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## The perception and production of Spanish pure vowels by native English speakers

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THE PERCEPTION AND PRODUCTION  
OF SPANISH PURE VOWELS  
BY NATIVE ENGLISH SPEAKERS

A Thesis

Submitted

in Partial Fulfillment

of the Requirements for the Designation

University Honors with Distinction

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University of Northern Iowa

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This Study by: Lauren Erickson

Entitled: The Perception and Production of Spanish Pure Vowels by Native English Speakers

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University Honors with Distinction

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Date, Dr. Juan Carlos Castillo, Department of Modern Languages

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Date, Jessica Moon, Director, University Honors Program

## **Abstract**<sup>1</sup>

Quantitatively measuring a person's fluency in a second language (L2) is difficult, but analysis of formant movements during vowel production may provide a more accurate way of measuring the accuracy of acquiring a native-like production of the L2. This study examined the accuracy with which two groups of native English speakers perceived and produced the Spanish vowel /e/ and diphthong /ei/, and compared their results with the results from a group of native Spanish speakers. For the perception portion of the study, participants were asked to correctly identify matching sounds, and the number and percentage of correct responses were compared across groups. For the production portion of the study, participants were recorded while reading a list of Spanish words. The results were analyzed using spectrographic analysis. While the results obtained in this study were statistically significant; due to several recommended changes in the study itself, as well as the delivery of the study, it is recommended that the study be repeated with the recommended changes in order to ensure that these results were not obtained purely by chance.

### **1. Literature Review**

#### *1.1 Introduction*

Learning a second language is difficult in itself, but it may be even more difficult to measure a person's progress towards fluency due to the subjective nature of evaluating fluency. We can

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measure fluency by the size of a person's vocabulary inventory, or perceived strength of foreign accent; however, these methods are highly subjective and extremely difficult, if not impossible, to measure quantitatively. While it may be difficult to measure these aspects of a language, it is possible to use spectrographic analysis to measure certain qualities of vocal sounds. Each sound has certain values and measurements that are specific to it, and measuring the accuracy with which a non-native speaker pronounces a sound from their second language (L2) may be a more precise way to measure their accuracy of acquiring a native-like pronunciation of the L2.

The objective of this study was to examine the accuracy with which English speaking students perceive and pronounce certain Spanish vowels. This was accomplished by measuring the F1 and F2 values of these Spanish vowels and comparing these results to the values obtained from native Spanish speakers. Measuring and comparing the F1 and F2 values will hopefully provide us with quantitative values that can be compared from person to person as well as more information regarding the acquisition of a second language.

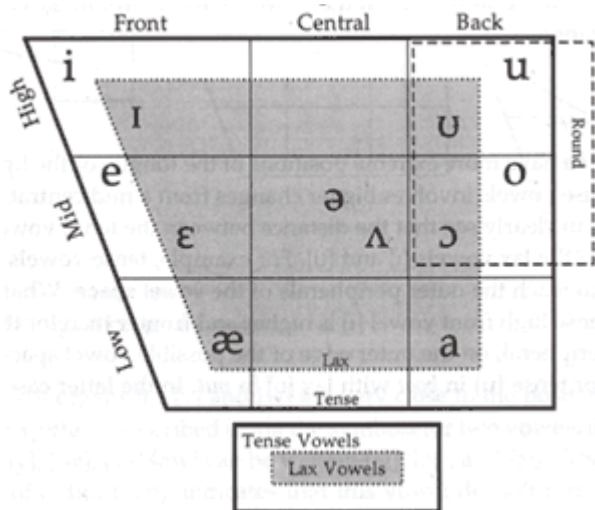
### *1.2 Describing Vowels*

A common characteristic of all languages is the presence of vowels, yet all vowels, or vowel systems, are not the same. Many people are familiar with written vowels such as a, e, i, o, and u; however, they do not know how to describe vowels using phonetic terms. Consonants are described by the manner in which they are articulated in the vocal cavity, but according to Hammond (2001:31), "all vowels are articulated (or produced) by a relatively lesser obstruction of the airstream in the oral cavity than in the articulation of any other speech sound." Since airflow is relatively unobstructed during vowel production, vowels in English and Spanish are described according to three different characteristics: the position of the tongue on a front-back axis, the relative height of the tongue in the mouth, and the amount of lip rounding while producing the vowel sound (Ladefoged 1975).

Sometimes a fourth characteristic, the relative tension of the muscles used to produce the vowels, is also used to describe vowels in English.<sup>2</sup> In this instance we will be looking at the vowel systems of English and Spanish. These two vowel systems differ in many qualities, one of the most obvious being the number of vowel sounds in each language. English contains thirteen vowel sounds (see Figure 1), while Spanish contains only five (see Figure 2) (Bradlow 1994)<sup>3</sup>. Each of the previously mentioned characteristics will be discussed in turn with regards to both English and Spanish. Using Figures 1 and 2 may help provide a visual reference to the positions of the vowels as the characteristics are being discussed. They should be pictured as if they were a map of the oral cavity, with the left side of the figures being where the lips and the teeth are located, and the right sides being where the back of the

tongue and the throat are located.

Figure 1 shows that the oral cavity can be broken into three sections of varying heights: high, middle, and low. These sections allow us to describe the relative height of the tongue when pronouncing vowels. When pronouncing the high vowels, the tongue is positioned relatively close to the hard palate. Moving down towards



**Fig. 1** English Vowel Chart  
<http://www.ic.arizona.edu/~lsp/IPA/SSAE.html> Chart

<sup>2</sup> In some languages, additional features such as voicing or nasalization are also used to describe vowels. French, for example, has nasalized vowels.

<sup>3</sup> The number of vowels in English is subject to debate. Ladefoged (1975) and Bradlow (1994) say that there are thirteen English vowels; whereas Whitley (2001) states that there are eleven English vowels. Figure 1 only shows twelve English vowels on the chart. The key issue is whether or not certain diphthong sounds are categorized as vowels. For example, the diphthongs /ai/, /oi/, and /aw/ are not included in Figure 1, but are still considered by many linguists to be English vowels.

the intermediate position, or mid level vowels, the tongue relaxes and moves farther away from the hard palate, and a speaker might also notice a slight lowering

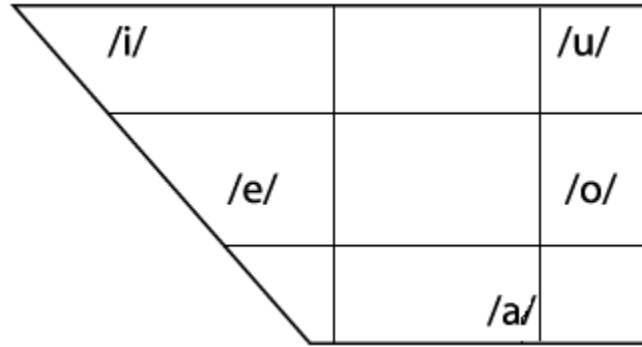


Fig. 2 Spanish Vowel Chart  
<http://www.indiana.edu/~hlw/PhonUnits/vowels.html>

of the jaw. This lowering of the tongue and relaxation of the jaw is even more pronounced and noticeable when a person

moves to the low position. These changes may be felt by saying the words “heed,” “head,” and “had” in sequence (Hammond 2001).

Figure 1 also shows the oral cavity broken into three sections moving from the left side of the figure to the right. These sections are commonly called front, central, and back. Breaking down the oral cavity in this manner allows us to describe the position of the tongue when producing vowels on a front to back plane. The tongue is moved relatively forward and close to the teeth when in the front position, and as it moves through the central and back sections, the tongue retracts until it is positioned closer to the throat. These changes can be felt by saying the words “heed,” “had,” and “hood” in sequence (Ladefoged 1975). These two characteristics combined allow us to map the position of a vowel on a two dimensional plane, which can be accomplished by looking at Figures 1 and 2. For example, in Figure 2, the vowel /i/ would be classified as a high, front vowel, and the vowel /a/ would be classified as a low, central vowel.

The movement of the lips adds another level of complexity to the description of vowels. If a person says the words “see” and “too” that person may feel that the lips are more spread when saying the word “see”, and how they are more rounded when saying the word “too”. In both English and Spanish, all vowels in the front and central sections of the oral cavity are automatically articulated

with unrounded lips, while vowels located in the back section of the oral cavity are automatically articulated with rounded lips (Hammond 2001).

Both the English and Spanish vowel systems contain vowels that are articulated high in the oral cavity, and low in the oral cavity. Both systems also include vowels that are articulated towards the front oral cavity and relatively farther back. Both systems follow similar rules regarding rounding of the lips when articulating vowels; yet, perhaps the most obvious difference between the two systems may be the presence of lax vowels in English, and their absence in Spanish. “Tense” and “lax” are two terms that are used to describe the relative tension of the tongue muscles while producing a vowel (Stockwell & Bowen, 1975). For example, the English word “bait” is pronounced with more tension of the tongue than the English word “bet” (Whitley 2001). Tense/lax vowel pairs such as /i/ and /ɪ/ are typically found when more than one vowel occupy the same section of the oral cavity, which is much more common with the larger vowel inventory, like that of English. A vowel system that has fewer vowels that are more spread out within the vocal cavity would not require this additional characteristic (Hammond 2001). For this reason, the tense/lax contrast exists in English but not in Spanish (Ladefoged 1975; Whitley 2001).

When comparing the English tense vowels /i, e, o,u/ with their Spanish vowel counterparts, one notices that in most cases, the Spanish vowels are comparatively more tense than the corresponding English vowel. This may make it easier for English speakers to distinguish the sounds of Spanish vowels; however, it may also cause miscommunication issues when a native English speaker attempts to speak Spanish. In English, vowels that fall in unstressed syllables tend to be reduced to a more lax vowel, the most notable of which is the schwa or /ə/. This is the most lax of all American English vowels, and a very common error for speakers of English is to reduce the normally tense vowels of Spanish to their lax English counterparts, or even to the very lax /ə/. This is one of the strongest



indicator of a foreign accent when speaking Spanish, since this sound simply does not exist in Spanish (Hammond, 2001). This may lead to miscommunication issues, which in certain cases may keep a native English speaker from being understood when attempting to speak Spanish.

### *1.3 Vowels and Diphthongs*

These four characteristics (height, position on a front-back axis, lip rounding and tense/lax) are vitally important when discussing the characteristics of vowels in a language, and they do provide us with some basic information regarding the differences between the vowels of Spanish and English. However, we can still look more specifically at these two systems to see how vowels and combinations of vowels, or diphthongs, differ between the two. A diphthong is a sound that is produced when the position of the lips and tongue change throughout the articulation of the sound (Ladefoged 1975). The five Spanish vowels have several characteristics in common: Spanish vowels are always tense and they are never diphthongized, which causes the duration of Spanish vowels vary much less than English vowels (Hammond 2001). On the other hand, English vowels may be tense or lax; and tense vowels are diphthongized, or, the place of articulation of the vowel varies throughout the duration of the vowel (Whitley 2002). This causes the duration of vowels to show a large amount of variance in English.

The Spanish vowels are commonly referred to as pure vowels since all of the Spanish vowels, /a e i o u/, are monophthongs, meaning that the position of the tongue and lips does not change during the articulation of the vowel (Ladefoged 1975). The English equivalent vowels /i e o u/ are diphthongs when located in stressed syllables (Whitley 2001). This is generally represented by adding the /j/ glide to the high, front vowels, and the /w/ glide to the high, back vowels to produce the English sounds /I ei ou u/. For example, the English vowel /e/ generally begins in a similar position as the Spanish /e/. The articulation then tends to slide upward towards the point of articulation for the English vowel /i/,

and the resulting sound combination of the diphthong /ei/ is the common English pronunciation for the vowel /e/ (Ladefoged 1975; Whitley 2001; Hammond 2001). A very common mistake for a native English speaker is to pronounce this Spanish vowel, as well as the other mid and high vowels, with a diphthong. However, diphthongized vowels simply do not exist in Spanish and, to a native Spanish speaker, are another common indicator of a foreign accent (Hammond 2001; Whitley 2001). For example, in the Spanish word *vente* or “come here” the /e/ is pronounced with no diphthongization at all; however, it is common for English speakers to substitute the English diphthongized /e/ in place of the Spanish /e/ which may cause a native Spanish speaker to confuse the word with *veinte* or “twenty.”

Diphthongs do exist in Spanish, but they are perceived as completely contrasting sounds to vowels, unlike English where no distinction between the two exists. Therefore, to a native Spanish speaker, the words *reino* “kingdom” and *reno* “reindeer” contain two completely different sounds, /e/ and /ei/, which are never interchangeable without changing the meaning of the word<sup>4</sup>. Therefore, if an English speaker substitutes the diphthongized English /e/ in place of the Spanish /e/, it is quite possible that the pronunciation of the speaker will be misinterpreted as the Spanish diphthong /ei/ (Morrison 2003; Whitley 2001), like in the words *vente* “come here” and *veinte* “twenty”. It is likely that the duration of a diphthongized vowel will be longer than that of a monophthong vowel simply because of the additional movements taking place during production; however, this fact has been debated (Ladefoged 1975; Stockwell & Bowen 1975).

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<sup>4</sup> It would be interesting to examine the contrast between /o/ and /ou/ to see if a similar situation exists; however, modern Spanish has evolved from Latin in such a way that the /ou/ sound is highly uncommon. Most linguists assume that as the Latin word for gold (*auro*) passed through an intermediate phase (*ouro*) as it evolved into the modern Spanish word (*oro*). This also occurred in the Latin word *audire* as it evolved to *oudire* and then to the modern Spanish word *oir* (to hear). The intermediate phase of these words, as well as several others, all contained the /ou/ diphthong which has since evolved to the vowel /o/ in modern Spanish.

Each characteristic of a vowel contributes in determining that vowel's point of articulation. For vowels, the point of articulation is described as the physical position of the lips and the highest position of the tongues during the pronunciation of a vowel (Ladefoged 1975). English has thirteen vowels and many corresponding points of articulation. Each point covers a specific area in the vocal cavity, and any articulation that falls within this area will most likely be interpreted as the vowel sound corresponding to that area of articulation (Bradlow 1994; Flege, Schirru, and MacKay 2003). Likewise, the five vowel points of articulation in Spanish have a corresponding area of articulation, and any articulation that falls within a given area will be interpreted as the appropriate Spanish vowel.

A common cause of confusion for people trying to learn a second language is the inability to recognize the different articulation boundaries between vowels in the second language (Flege 1995; Morrison 2003). This may mean that English speakers will pronounce Spanish vowels according to the points of articulation of English vowels, which may confuse how a Spanish speaker hears the vowel when it is said by an English speaker (Flege 1995; Stockwell & Bowen, 1975; Whitley 2001). The same confusion may occur when a native Spanish speaker attempts to pronounce an English vowel.

#### *1.4 Spectrograph Analysis*

One way of examining a sound is to begin by taking a recording of a sound. This is the only way to produce a permanent record of a sound that can later be analyzed in a variety of ways and can give us more information regarding the sound. One type of analysis that may be performed is spectrographic analysis. A spectrograph does not measure the pitch or intensity (loudness or softness) of a sound, but it allows us to measure the quality of a sound. According to Ladefoged (1975), a vowel sound contains many different pitches resonating simultaneously within it. These pitches are called the overtones, and each vowel sound has its own unique combination of overtones that provide the

vowel with its individual quality. In other words, the quality of a vowel sound is dependent on its overtones.

Each individual pitch provides us with information regarding certain characteristics; however, it is typically difficult to separate the overtones of a vowel out into their individual pitches. This can be achieved through spectrographic analysis. Each characteristic is represented on a spectrogram as vowel formants. There are three main characteristic formants, and they are numbered from one to three: formant 1 (F1) being the lowest, and formant 3 (F3) being the highest.

The formants are recorded by the way that air moves through the vocal tract. The vocal cords are continuously opening and closing, which sends small bursts of air through the vocal tract while the vocal cords are vibrating. These bursts of air are specific to the shape of the vocal tract at that moment in time; therefore since each vowel has a characteristic point of articulation, each vowel will also have a characteristic set of vibrations and formants. The formants are shown as dark horizontal bars going across the spectrograph, and the intensity of each formant is shown by the darkness of its color. The horizontal axis is typically a timescale, and the vertical axis measures the frequency of the vibrations. Each of the formants correlates to one of the previously mentioned vowel characteristics. F1 is inversely related to the height of the vowel, meaning that as a speaker pronounces a high vowel like /i/ and moves toward a lower vowel like /a/, the F1 value will rise, or show a positive change in the F1 value. Likewise, as a speaker moves from a lower vowel toward a higher value, the F1 value will lower, or show a negative change. F2 is somewhat related to the relative front-back position of a vowel in the oral cavity. As a speaker moves from pronouncing a front vowel, such as /e/, to pronouncing a back vowel such as /o/, the F2 value decreases and shows a negative change; and as a speaker moves from a back vowel towards a front vowel, the F2 value increases and shows a positive change. This correlation is not as strong as the correlation between F1 values and the point of

articulation of a vowel in the vertical plane, but it still provides us with a way to measure the relative position of a vowel in the oral cavity.

Figures 3 and 4 show examples of spectrographs and some of the changes previously described in the introduction. Figure 3 shows the Spanish word *reino* or “kingdom”. You can see in the spectrograph that as the speaker pronounces the diphthong /ei/, the F1 drops towards the bottom of the image and the F2 raises toward the top. Accordingly, you can see in Figure 4 (the Spanish word *reno* or “reindeer”) that both the F1 and F2 values remain relatively unchanged throughout the

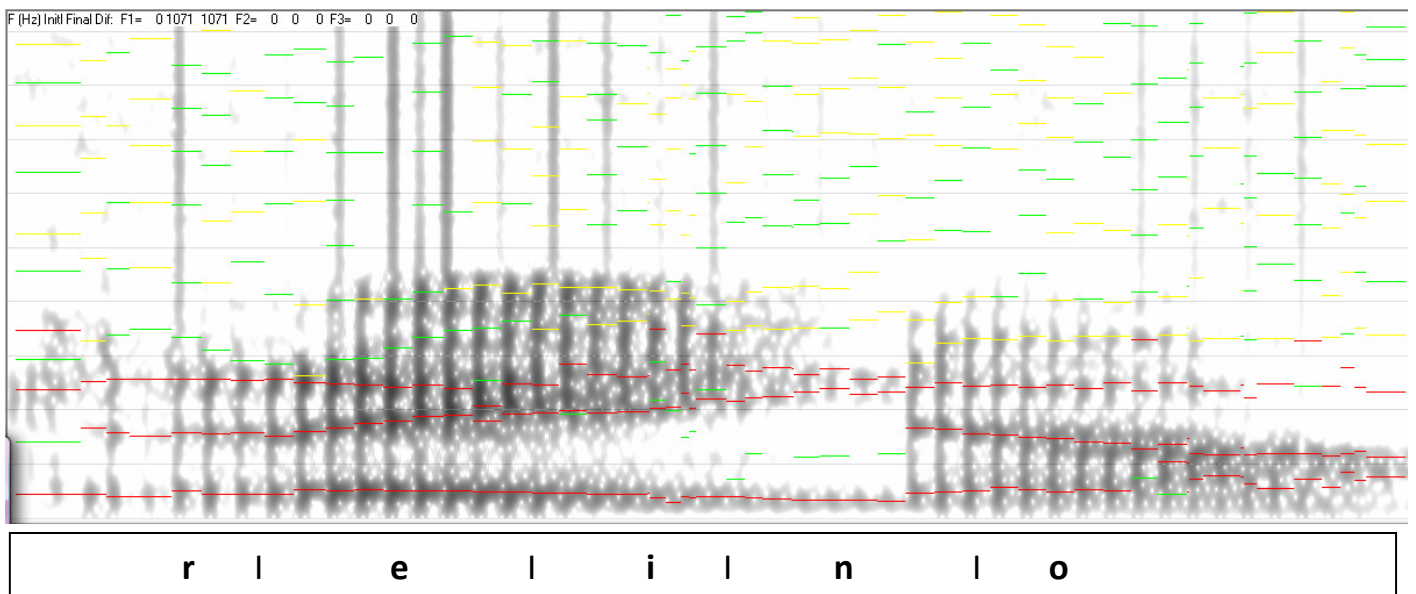
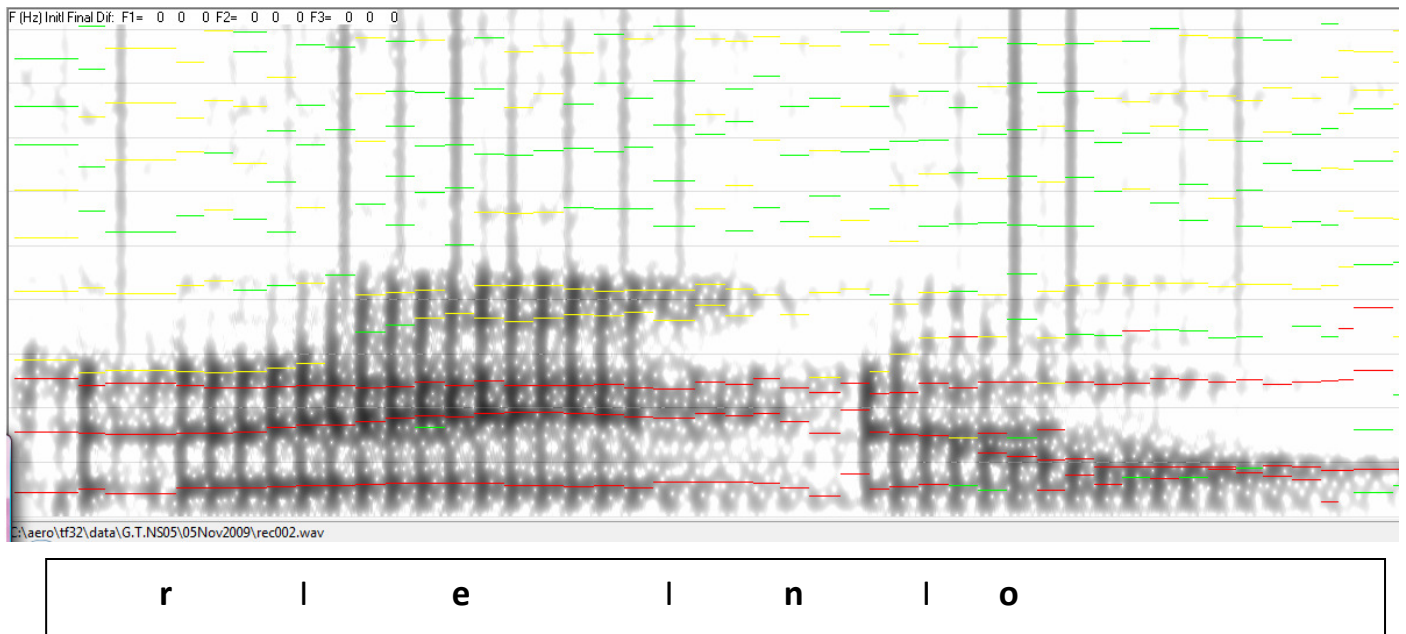


Fig. 3 “reino”

pronunciation of the /e/ vowel.



**Fig. 4** "Reno"

It is also noted that the amount of roundedness in the lips can also affect the frequencies of the formants, generally causing formants to decrease as the lips become more rounded. This affect is strongest in the third formant (F3) and will not be discussed in this study.

### 1.5 Previous Studies

The previous discussion of vowels and their descriptive characteristics, combined with spectrographic analysis provide us with the background knowledge to begin to discuss the issues that were examined in this study. Spectrographic analysis provides us with a way of measuring the point where a sound is being articulated in the oral cavity as well as the movements, or lack of movements that occur during the duration of the sound. This was chosen as a way to quantitatively measure the accuracy with which native English speakers perceive and pronounce the Spanish vowel /e/ and the contrasting diphthong /ei/. We have previously mentioned that in Spanish, vowels and diphthongs are not interchangeable; they are two entirely different sounds and are not interchangeable without

changing the meaning of a word. However in English, both mid and high vowels are diphthongized, and some very common mistakes for native English speakers are to diphthongize the Spanish /e/, as if they were pronouncing an English /e/, or to not pronounce the Spanish /ei/ with a strong enough diphthong.

In the same line of thinking, most linguists do not believe that bilingual speakers are able to separate out the phonetic systems of their first language (L1) and L2 (Flege, Schirru & MacKay, 2003). It is well documented that adults have difficulty discriminating and identifying foreign consonant contrasts, and that non-native listeners are less accurate than native speakers in identifying sounds in the native language (Polka, 1994). In the early stages of learning an L2, L2 learners may not be able to accurately produce an L2 sound, and may then substitute similar but slightly different sounds from their L1 in place of the L2 sound. This is more likely to occur when the L2 sound is perceived as being very similar to an L1 sound (Morrison, 2003). Some linguists believe that increased learning and exposure to an L2 will also increase a person's awareness of the phonetic difference between L1 and L2. Assuming that L2 speakers' perception of an L2 and the accuracy with which they produce L2 sounds are connected, this means that over time as they become more perceptually aware of phonetic differences, they may be able to establish new phonetic categories and more accurately produce these sounds (Flege 1991). The sounds may be accented at first, but as learners gain experience in an L2, their production of L2 sounds may come to more closely resemble the production of native speakers even though exposure to an L2 is not always a direct link to proficiency in speaking or understanding (Fox, Flege & Munro, 1992; Morrison, 2003).

Catherine Best (1994) has proposed a model in which she outlines a method by which learners of an L2 may familiarize themselves with the sounds in an L2, and thereby more accurately perceive the differences between L2 sounds and L1 sounds. Best states that adults are likely to assimilate L2

sounds into the categories of their L1 perceptual space whenever possible. She further states that the ability to distinguish the L2 sounds from one another is excellent when the separate L2 sounds have been assimilated into separate L1 categories and more difficult when the separate L2 sounds are assimilated into the same L1 category. She also states that it is possible for two L2 sounds to be assimilated into the same L1 category, yet differ in their accuracy of fit to that category (Polka, 1994). For example, in the case of English speakers learning Spanish, it may be difficult for English speakers to perceive a difference between the Spanish vowel /e/ and the diphthong /ei/. It is possible that an English speaker would identify these two sounds with the English /e/ which may lead to difficulty distinguishing between the two. According to James Flege (1991), errors in perception may be inferred by how learners pronounce the L2 sounds. Accordingly, he has proposed his own model, the Speech Learning Model (SLM) to account for limits on the ability to produce L2 consonants and vowels in a native like manner.

To begin, Flege (1995: 239) states that “the phonetic systems used in the perception and production of vowels remains adaptive over the life span.” He hypothesizes that L2 learners are more likely to establish a new production category for L2 sounds if they are very different from L1 sounds, and that when this does not happen, it limits the accuracy of production of the new sound. He proposes that L2 learners begin by producing L2 words with sounds from their L1, but as they gain more experience in the L2, they may be better able to approximate the differences between the two languages. Flege states that L2 sounds may be assimilated into the same category as an L1 sound through the process of *category assimilation*. He proposes that a new L2 category will not form if the L2 sound continues to be identified as an L1 sound; the production of the L2 sound will be less native-like and the L2 sound will therefore be produced very similarly to the L1 sound to which the L2 sound has been assimilated. On the other hand, an L2 learner may indeed be able to identify and establish a new category for an L2 sound. In this case the L2 sound will be pronounced with much more native-



like accuracy. Flege also states that since L1 and L2 sounds exist in the same space, and if the L1 and L2 sounds are relatively similar, they may shift away from each other in the phonetic space as a means of preserving the phonetic differences between the two. He calls this *category dissimilation*; and further states that this category dissimilation may in some cases, cause further distortion of the production of an L2 sound.

Linda Polka (1994) performed a study to test the ability of English speaking adults in discriminating between two German vowel contrasts, the tense pair /U/-/Y/ and the lax pair /u/-/y/ at the same proficiency level as native German speakers. She found that English speakers correctly identified the tense vowel pair /U/-/Y/ with more accuracy than the lax vowel pair /u/-/y/; however, both were identified correctly at lower rates than native German speakers. She also found that the English speakers perceived the back, high, rounded vowels /u/ and /U/ as more similar to English vowels than their front, high, rounded counterparts /y/ and /Y/. From these results, she concludes that the linguistic experience of the English speakers shapes their ability to discriminate between consonants and vowels in a similar manner, and that this provides positive evidence supporting Best's model of perception since native English speakers were better able to assimilate the more familiar /u/ and /U/ vowels into their perceptual space.

James Flege (1991) also performed a study in which he tested the ability of two groups of native Spanish speakers to identify English vowels. A group of Spanish speakers with little experience in English, and a group of Spanish speakers with a greater amount of experience in English were given the task of identifying English vowels with the Spanish vowel it most resembled. Spanish speakers were also given the option to choose "none" if they felt that the sound they heard did not have a corresponding vowel in Spanish. Flege demonstrated that Spanish speakers with more experience in English selected the response "none" when asked to identify the English vowels /æ/ and /I/, more

often than Spanish speakers with little experience (42% vs. 18%). These two vowels are present in English, but not Spanish which may suggest that some participants were able to identify these vowels as non-existent in Spanish<sup>5</sup>.

Flege, Schirru, and MacKay (2003) performed a study in which they examined four groups of Italian subjects and whether or not their productions of the English /e/ showed evidence of category dissimilation from the Italian /e/, which is pronounced as a monophthong, much like the Spanish /e/. Native Italian speakers were divided into four groups based on two factors: their age of arrival to Canada (early in life vs. late in life) and the degree of which they continued to use Italian in their daily life after arrival (high use of Italian vs. low use of Italian). The data showed that all four groups of bilinguals produced the English /e/ with less diphthongization than the control group of English speakers, which demonstrates that the English /e/ had been perceptually assimilated with the Italian /e/. The data further demonstrated that the early arrival, low Italian use group produced the English /e/ with more movement than the late arrival, high Italian use group, as well as the native English speakers. The early arrival, low Italian group produced more “overshoot” values, or values that showed more movements in F1 and F2 than what would be expected from a native English speaker. The study attributes this fact to category dissimilation; that the early arrival, low Italian use group was in fact exaggerating the pronunciation of the English /e/ in order to maintain its phonetic difference from the Italian /e/.

A study performed by Morrison (2003) examined the abilities of native Spanish speakers and native English speakers to identify the five Spanish vowels with their respective L1 vowels. The results showed that native English speakers more often perceived the Spanish /i/ and /e/ by assimilating

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<sup>5</sup> Flege only states that these results may suggest that some participants were able to identify the vowels as non-existent in Spanish because the percentages were so low. The data was not significant enough to say that many L2 learners of Spanish are able to identify these vowels as non-existent in Spanish, only that some participants demonstrated this tendency.

them to the English /i/ and /e/ (respectively). This supports Best's model by showing that L2 learners tend to assimilate the new L2 sounds into their L1 categories. The study also shows that when speaking Spanish, English speakers were more likely to substitute the English /i/ and /e/ in place of their corresponding Spanish vowels. This provides evidence that the perception and production of vowels may be connected to a certain extent, and also provides further evidence in support of Best's model of perception as well as Flege's SLM model.

This brings us to the questions presented in the current study. We aimed to see if native English speakers were able to perceive Spanish vowels with similar accuracy as native Spanish speaker, and if English speakers were able to produce Spanish vowels with similar accuracy as a native Spanish speaker. We decided to further examine whether or not English speakers with more exposure to Spanish were more accurate in their perception and production of Spanish vowels than native English speakers with less exposure to Spanish. This was achieved first by seeing if participants were able to match the /e/ and /ei/ sounds, and then looking at the differences in pronunciation of /e/ and /ei/ across groups of participants. We then looked at the data more in depth to determine whether or not the phonological environment of the /e/ or /ei/ made a difference in the pronunciation. We assumed that both groups of native English speakers would show perception and production results that were not as accurate as native Spanish speakers. We also assumed that native English speakers with more exposure to Spanish would show more native-like perception and production of Spanish vowels than would native English speakers with less exposure to Spanish.

## **2. Methods**

### *2.1 Participant Demographics*

Subjects for this study were recruited by in class visits to Spanish classes at the University of Northern Iowa (UNI) during the Fall 2009 semester. Students were asked to provide contact

information if they were interested in participating, and were later contacted by email in order to make an appointment to participate in the study. Before participating in the study, subjects were asked to complete a short questionnaire in order to assess their level of exposure to the Spanish language, as well as their proficiency in Spanish, and were grouped according to the following criteria:

**Native Speaker (NS):** Born in a Spanish speaking country, lived there for twelve years or more, currently enrolled at UNI

**Upper level native English speakers (UL):** Born in a non-Spanish speaking country, speak English as a primary language, currently enrolled at UNI, studying in Spanish, more than three years of college-level language experience.

**Lower level native English speakers (LL):** Born in a non-Spanish speaking country, speak English as a primary language, currently enrolled at UNI, studying in Spanish, less than two years of college-level language experience.

Native Spanish speakers in the experiment were 4 men, 1 each from Chile, Mexico, Puerto Rico, and Southern Texas, and 3 women, 1 each from Chile, Spain, and Argentina, for a total of seven speakers ranging in age from 19 to 74. A total of 15 students were placed in the UL category, 4 men and 11 women, ranging in age from 19 to 23. A total of 13 students were placed in the LL category, 1 man and 12 women, ranging in age from 18 to 24, for a total of 35 participants in the study.

All of the subjects in the UL groups studied Spanish for at least 1 year in high school, the majority (11 of 15) studied Spanish for all 4 years of high school with an average of 3.53 years

studied. All have at least also traveled to a Spanish speaking country, while 10 of the 15 subjects have studied in a Spanish-speaking country for at least 4 weeks. Four subjects have not studied abroad at all, and 1 has studied in Austria. As for the LL group, all of the subjects except for 1 have studied Spanish for at least 2 years in high school; about half (6 out of 13) studied Spanish all 4 years, with an average of 3.23 years. As for having a native Spanish speaker for a teacher, only 6 out of 13 LL subjects report having a native Spanish speaker as a teacher, compared with all 15 of the UL subjects. Only 6 of the 13 LL subjects have traveled to a Spanish-speaking country, while only 1 LL subject has studied abroad. This demographic information is summarized in Table 1.

Group	Average years of Spanish in High School	% who Studied Spanish for 4 years in High School	Studied Abroad	Traveled to a Spanish speaking country
NS	4	100	100	100
UL	3.53	73	67	100
LL	3.23	46	8	46

**Table 1:** Demographic Information

## *2.2 Methods for the Perception Portion of the Study*

Participants were asked to complete a matching exercise using Microsoft PowerPoint. A male, native Spanish speaker of Castilian Spanish was recorded saying all five Spanish vowels and all fourteen Spanish diphthongs. This recording was then spliced into individual recordings of each sound. Twenty data sets were assembled, each one composed of a combination of five individual vowel or diphthong sounds. Of these five sounds, two were identical and the other three sounds were selected as distracters. Ten of the assembled data sets were selected as controls in which the two identical sounds were neither /e/ nor /ei/. In addition, five of the data

sets had /e/ as the two identical sounds and five other data sets had /ei/ as the two identical sounds.

The data sets were organized in a random order to keep the participants from identifying a pattern in the delivery, but each participant listened to the same order of data sets. Each data set was delivered with a one second pause between each sound. After hearing each data set for the first time, subjects were given the option of listening to each data set a second time. Subjects were allowed to listen to each data set a maximum of two times. The subjects were asked to identify the two identical sounds from each data set. Each sound was assigned a corresponding number (ie. 1, 2, etc.) and subjects identified which two sounds they believed to be the same by circling the two corresponding numbers in each data set on a separate answer sheet.

### *2.3 Methods for the Production Portion of the Study*

Participants were recorded reading a list of Spanish words. The list consisted of 110 words. It was originally planned that 36 words would be used as key words in the study; however this list was later narrowed down to 14. The remaining 96 words were therefore used as control words. Seven of the key words contained the /ei/ diphthong while 7 others contained the /e/ vowel sound.

Prior to their scheduled appointment time, subjects were emailed a vocabulary list of the words used in the study in order to provide each speaker with exposure to each word. This list contained all one hundred ten Spanish words and their corresponding English translations.

Each word was also used in an example sentence, and the English equivalent sentence was also provided.

Each speaker was recorded reading this list of words using TF32 time-frequency analysis software program. The data was then analyzed using the same software. The amount of change in the F1 and F2 values were examined for the /e/ or /ei/ vowel in each key word. This was accomplished by recording the starting value, final value, and change for both F1 and F2 from each speaker.

### **3. Perception Findings and Discussion**

#### *3.1 Perception Results*

The data sheets for the perception portion of the study were collected and corrected, and both the control results and the key results were recorded in a Microsoft Excel spreadsheet (see Appendix D). An “X” marks a correct match, and if an incorrect answer was recorded, the two vowels or diphthongs that were incorrectly chosen were recorded in the answer space.

Following the hypothesis proposed in this study, it was expected that NS participants would have a higher percentage of correct answers than both UL and LL participants. We also assumed that UL participants would have a higher percentage of correct answers than LL participants, although still a lower percentage than the NS participants. A basic analysis of the perception data was done by first separating the data sets into a key results category and a control results category. The results of each individual were totaled and these totals were used to calculate the average number correct for each group of participants. The results are summarized in Table 2, and explained in detail below.

Group	Avg. number of correctly matched controls	Avg. number of correctly matched key sets	Avg. number of correctly matched /e/-/e/ pairs	Avg. number of correctly matched /ei/-/ei/ pairs
NS	8.3	7.7	27/35 (77.1%)	23/35 (65.7%)
UL	9.4	8.7	65/75 (86.7%)	63/75 (82.7%)
LL	9.3	8.8	52/65 (80.0%)	54/65 (83.1%)

**Table 2:** Perception Results

The NS group averaged 8.3 out of 10 correctly answered control data sets, and 7.7 out of 10 correctly answered key sets. Of the key sets, the NS speakers correctly paired 27 out of 35 /e/-/e/ pairs (77.1% correct) for an average of 3.9 correct matches per each participant. NS speakers correctly matched 23 out of 35 /ei/-/ei/ pairs (65.7% correct) for an average of 3.3 correct matches per each participant.

The UL group averaged 9.4 out of 10 correctly answered control data sets, and 8.7 out of 10 correctly answered key sets. Of the key sets, the UL speakers correctly paired 65 out of 75 /e/-/e/ pairs (86.7% correct) for an average of 4.3 correct matches per each participant. UL speakers correctly matched 63 out of 75 /ei/-/ei/ pairs (82.7% correct) for an average of 4.2 correct matches per each participant.

The LL group averaged 9.3 out of 10 correctly answered control data sets, and 8.8 out of 10 correctly answered key sets. Of the key sets, the LL speakers correctly paired 52 out of 65 /e/-/e/ pairs (80.0% correct) for an average of 4.0 correct matches per each participant. LL speakers correctly matched 54 out of 65 /ei/-/ei/ pairs (83.1% correct) for an average of 4.2 correct matches per each participant.

### *3.2 Discussion of Perception Results*



It was expected that the NS group would have the highest percentage of correct answers, followed by the UL group and then by the LL group. However, the results obtained from this portion of the study were not as anticipated. Overall, the UL group had the highest percentage of total correct pairs (84.7%), followed by the LL group (81.5%) and then the NS group (71.4%). The NS and the UL group correctly identified more /e/-/e/ pairings than /ei/-/ei/ pairings, while the LL group correctly identified more /ei/-/ei/ pairings than /e/-/e/ pairings. It is possible that the NS group had the lowest percentage of correct pairs due to the fact that the NS group had the smallest number of participants, therefore any errors would be more greatly reflected in the final results. There may also have been an issue as to whether or not all of the participants fully understood the task at hand. There may have been some confusion as to exactly what they were asked to identify or they may have been confused in regards to the manner in which they were supposed to mark their answers. All of these factors may have influenced the results, but it is difficult to say whether or not they are the only reason for the unexpected results.

The data collected in the perception portion of this study does not support the perception model proposed by Catherine Best. Our results show that both groups of non-native Spanish speakers were more accurately able to identify the /e/-/e/ and /ei/-/ei/ pairs than native Spanish speakers, and that the LL group was more accurate than the UL group.

### *3.3 Recommendations for Future Research*

Participants trained for the perception task by only one example slide; therefore it is quite possible that the subject's poor performance may be due to misunderstanding the directions for the task at hand. For example, the directions presented at the beginning of the

perception portion of the study may have been unclear, and therefore misunderstood or misinterpreted by the participants which may have led to a poor performance for that individual. It is also imperative that each subject understand not only the directions, but also the purpose that they serve in the study and why their participation is important. This may help to motivate the participants to give the maximum effort and attention to the tasks at hand.

**4. Production Findings and Discussion According to Group**

*4.1 Analysis of Production Results According to Group*

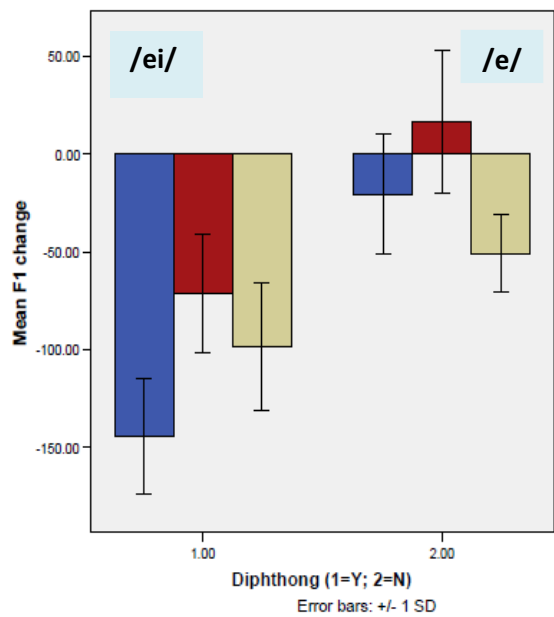
Readings for the initial value, final value, and the amount of change in F1 and F2 for either /e/ or /ei/ sound of each key word were entered into a Microsoft Excel spreadsheet. In some cases, values were eliminated due to mispronunciation of the word or due to poor quality of the recording and the inability to read the spectrogram. The number of deleted values is shown in Table 3. Using the remaining values, the mean and standard deviation for each initial value, final value and change were calculated for both F1 and F2.

	<i>/ei/</i>	<i>/e/</i>
<b>NS</b>	1/35	1/35
<b>UL</b>	18/105	7/105
<b>LL</b>	20/91	13/91

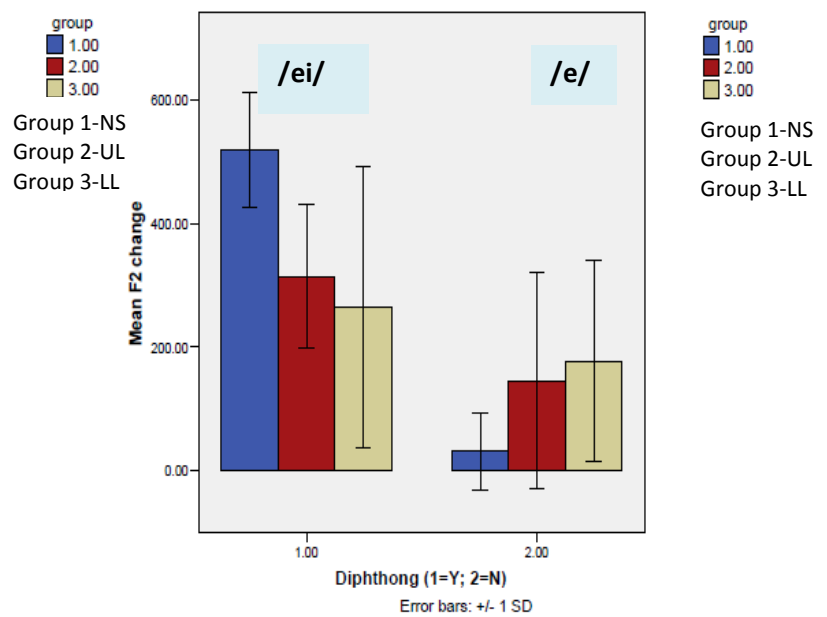
**Table 3:** Number of deleted data points

The actual data that was examined was the amount of change for both F1 and F2. To begin the data was divided into two categories: words containing /e/ and words containing the

/ei/ diphthong. Two separate ANOVAs were conducted using SPSS to determine if there was a significant difference in the amount of change of F1 for each group, and a significant difference in the amount of change of F2 for each group. Results show that the group had a significant effect on the amount of change in both F1 and F2 [ $F(4,20)=5.012, p=.002$ ]. The results for F1 are shown graphically in Figure 5 and the results for F2 are shown in Figure 6.



**Fig 5:** F1 results-group



**Fig 6:** F2 results-group

For words with /ei/, the F1 values show that NS speakers show a greater negative change, or lowering of the formant, than LL speakers, and that LL speakers show a greater negative change than UL speakers, which does not support the assumed hypothesis. The F2 values for words containing /ei/ do show the expected pattern, where NS exhibits more positive change than UL speaker, and UL speakers show more positive change than LL speakers. The difference between the amount of change for the NS group and the two groups of non-native speakers is much greater (about 200 cps) than the difference in the amount of change between the UL group and the LL group (about 50 cps). This does little to support the

assumption that as non-native speakers gain exposure to an L2, the production becomes significantly more native-like.

The results for F1 and F2 results for words containing /e/ prove to be more interesting. For both F1 and F2 we see that the NS group showed much less change than both the UL and LL groups, which was expected. For F2, the UL group shows slightly less positive change than the LL group; however, the most interesting UL data with respect to the NS group is the F1 data. The LL group exhibits a greater negative change than the NS group, and the UL group also exhibits a greater change than the NS group; however, the direction of the change is *positive*.

#### *4.2 Discussion of Production Results by Group*

If a greater amount of exposure to an L2 did cause non-native speakers to have significantly more native-like production, we would have expected to see greater difference in the amount of F2 change for words containing /ei/ between the UL group and the LL group. Alternatively, the small difference may be attributed to the deletion of many more LL data points. We were unsure if the results for the words containing /ei/ would support our assumptions that the UL would show more movement than the LL group, and it is important to note that a greater percentage of words containing /ei/ were deleted for LL speakers due to mispronunciations. This might have affected final results by eliminating the values which showed more variance, leaving only the most accurate data for the LL group and not including the values that may have been less accurate, thereby skewing the data towards a value that is more similar to the native speakers.

The F1 and F2 data for words containing /e/ may provide evidence in support of Flege's SLM theory of category dissimilation when two sounds in a L2 are very similar. It may be possible that the subjects in the UL group were perceptually aware of the /e/-/ei/ contrast in Spanish, but these sounds have been further deflected away from one another in the perceptual space. The positive change in F2 (meaning that the position of the tongue moves farther back in the oral cavity during production) during /e/ production may demonstrate that, in an attempt to avoid producing the /ei/ diphthong, the UL subjects actually show movement in the exact opposite direction of the /ei/ diphthong.

## **5. Production Findings and Discussion According to Phonologic Environment (Category)**

### *5.1 Analysis of Production Results According to Category*

Another question examined in this study was whether or not the accuracy with which native English speakers pronounced Spanish vowels varied with the phonologic environment around the vowel. The same production data was used in the analysis by phonologic environment as was used in the analysis by group. Fourteen possible environments were identified, and 7 different environments were examined in this study<sup>6</sup>. The environments were all based on the structure of the syllable which contained the /e/ or /ei/. We examined a combination of both stressed and unstressed syllables, as well as open and closed syllables. An open syllable is one that ends in a vowel, and a closed syllable is one that ends in either a voiced or voiceless consonant. A consonant is voiced if the vocal cords vibrate throughout the

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<sup>6</sup> Fourteen categories were originally identified, but they were narrowed down to eight categories due to the sheer volume of data. Of these eight categories, only seven were examined, and the category containing words with /ei/ in an unstressed syllable followed by a voiceless consonant was eliminated. Words containing syllables with these characteristics are mainly found in the vosotros form of Castilian Spanish and are not used in many other dialects of Spanish. Because of this, some of the native Spanish speakers had difficulty pronouncing the words, and several of the native English speakers were unfamiliar with, and mispronounced these words as well.

pronunciation of the sound and voiceless if the vocal cords do not vibrate. Appendix B shows a complete listing of all phonologic environments identified, and Table 4 shows a list of the categories examined. Two separate ANOVAs were conducted using SPSS to determine if the phonologic category had a significant effect in the amount of change in F1 and F2.

Category	Category Description
1	Stressed, open syllable, /ei/
2	Stressed, closed syllable closed by a voiced consonant, /ei/
3	Unstressed, open syllable, /ei/
4	Stressed, open syllable, /e/
5	Unstressed, open syllable, /e/
6	Stressed, closed syllable closed by a voiceless consonant, /e/
7	Stressed, closed syllable closed by a voiced consonant, /e/

**Table 4:** Phonologic categories examined in the study

Results show that the amount of change in both F1 and F2 is significant when looking at phonologic categories [ $F(12,42)=16.885, p<.001$ ]. When these statistics are combined with the amount of change for both F1 and F2 [ $F(24,42)=2.067, p=.019$ ]. The results for F1 are shown graphically in Figure 7 and the results for F2 are shown in Figure 8.

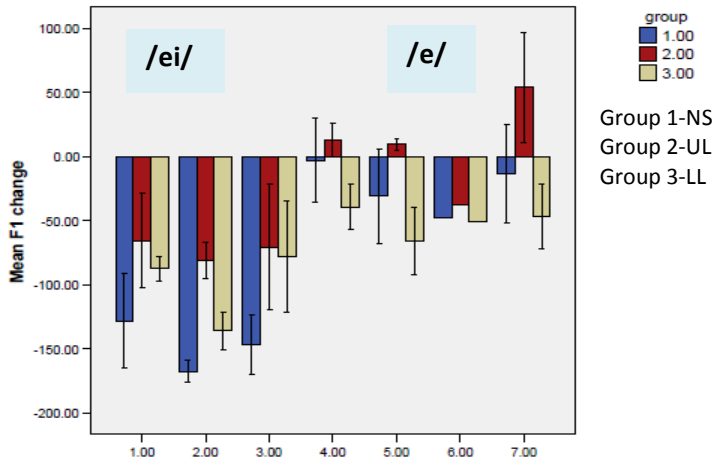


Fig 7: F1 results-category

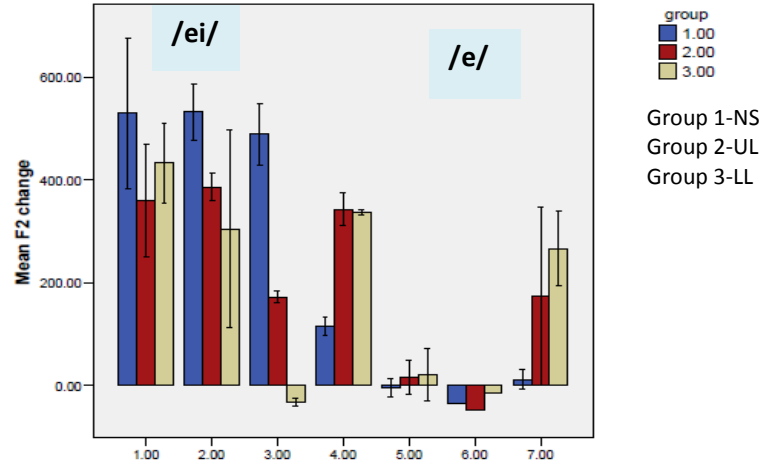


Fig 8: F2 results-category

### 5.2 Discussion of Production Results by Category

For words containing the /ei/ diphthong, the F1 values for all three categories showed that the NS group produced the greatest amount of negative change and that the LL group produced more negative change than the UL group; however, still less change than the NS group. All three categories of words show the same pattern, which shows that at least for F1, there does not appear to be a phonologic environment in which non-native Spanish speakers are significantly more or less able to accurately produce the /ei/. However for the F2 values for words containing the /ei/ diphthong show a different story. In categories 1, 2 and 3 the NS group produced the greatest amount of movement in the positive direction. In category 1 the UL group produced more positive movement than the LL group, but both groups did exhibit movement in the positive direction. In category 2 the LL group produced more positive movement than the UL group and again, both groups exhibited movement in the positive direction. Category 3 shows that the UL group produced more positive movement than the LL group, and that the LL group produced a slight movement in the negative direction. The

magnitude of the movement is very slight, but it may demonstrate that LL speakers have a more difficult time producing a diphthong in an unstressed open syllable. One more thing to keep in mind is that for the LL group, 9 of the possible 26 vowel readings from category 3 were deleted, so this also may have affected the data.

For words containing the /e/ vowel, the F1 values for all 4 categories show that the NS group shows the least amount of negative change of any group, and the LL group showed the greatest amount of negative change. For categories 4, 5, and 7, the UL group exhibited a positive change in the F1 value, and for category 6, the UL group showed a greater negative change than the NS group but less negative change than the LL group. The positive F1 values for the UL group in categories 4, 5, 7 may show evidence in support of category dissimilation as outlined in Flege's SLM. It may be possible that the UL group is able to perceive a difference between the English /e/ and the Spanish sounds /e/ and /ei/. These sounds all share very similar points of articulation in the oral cavity and it may be that in an attempt to distinguish between them, the UL group has inadvertently dissimilated the categories in an attempt to preserve the differences in the sounds. This may have caused the categories to spread out, which may be why we see the positive F1 change where we assumed that we would see a negative F1 change.

The F2 values for the 4 categories that contain the /e/ vowel were much more unpredictable. For category 4, the NS group showed the least amount of positive change and the LL group showed slightly less positive change than the UL group, although there was hardly any difference between the two groups of non-native speakers. Categories 5 and 7 showed that the NS group produced the least amount of positive change, while the UL group produced



slightly less change than the LL group. It is important to note that the magnitude of change in category 5 is much less than the magnitude of change of category 7. For category 6, the LL group showed the least amount of negative change, and the NS group showed slightly more negative change than the UL group.

Categories 4 and 5 compare the difference between stressed and unstressed /e/ vowels in an open syllable (respectively) and there is a large difference in the results for these data. One possible explanation is that in English, it is restricted against producing a lax vowel in an open syllable if it is the last syllable in a word (Morrison, 2003). The word "le" was used in category 4 which is a prime example of a lax vowel in an open syllable in the last syllable of a word. It is possible that, for this word, the native English speakers produced much more movement due to the influence of their L1. This most likely caused the average change in F2 for category 4 to increase. The /e/ vowel in category 5 appears in a phonological context that is more familiar to native English speakers, and therefore, it may not have been as difficult for them to produce the Spanish /e/ which is similar to the English lax /e/.

Category 6 showed movement in the negative direction for F2; and of a much smaller magnitude whereas category 7 showed a large amount of movement in the positive direction. Both categories compared the difference between stressed, closed /e/ vowels, the only difference was that category 6 was closed by a voiceless consonant and category 7 was closed by a voiced consonant. It is important to note that category 6 only contained the word *este*, whereas category 7 was made up of two words. The smaller amount of data for category 6 may not have been sufficient enough to provide enough data to accurately examine this category.

### *5.3 Recommendations for Future Research*

As far as the production portion of the study, there are several changes in organization of the word list itself that would most likely improve the accuracy and quality of the data obtained. Key word placement within the list of words itself is important. In this study, the word “treinta” was the final word in the list of words that each participant read. In some instances, the participants would either cut the word short, or shorten the duration of the word. This may have inadvertently affected the F1 and F2 values of the /ei/ diphthong in the word. Also, the first four words recorded by each person tended to have a metallic, distorted sound to them. This may be due to the quality of the microphone or the quality of the recording program used in this study. This metallic quality made it difficult to read the spectrogram for the words “tren” and “peinó” which were among the first four words of the list. It may be more beneficial to have the participants read more control words at the beginning and end of the word list to avoid any complications with the recording equipment or with the subjects.

If the subjects were unfamiliar with the words, this may have worsened their performance on the production portion of the study simply due to unfamiliarity of the words. In an attempt to expose each speaker with each word in the study, the vocabulary list was sent out in order to familiarize each participant, especially the UL and LL subjects. Although each of the subjects was provided with a vocabulary list prior to the beginning of their session, there was no guarantee that the subjects studied or reviewed the list prior to their session. It is recommended that subjects in a future study undergo more intense preparation in order to further ensure that each person has exposure to the words. This may include some type of training session to teach proper pronunciation before the actual data collecting session.

Additional training may further eliminate any chance that a poor production performance is due to lack of exposure to certain words.

There are also several ways in which the selection of key words used in the study could be improved. It is shown that the linguistic environment of a vowel may affect the pronunciation of a vowel and make the vowel more difficult to hear clearly. It is recommended that when selecting future key words caution is taken to avoid words where the /e/ vowel is followed by a nasal (/n/, /ñ/). Hammond (2001) states that a vowel is normally nasalized when it is immediately followed by a nasal consonant in the same syllable. This occurs in both English and Spanish; however, the extent of nasalization is highly individualized in both languages. It was seen that some of the participants in this study produced highly nasalized /e/ vowels which, in some instances, caused interference in reading of the F1 values and also in the F2 values. The values were split due to the nasalization of the vowel, which resulted in inaccurate readings and the inability to use the data for that word.

It was often difficult to obtain a reading from words containing /r/ immediately preceding or following the vowel or diphthong in question. The /r/ sound tended to overlap the vowel or diphthong in question, which in some cases made it difficult to obtain readings. This is a phenomenon called r-coloring, which is an additional auditory property of a vowel (Ladefoged, 1975) that was not addressed in this study, nor was its influence anticipated in the results. Upon reviewing the words that were to be used in the final assessment, words in which an /r/ immediately followed a vowel were disregarded due to the additional complications presented by this auditory property.

It is also recommended that care is taken when looking to find data for the /e/ vowel in order to avoid selecting words in which the /e/ is part of another diphthong (/ie/, /ue/). The words *muerto*, *dueño* and *siesta* were to be used in this study, but upon analysis of the data it was seen that the presence of the first vowel in the diphthong greatly affected the F1 and F2 values of the /e/ and most likely resulted in inaccurate readings.

## 6. Summary

The results from the production portion of this study provide evidence in support of Flege's SLM model in two ways. The results show that in certain phonologic categories non-native Spanish speakers do not produce words containing the /ei/ diphthong with as much diphthongization as native Spanish speakers. Non-native Spanish speakers also tend to produce the /e/ vowel with more diphthongization than native Spanish speakers, suggesting that their L1 exhibits an influence over their L2 production. It is interesting to note that UL speakers demonstrated category dissimilation in three of four categories of words containing the /e/ vowel. While these data show support of the theories mentioned in the introduction to this study, it does not appear to support the idea that increased experience in an L2 will lead to a more native like perception and production of the L2. The results for the production portion of the study show that for production, there is not much difference between the UL group and the LL group; but there is a greater difference in between the NS group and the two groups of non-native speakers. It is also important to note that it is difficult to have confidence in these results due to the vast numbers of changes that would produce more accurate data. The results for the production portion of the study were statistically significant, but it is highly recommended that

the study be repeated with the suggested changes in order to assure that the results obtained were not obtained purely by chance.

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APPENDIX A: WORD CATEGORIES

Category	Word	e/ei	Stressed syllable or Unstressed syllable	Syllable ends in consonant or vowel	Followed by voiced consonant, voiceless consonant, or vowel	Contrasting Word
1	Ley	Ei	Stressed	Vowel		Le
1	Reino	Ei	Stressed	Vowel	Voiced	Reno
1	Aceite	Ei	Stressed	Vowel	Voiceless	
2	Veinte	Ei	Stressed	Consonant	Voiced	Vente
2	Treinta	Ei	Stressed	Consonant	Voiced	Tren
3	Peinó	Ei	Unstressed	Vowel		Penó
3	Peinaba	Ei	Unstressed	Vowel		Penaba
4	Dueño	E	Stressed	Vowel	Voiced	
4	Reno	E	Stressed	Vowel	Voiced	Reino
4	Le	E	Stressed	Vowel		Ley
5	Tigre	E	Unstressed	Vowel		
5	Penó	E	Unstressed	Vowel		Peinó
5	Penaba	E	Unstressed	Vowel		Peinaba
5	Terapia	E	Unstressed	Vowel	Voiced	
6	Este	E	Stressed	Consonant	Voiceless	
6	Siesta	E	Stressed	Consonant	Voiceless	
7	Tren	E	Stressed	Consonant	Voiced	Treinta
7	Alergia	E	Stressed	Consonant	Voiced	
7	Vente	E	Stressed	Consonant	Voiced	Veinte
7	Muerto	E	Stressed	Consonant	Voiced	
8	Leyes	E	Unstressed	Vowel	Voiced	
8	Seleccion	E	Unstressed	Consonant	Voiceless	
9	Imagen	E	Unstressed	Consonant	Voiced	
9	Suéter	E	Unstressed	Vowel	Voiceless	
9	Ejercicio	E	Unstressed	Consonant	Voiced	
10	Lees	E	Stressed	Consonant	Voiceless	
10	Vea	E	Stressed	Vowel	Vowel	
10	Lea	E	Stressed	Vowel	Vowel	
11	Leí	E	Stressed	Vowel	Vowel	
11	Creó	E	Stressed	Vowel	Vowel	
12	Corrieseis	Ei	Unstressed	Consonant	Voiceless	
12	Cantaseis	Ei	Unstressed	Consonant	Voiceless	
13	Bella	Ei	Stressed	Vowel	Voiced	
13	Creyó	Ei	Unstressed	Vowel	Voiced	
13	Leyes	Ei	Stressed	Vowel	Voiced	

Words highlighted in yellow were used in the final data analysis.



APPENDIX B: LIST OF WORDS USED IN THE PRODUCTION PORTION OF THE STUDY

You will be recorded as you read this list of words. Read each word and pause for 1-2 seconds before moving onto the next.

Pato	Autor	Quiero
Cien	Cantases	Tradición
Peinó	Hablé	Piel
Tren	Tome	Terapia
Acción	Le	Vea
Tablera	Creo	Pulmón
Acabé	Que	Guerra
Cuota	Tomé	Puedo
Robe	Bello	Vente
Creyó	Tigre	Cantaseis
Lees	Pasto	Bueno
Escribir	Diego	Auténtica
Obvio	Veinte	Guión
Buzón	Acabe	Selección
Ley	Corrieses	Pingüino
Corrieseis	Suéter	Pierdo
Taco	Robé	De
Ciudad	Automático	Leí
Imagen	Guisado	Superficie
Lee	Mega	Sueño
Reí	Peinaba	Meiga
Idea	Inyección	Penaba
Tomé	Aire	Diario
Cine	Fue	Aceite
Europa	Juan	Creó
Claro	Alergia	Leyes
Deuda	Ejercicio	Veo
Suave	Estoico	Oscuro
Esté	Reino	Tema
Hable	Penó	Siesta
Cuidado	Velocidad	Oigo
Muerto	Cuando	Farmacia
Paula	Murciélago	Icónico
Bombero	Bella	Caigo
Guardar	Reno	Dueño
Armario	Aumentar	Treinta
Este	Agua	



Participant	M/F	Age	Classification in College	Spanish classes in high school?	Had a native Spanish speaker as a teacher?	Studied Abroad?	Traveled to Spanish speaking country?	Lived in Spanish speaking country?	Hours using Spanish outside of class each week	Other exposure to Spanish
NS01	M	19	Sophomore	4 years	Yes	Yes (USA-2 years)	Yes	Yes	All the time	None
NS02	M	74	Graduate Student	No	Yes	No	Yes	Yes	8 hours	Has taught Spanish classes at the high school and college level
NS03	F	47	Graduate Student	4 years	Yes	Yes (Argentina-5 years)	Yes	Yes	50% of the time	Teaching Spanish
NS04	F	21	Sophomore	4 years	Yes	Yes (USA-2 years)	Yes	Yes	6 hours	Talking with roommate from South America
NS05	M	25	Senior	4 years	Yes	Yes (USA-5 years)	Yes	Yes	8 hours	
NS06	M	24	Senior	4 years	yes	Yes (USA-4 years)	Yes	Yes	80 hours	Speaking with his family
NS07	F	34	Senior	4 years	Yes	Yes (France-1 month)	Yes	Yes	All the time	None
UL01	F	21	Junior	4 years	Yes	Yes (Nicaragua-4 weeks)	Yes	No	0 hours	None
UL02	M	22	Senior	4 years	Yes	Yes (Austria-1 academic year)	Yes	No	5 hours	Listen to the radio and news in Spanish
UL03	F	22	Senior	3 years	Yes	Yes (Spain-1 semester)	Yes	Yes	2 hours	None
UL04	F	21	Senior	3 years	Yes	Yes (Chile- 2x 2 months)	Yes	Yes	5 hours	Uses Skype with exchange students at UNI
UL05	M	20	Junior	4 years	Yes	Yes (Spain-1 semester)	Yes	Yes	2 hours	Working with a fill company translating from Spanish to English and vice versa. Also interviews with latino persons.
UL06	F	20	Sophomore	4 years	Yes	No	Yes	No	5 hours	Read books in Spanish, listen to music in Spanish. Stayed with a host family.
UL07	F	20	Junior	4 years	Yes	no	Yes	No	2-3 hours	Music, journaling. Spanish conversation group and chat online.
UL08	M	22	Senior	4 years	Yes	No	Yes	No	0 hours	None
UL09	M	20	Senior	4 years	Yes	Yes (Spain-6 weeks)	Yes	No	7 hours	Interpret with the Waterloo Community Schools. Done some translating with Dr. Olivares.
UL10	F	19	Sophomore	4 years	Yes	Yes (Italy-9.5 months, Chile-2 months)	Yes	No	Hardly Ever	None
UL11	F	23	Senior	1 year	Yes	Yes (Spain-1 semester)	yes	Yes	1 hour	Cousins from Spain.

UL12	F	21	Senior	4 years	Yes	No	Yes	No	1 hour	Limited volunteer work. Spanish movies and music. Trying to teach mom Spanish.
UL13	F	22	Senior	4 years	Yes	Yes (Spain-1 semester)	Yes	Yes	2-3 hours	Had Spanish exchange students live with family when was 2 years old and again during the summers from ages 14 to 17.
UL14	F	21	Senior	4 years	Yes	Yes (Peru-2 months)	Yes	Yes	0 hours	None
UL15	F	22	Senior	2 Years	Yes	Yes (Spain-1 semester)	Yes	Yes	5-7 hours	Mission trip to Mexico in January 2008 for one week.
LL02	F	19	Sophomore	3 years	Yes	No	No	No	0 hours	Student helper one semester in high school ESL classes.
LL03	F	18	Freshman	4 years	Yes	No	Yes	No	1 hour	Occasionally speaks Spanish with roommate. Instant messages host sister from Costa Rica.
LL04	F	18	Freshman	4 years	No	No	No	No	1-2 hours	None
LL05	F	18	Freshman	4 years	No	No	No	No	1 hour	None
LL06	F	21	Junior	2 Years	Yes	No	No	No	1 hour	None
LL07	M	24	Graduate Student	2 Years	Yes	Yes (Costa Rica-4 months)	Yes	Yes	.5 hours	None
LL08	F	18	Freshman	4 years	No	No	Yes	No	0 hours	Very little
LL09	F	18	Freshman	4 years	No	no	Yes	No	1-2 hours	None
LL10	F	20	Junior	No	No	No	Yes	No	0 hours	Little additional exposure.
LL11	F	22	Senior	3 years	Yes	No	Yes	No	1 hour	Sisters who speak Spanish.
LL12	F	18	Freshman	4 years	Yes	No	No	No	0 hours	None
LL13	F	18	Freshman	5 years	No	No	No	No	0-1 hours	None
LL14	F	21	Junior	3 years	No	No	No	No	less than 1	Listening to some Spanish music.











