—a language with 0.1% of lexical exceptions—are able to encode stress in a more efficient manner than speakers of French, Finnish and Hungarian—languages with no lexical exceptions—but less efficiently than speakers of Spanish—a language in which exceptions account for about 20% of lexical items. In the case of English, the lexical exceptions make up for 10% of the data (Cutler & Carter, 1987), which would predict that English speakers are less stress ‘deaf’ than speakers of Polish, but more than speakers of Spanish. This study helped to demonstrate the predictions of this model by providing evidence that Spanish speakers are more successful in the processing of stress than English speakers.

With regards to early bilingualism, the results from this study suggest that early bilinguals display a stress processing behavior that is comparable to that of late learners of Spanish. This is different from the findings in Dupoux et al. (2010) where language experience appeared to modulate French-Spanish early bilingual’ performance. Bilinguals with higher early exposure to Spanish were found to pattern with the monolingual group, while those who were exposed more to French during infancy behaved like advanced late learners. Their distribution correlated with country of residence between the ages of 0-2, 2-4. The limited number of early bilingual participants we were able to obtain (N=10) makes it difficult to explore our results by taking into account subjects’ linguistic experience. Our study cannot help determine whether early experience with one of the languages can predict monolingual-like behavior of early learners. But it does weigh in to the study of early bilingualism in that it corroborates previous
findings that very early exposure to a language does not guarantee the successful development of stress processing abilities.

Our results also indicate that, when tested on speech processing knowledge alone, early and late learners of Spanish do not behave very differently from each other. This diverges from studies that tested stress by asking participants to exploit the morphological consequences of stress contrasts (Kim, 2015). In this study, early and late learners were asked to indicate the correct subject of sentences of the type ‘por la plaza paso...’—“through the square (I) pass”—and ‘por la plaza pasó...’—“through the square (s/he) passed”. Note that this experiment requires that participants pay attention to the stress pattern of a word in order to make a linguistic decision with regards to the morphological information signaled by the location of stress. In this task, early learners’ accuracy is identical to that of native speakers. Late learners in this task had more difficulties than the other two testing groups. This could be interpreted as a sign that EL and LL groups could differ with regards to how sensitive they are to stress. However, our results indicate that our early and late bilinguals do not differ when it comes to discriminating words in the presence of stress contrasts. These contradictory findings could be due either to methodological differences (the two tasks tap into different types of knowledge) or to non-comparable samples of EL groups (it maybe the case that the early learners in Kim (2015) were more dominant in Spanish than those in our experimental group). Nevertheless, the early bilingual group in our study behaved similarly to the late bilingual group when tested on a simple AX task.

Similarly to other studies in the identification of Spanish stress by L2 (Beaudrie, 2007; Romanelli, Menegotto & Smyth, 2015a, 2015b; Romanelli & Menegotto, 2015) and heritage
speakers (Beaudrie, 2017), the present study finds that these two populations also present difficulties when it comes to discriminating stress differences. In these studies, participants were tested on their ability to indicate/circle the stressed syllable of a word, while in our study, they had to indicate whether two words were the same or different. Our design relies more on the perception of stress differences than previous studies as it does not ask participants to map the sound patterns they heard to their orthographic representation. Thus, our results are a good complement to these studies because they indicate that the obstacle to successful stress identification is, at least in part, related to listeners’ perceptual abilities. It also helps to explain why explicit instruction on learners’ metalinguistic awareness can only do so much as learners display processing disadvantages that limit their encoding and retrieval of stress information. Therefore, our study complements those studies on heritage and L2 perception by looking at stress processing at a purely perceptual level.

In sum, the present study provides relevant results for the fields of cross-linguistic stress perception, language learning, and early bilingualism. We find that English speakers are stress ‘deaf’ when compared to Spanish speakers. This cross-linguistic processing difference is predicted by the lexical statistics account (Peperkamp et al., 2010). The relative lower percentage of stress pattern exceptions in the English language makes speakers less sensitive to stress information. These findings also help us to understand why native English speakers L2 learners of Spanish have difficulties when it comes to perceiving stressed syllables in Spanish words (Beaudrie, 2007; Romanelli, Menegotto & Smyth, 2015a, 2015b; Romanelli & Menegotto, 2015). Finally, the present study reveals that the behavior of early Spanish-English bilinguals is comparable to that of late learners of Spanish when it comes to discriminating stress minimal
pairs. Therefore, early experience with Spanish does not lead to more efficient stress processing abilities.

5.7.3 Conclusion

In this experiment, we asked participants to indicate whether two word forms contrasting in stress or consonantal information were the same word or different words. Our results indicate that the early and late learner groups are not challenged by consonantal contrasts. When presented with words differing segmentally (fídape—lídape) they are very successful in identifying that difference. Meanwhile, when they hear two words that have different stress patterns (fidape—fidápe), they find it difficult to determine whether they are the same word or different words. In this regard, early and late learners did not differ in their accuracy rate. Moreover, L2 proficiency and language dominance were very modest predictors of stress processing abilities, which indicates that beginning learners were not very different from advanced learners. This finding provides evidence that learners’ stress-processing behavior remains relatively unaltered during the language learning process.

The main point we would like to highlight from this study is that learners whose L2 is English and early English-Spanish bilinguals display some degree of stress ‘deafness’. This stress-processing difficulty stems from their experience with English and affects how they perceive Spanish stress. Furthermore, we hypothesize that such degree of stress ‘deafness’ is also partially responsible for the previously reported challenges that learners have with stressed syllable identification and orthographic accentuation.
CHAPTER 6: CONCLUSION

6.1 Introduction

This dissertation explored the processing capabilities of Spanish stress by early and late learners of Spanish. Specifically, it has investigated whether early and late learners display robust mental categories to encode stress information and perceptual discrimination abilities of stress-based contrasts. The present chapter provides a summary of the findings followed by a discussion of their implications and directions for future research.

6.2 Summary of Main Findings

Chapter 3 outlined the motivations, method, analyses and findings of Experiment 1. This experiment sought to unveil the phonological encoding of lexical stress in early and late learners of Spanish. To that end, an ABX discrimination task was conducted probing participants on nonword triplets in which the first and second items were different according to three experimental conditions: consonantal change, stress change, redundant change (stress + consonantal change). In the first study, the responses of Spanish natives, early learners and the ten late learners with the highest overall proficiency were analyzed. Both early and late learners were less accurate in the stress condition than in the consonant condition. Thus, both groups appeared to be challenged by stress contrasts. In the second study, the relationship between late learners’ scores (proficiency and language profile), and their individual accuracy was assessed. Unlike their language profile scores, learners’ proficiency was found to be a significant predictor
of their performance with the stress contrast, which indicates that stress-encoding abilities are modulated by learners’ knowledge of the language.

Chapter 4 outlined the motivations, method, analyses and findings of Experiment 2. The aim of this experiment was to test participants perceptual discrimination on stress-based contrasts. In order to address this question, an AX discrimination was carried out on the same participant groups as Experiment 1. Subjects were tested on a stress and on a consonantal contrast in two stimulus onset asynchronies, which involved a long or a short intervening tone between the two experimental items. It was hypothesized that a long tone would destroy the phonetic trace of the first item which would require participants to rely on their abstract representation of it. A short tone was expected to yield virtually no effect and to facilitate participants reliance on their acoustic remembrance of the first item. Results from the first study indicate that early learners and the ten late learners with the highest overall proficiency score were significantly less accurate in the stress condition than in the consonant condition. Results from the second study indicated late learners perceptual discrimination was only modestly predicted by participants’ linguistic profile and a sentence-based cloze test. Higher linguistic dominance in Spanish and higher proficiency scores (in that particular test) led to higher accuracy rate in the stress condition for the learners. The manipulation of stimulus onset asynchrony did not yield any effect for any of the groups included in both studies.

6.3 Phonological Encoding of Stress by Early and Late Learners of Spanish

The main finding of the present work is that English speakers appear to be stress ‘deaf’ (at least in comparison to speakers of Spanish) when stress is signaled exclusively through
suprasegmental cues. This was successfully predicted by the lexical statistics account (Peperkamp et al., 2010) and hinted at by previous studies that looked at the encoding of stress by English native speakers (Lin et al., 2014).

When learning Spanish as a second language in adulthood, English speakers are able to develop their stress processing abilities in such a way that their encoding of stress in phonological memory appears to become more robust with increased proficiency. This indicates that experience with Spanish leads to an improvement in the processing of phonological categories. These results go in line with those found by Tremblay (2009) who revealed that learners’ reported a daily use of L2 English modulated stress encoding abilities in such a way that their perception of stress improved with higher L2 use on a daily basis. Thus, our results further support that stress processing is an ability that can develop.

In the case of early bilinguals, the results from the present study reveal that early exposure to Spanish is not sufficient to develop stress processing abilities that are comparable to those of monolingual Spanish speakers. Our group of early bilinguals was challenged by stress contrasts in both experiments, which indicates that their stress-encoding is not robust (at least when compared to speakers who grew up monolingual). However, these findings should be treated with caution due to the limited number of early bilinguals included in this study. Thus, the early learner group examined in this dissertation cannot be representative of the broad spectrum of bilingualism. Dupoux et al. (2010) found that French-Spanish bilinguals who grew up in a French-speaking country processed stress similarly to monolingual speakers of French while those who were raised in Spanish-speaking countries displayed encoding abilities comparable to Spanish monolinguals’. It is the case that our early bilingual group is homogenic
in the sense that they were all born in an English-Speaking country, which according to Dupoux’s findings, may have caused them to develop processing abilities in an English-like fashion. Therefore, these findings only provide limited evidence of early bilinguals with this specific profile. It remains unknown whether English-Spanish bilinguals with varying linguistic experience process stress in different ways.

6.4 Implications for Accentuation Teaching

Research on the teaching of accentuation in Spanish has demonstrated that what seems to be challenging for both heritage and second-language learners is not the memorization of accentuation rules but rather the identification of stressed syllables (Beaudrie, 2007; 2017). Without the correct identification of stressed syllables, knowledge of the accentuation rules is fruitless. Yet accentuation teaching appears to rely heavily on the perceptual abilities of heritage and second-language learners of Spanish. Thus, according to the findings of the present study, we could argue that perception-based teaching approaches to stressed syllable identification may be tapping on phonological abilities that these populations lack.

For instance, in Beaudrie (2017) heritage learners heard a real sentence in Spanish and were presented with its written form. They were asked to mark the stressed syllable of the word that was highlighted. For example, they were presented with sentences such as <La caza de la BALLENA es habitual en algunos países>, and their task was to mark the stressed syllable of the word BALLENA. Similarly, Romanelli et al. (2015) carried out a perceptual training study in which second-language learners had to identify the nonword they heard by selecting one option from a worksheet. These training techniques relied heavily on the perceptual and phonological
abilities of learners, which, as revealed by the two experiments reported in this study, may be limited when it comes to processing stress.

Carreira (2002) approached this in a different way. Heritage speakers were trained to identify stressed syllables in words that had been produced with an exaggerated pronunciation of the stressed syllables (pitch, loudness, duration). This training technique yielded positive effects in syllable identification in words pronounced in a natural fashion.

Overall, training learners to identify stressed syllables shows mixed effects. Some studies have been able to capture a development in this ability as an effect of instruction (EL: Beaudrie, 2017; Carreira, 2002; LL: Romanelli et al., 2015), while others have not (LL: Beaudrie, 2007; Saalfeld, 2012). It appears, then, that perceptual training can help to develop stress identification skills under certain circumstances. Yet, attempts to circumvent this poorness in perceptual processing when teaching stress identification have not been made. It would be of interest to the field of language teaching to explore whether second language learners and heritage speakers who are able to correctly pronounce lexical item X in Spanish can identify its stressed syllable by manipulating its stress structure. For example, if a learner produces the word ballena with the correct stress pattern. Would it be possible for this learner to identify its stressed syllable by trying out the three possible stress configurations of the word (BAllena, baLLEna, balleNA)? This would allow the learner to access all possible combinations of the word as many times as needed in order to come up with the one that matches their intuition. This training proposal would serve to avoid the issue of retention of one item in working memory by providing an opportunity to access the word indefinitely and compare it to its limited nonword competitors.
6.5 Future Directions

The present study found that English native speakers are stress ‘deaf’ at least when compared to native speakers of Spanish. The lexical statistics account (Peperkamp et al., 2010) was able to predict this effect. However, we do not know how ‘deaf’ English speakers are in relation to speakers of other languages. In order to fully support the lexical statistics account, English should be compared to other languages like Polish whose speakers display an intermediate degree of ‘deafness’. This account predicts that Polish speakers should be more challenged by stress than English speakers since Polish presents a 0.1% of lexical exceptions while English’ is about 10% (Cutler & Carter, 1987). Such a study would provide further evidence of the decisive role of languages’ lexical distribution of stress patterns on speakers’ development of stress-encoding abilities.

Another point of interest is that of the development of stress processing skills by early bilinguals. Future studies should consider gathering a larger and more varied pool of bilingual participants in order to further explore how differences in linguistic experience affect the development of stress processing capabilities.

Finally, much remains unknown with regards to the use of suprasegmental acoustic information in the perception of stress by native speakers of English. Ortega-Llebaria et al. (2013) looked at the perception of vowel length by advanced learners of Spanish. However, we still do not know to what extent learners are able to use this and other suprasegmental cues in the presence and absence of accent when perceiving Spanish stress.
6.5 Conclusion

The present project has tested the phonological encoding of stress by English-speaking L2 learners of Spanish and English-Spanish bilinguals. The two experiments appear to be captured a stress ‘deafness’ effect, characterized by challenges in processing stress contrasts. This study adds to the existing literature on stress ‘deafness’ (Dupoux et al., 1997, 2001, 2008, 2010; Lin et al., 2014; Peperkamp et al., 2010; Qin et al., 2017; Tremblay, 2009) by providing evidence that English speakers processing of stress in less efficient than that of Spanish speakers. Furthermore, these findings also complement studies on heritage and second-language stress perception (Beaudrie, 2007, 2017; Kim, 2015, 2016; Romanelli & Menegotto, 2015; Romanelli, Menegotto & Smyth, 2015a, 2015b; Saalfeld, 2012) in that they suggest that stress is challenging for L2 and heritage learners at a purely phonological level.
APPENDIX A

Bilingual Language Profile

I. Biographical information

Participant number _______ Age _______ Male ☐/ Female ☐

Current place of residence: city/state _______ country _______

Highest level of formal education:
☐ Less than highschool ☐ High school ☐ Some college
☐ College ☐ Some grad school ☐ Masters
☐ PhD/MD/JD ☐ Other: _________

II. Language history

1. At what age did you start learning the following languages?

ENGLISH

☐ Since birth

SPANISH

☐ Since birth

2. At what age did you start to feel comfortable using the following languages?

ENGLISH

☐ Since birth

SPANISH

☐ Since birth

3. How many years of classes (grammar, history, math, etc.) have you had in the following languages (primary school through university)?
4. How many years have you spent in a country/region where the following languages are spoken?

ENGLISH
☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐
Since birth 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

SPANISH
☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐
Since birth 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

5. How many years have you spent in a family where the following languages are spoken?

ENGLISH
☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐
Since birth 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

SPANISH
☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐
Since birth 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

6. How many years have you spent in a work environment where the following languages are spoken?

ENGLISH
☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐
Since birth 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+
III. Language Use

7. In an average week, what percentage of the time do you use the following languages with friends?

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8. In an average week, what percentage of the time do you use the following languages with family?

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9. In an average week, what percentage of the time do you use the following languages at school/work?

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10. When you talk to yourself, how often do you talk to yourself in the following languages?

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11. When you count, how often do you count in the following languages?

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IV. Language proficiency

12. a. How well do you speak English?          ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
    b. How well do you speak Spanish?          ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

13. a. How well do you understand English?    ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
    b. How well do you understand Spanish?    ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

14. a. How well do you read English?          ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
    b. How well do you read Spanish?          ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

15. a. How well do you write English?          ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
   b. How well do you write Spanish?          ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
V. Language Attitudes

16. a. I feel like myself when I speak English. □0 □1 □2 □3 □4 □5 □6
    b. I feel like myself when I speak Spanish □0 □1 □2 □3 □4 □5 □6

17. a. I identify with an English-speaking culture. □0 □1 □2 □3 □4 □5 □6
    b. I identify with an Spanish-speaking culture. □0 □1 □2 □3 □4 □5 □6

18. a. It is important to me to use English as a native speaker □0 □1 □2 □3 □4 □5 □6
    b. It is important to me to use Spanish as a native speaker □0 □1 □2 □3 □4 □5 □6

19. a. I want others to think I am a native speaker of English □0 □1 □2 □3 □4 □5 □6
    b. I want others to think I am a native speaker of Spanish □0 □1 □2 □3 □4 □5 □6
The sequence of stimuli used is the following. Words are translated in English; nonwords are indicated as NW:

- terzo (NW)
- pellizcar (pinch)
- pulmones (lungs)
- batillón (NW)
- zapato (shoe)
- tergiversar (distort)
- pésimo (abysmal)
- cadeña (NW)
- hacha (axe)
- antar (NW)
- cenefa (edging)
- asesinato (murder)
- helar (freeze)
- yunque (anvil)
- regar (water)
- abracer (NW)
- floroso (NW)
- arsa (NW)
- brecedad (NW)
- ávido (avid)
- capillo (NW)
- lampera (NW)
- látigo (whip)
- bisagra (hinge)
- secuestro (kidnapping)
- acutación (NW)
- merodear (prowl)
- depar (NW)
- pandilla (gang)
- fatacidad (NW)
- pauca (NW)
- aviso (notice)
- rompido (NW)
- lor (parrot)
- granuja (rascal)
- estornudar (sneeze)
- torpe (clumsy)
- alfombra (carpet)
- rebuscar (rummage)
- cadallo (NW)
- canela (cinnamon)
- cuchara (spoon)
- jilguero (goldfinch)
- martillo (hammer)
- cartinar (NW)
- ladrón (thief)
- ganar (win)
- flamida (NW)
- candado (padlock)
- camisa (shirt)
- vegada (NW)
- fomentar (promote)
- nevar (snow)
- musgo (moss)
- tacaño (stingy)
- plaudir (NW)
- besar (kiss)
- matar (kill)
- seda (silk)
- flaco (skinny)
- esposante (NW)
- orgulloso (proud)
- bizcocho (cake)
- hacido (NW)
- cabello (hair)
- alegre (cheerful)
- engatusar (cajole)
- temblo (NW)
- polvoriento (dusty)
- pemición (NW)
- hervidor (kettle)
- cintro (NW)
- yacer (lie)
- atar (tie)
- tiburón (shark)
- frondoso (leafy)
- tropaje (NW)
- hormiga (ant)
- pozo (well)
- empirador (NW)
- guante (glove)
- escuto (NW)
- laúd (lute)
- barato (cheap)
- grodo (NW)
- acantilado (cliff)
- prisa (hurry)
- clavel (carnation).
APPENDIX C

Sentence Cloze Test from Martínez García (2016)

Each of the following sentences contains a blank indicating that a word or phrase has been omitted. Select the choice that best completes the sentence.

1. Al oír del accidente de su buen amigo, Paco se puso _____.
   a. alegre  b. fatigado  c. hambriento  d. desconsolado

2. No puedo comprarlo porque me _____.
   a. falta  b. dan  c. presta  d. regalan

3. Tuvo que guardar cama por estar _____.
   a. enfermo  b. vestido  c. ocupado  d. parado

4. Aquí está tu café, Juanito. No te quemes, que está muy _____.
   a. dulce  b. amargo  c. agrio  d. caliente

5. Al romper los anteojos, Juan se asustó porque no podía _____sin ellos.
   a. discurrir  b. oír  c. ver  d. entender

6. ¡Pobrecita! Está resfriada y no puede _____.
   a. salir de casa  b. recibir cartas  c. respirar con pena  d. leer las noticias

7. Era una noche oscura sin _____.
   a. estrellas  b. camas  c. lágrimas  d. nubes

8. Cuando don Carlos salió de su casa, saludó a un amigo suyo: -Buenos días, _____.
   a. ¿Qué va?  b. ¿Cómo es?  c. ¿Quién es?  d. ¿Qué tal?

9. ¡Qué ruido había con los gritos de los niños y el _____ de los perros!
   a. olor  b. sueño  c. hambre  d. ladrar

10. Para saber la hora, don Juan miró el _____.
11. Yo, que comprendo poco de mecánica, sé que el auto no puede funcionar sin _____.
   a. permiso   b. comer   c. aceite   d. bocina

12. Nos dijo mamá que era hora de comer y por eso _____.
   a. fuimos a nadar   b. tomamos asiento   c. comenzamos a fumar
   d. nos acostamos pronto

13. ¡Cuidado con ese cuchillo o vas _____ a el dedo!
   a. cortarte   b. torcerte   c. comerte   d. quemarte

14. Tuvo tanto miedo de caerse que se negó a _____ con nosotros.
   a. almorzar   b. charlar   c. cantar   d. patinar

15. Abrió la ventana y miró: en efecto, grandes lenguas de _____ salían llameando de las casas.
   a. zorros   b. serpientes   c. cuero   d. fuego

16. Compró ejemplares de todos los diarios pero en vano. No halló _____.
   a. los diez centavos   b. el periódico perdido   c. la noticia que deseaba   d. los ejemplos

17. Por varias semanas acudieron colegas del difunto profesor a _____ el dolor de la viuda.
   a. aliviar   b. dulcificar   c. embromar   d. estorbar

18. Sus amigos pudieron haberlo salvado pero lo dejaron _____.
   a. ganar   b. parecer   c. perecer   d. acabar

19. Al salir de la misa me sentía tan caritativo que no pude menos que _____ a un pobre mendigo que había allí sentado.
   a. pegarle   b. darle una limosna   c. echar una mirada   d. maldecir

20. Al lado de la Plaza de Armas había dos limosneros pidiendo _____.
   a. pedazos   b. paz   c. monedas   d. escopetas

21. Siempre maltratado por los niños, el perro no podía acostumbrarse a _____ de sus nuevos amos.
168

a. las caricias   b. los engaños  c. las locuras   d. los golpes

22. ¿Dónde estará mi cartera? La dejé aquí mismo hace poco y parece que el necio de mi hermano ha vuelto a _____.
   a. dejármela   b. deshacérmela   c. escondérmela   d. acabármela

23. Permaneció un gran rato abstraído, los ojos clavados en el fogón y el pensamiento _____.
   a. en el bolsillo   b. en el fuego   c. lleno de alboroto   d. Dios sabe dónde

24. En vez de dirigir el tráfico estabas charlando, así que tú mismo_____ del choque.
   a. sabes la gravedad   b. eres testigo   c. tuviste la culpa   d. conociste a las víctimas

25. Posee esta tierra un clima tan propio para la agricultura como para _____.
   a. la construcción de trampas   b. el fomento de motines   c. el costo de vida
   d. la cría de reses

26. Aficionado leal de obras teatrales, Juan se entristeció al saber _____ del gran actor.
   a. del fallecimiento   b. del éxito   c. de la buena suerte   d. de la alabanza

27. Se reunieron a menudo para efectuar un tratado pero no pudieron _____.
   a. desavenirse   b. echarlo a un lado   c. rechazarlo   d. llevarlo a cabo

28. Se negaron a embarcarse porque tenían miedo de _____.
   a. los peces   b. los naufragios   c. los faros   d. las playas

29. La mujer no aprobó el cambio de domicilio pues no le gustaba _____.
   a. el callejeo   b. el puente   c. esa estación   d. aquel barrio

30. Era el único que tenía algo que comer pero se negó a _____.
   a. hojearlo   b. ponérselo   c. conservarlo   d. repartirlo
Answer Key: Sentence Cloze Test

1. d  11. c  21. a
2. a  12. b  22. c
3. a  13. a  23. d
4. d  14. d  24. c
5. c  15. d  25. d
6. a  16. c  26. a
7. a  17. a  27. d
8. d  18. c  28. b
9. d  19. b  29. d
10. d  20. c  30. d

Total possible points: 30
APPENDIX D

Paragraph Cloze Test from Martínez García (2016)

In the following text, some of the words have been replaced by blanks numbered 1 through 20. First, read the complete text in order to understand it. Then reread it and choose the correct word to fill each blank from the answer sheet. Mark your answers by circling your choice on the answer sheet, not by filling in the blanks in the text.

El sueño de Joan Miró

Hoy se inaugura en Palma de Mallorca la Fundación y Joan Miró, en el mismo lugar en donde el artista vivió sus últimos treinta y cinco años. El sueño de Joan Miró se ha (1). Los fondos donados a la ciudad por el pintor y su esposa en 1981 permitieron que el sueño se (2); más tarde, en 1986, el Ayuntamiento de Palma de Mallorca decidió (3) al arquitecto Rafael Moneo un edificio que (4) a la vez como sede de la entidad y como museo moderno. El proyecto ha tenido que (5) múltiples obstáculos de carácter administrativo. Miró, coincidiendo (6) los deseos de toda su familia, quiso que su obra no quedara expuesta en ampollosos panteones de arte o en (7) de coleccionistas acaudalados; por ello, en 1981, creó la fundación mallorquina. Y cuando estaba (8) punto de morir, donó terrenos y edificios, así como las obras de arte que en ellos (9).

El edificio que ha construido Rafael Moneo se enmarca en (10) se denomina “Territorio Miró”, espacio en el que se han (11) de situar los distintos edificios que constituyen la herencia del pintor.

El acceso a los mismos quedará (12) para evitar el deterioro de las obras. Por otra parte, se (13), en los talleres de grabado y litografía, cursos (14) las distintas técnicas de estampación. Estos talleres también se cederán periódicamente a distintos artistas contemporáneos, (15) se busca que el “Territorio Miró” (16) un centro vivo de creación y difusión del arte a todos los (17).

La entrada costará 500 pesetas y las previsiones dadas a conocer ayer aspiran (18) que el centro acoja a unos 150.000 visitantes al año. Los responsables esperan que la institución funcione a (19) rendimiento a
principios de la (20) semana, si bien el catálogo completo de las obras de la Fundación Pilar y Joan Miró no estará listo hasta dentro de dos años.

Cloze Test Answer Sheet

1. a. cumplido  
   b. completado  
   c. terminado

2. a. inició  
   b. iniciara  
   c. iniciaba

3. a. encargar  
   b. pedir  
   c. mandar

4. a. hubiera servido  
   b. haya servido  
   c. sirviera

5. a. superar  
   b. enfrentarse  
   c. acabar

6. a. por  
   b. en  
   c. con

7. a. voluntad  
   b. poder  
   c. favor

8. a. al  
   b. en  
   c. a

9. a. habría  
   b. había  
   c. hubo

10. a. que  
    b. el que  
    c. lo que

11. a. pretendido  
    b. tratado  
    c. intentado

12. a. disminuido  
    b. escaso  
    c. restringido

13. a. darán  
    b. enseñarán  
    c. dirán

14. a. sobre  
    b. en  
    c. para

15. a. ya  
    b. así  
    c. para

16. a. será  
    b. sea  
    c. es

17. a. casos  
    b. aspectos  
    c. niveles

18. a. a  
    b. de  
    c. para

19. a. total  
    b. pleno  
    c. entero

20. a. siguiente  
    b. próxima  
    c. pasada
Answer Key: Paragraph Cloze Test

1. a  8. c  15. b
2. b  9. b  16. b
3. a  10. c  17. c
4. c  11. b  18. a
5. a  12. c  19. b
6. c  13. b  20. b
7. b  14. a

Total possible points: 20
REFERENCES


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