A LONGITUDINAL STUDY OF THE ACQUISITION

OF AMERICAN ENGLISH VOWELS

by

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ABSTRACT

An abstract of the thesis of Andrea Vergun for the Master of Arts in Teaching English to Speakers of Other Languages presented May 30, 2006.

Title: A Longitudinal Study of the Acquisition of American English Vowels.

An adult second language learner rarely acquires native-like pronunciation of the L2. Flege's (1995) Speech Learning Model provides a framework to study pronunciation change as the L2 is acquired. The model predicts that a learner will perceive and eventually pronounce *new* L2 sounds, but will make little modification to sounds which are *similar* to the L1. Most studies have been cross-sectional, using groups of inexperienced and experienced L2 speakers to simulate the actual learning process. More long-term studies, which follow learners through their L2 acquisition, are necessary to investigate different stages of pronunciation development. Most studies use elicited data, which do not capture the same rich dialect-driven sounds of spontaneous speech. Unfortunately, naturalistic data are rarely used. In order to further explore the vowel acquisition process, longitudinal studies using naturalistic data should be conducted.

This investigation is a two-year longitudinal case study of a Spanish-speaking learner of English. His naturalistic classroom speech was collected, and over 1,100 words were acoustically analyzed to answer three related research questions. First, is

the learner limited to his L1 categories in the initial stage of L2 learning? Findings show that he is. Next, how does the learner's ultimate pronunciation of one *new* vowel and two *similar* vowels compare to the L2 target? The results show that he has not attained target pronunciation of one of the *similar* vowels, and the results are inconclusive for the other. The *new* vowel is pronounced similarly to the target. Finally, does the data support the Speech Learning Model concerning *new* and *similar* vowels? The subject has not created a category for the *new* vowel, and it cannot be determined if he is pronouncing the *similar* vowels without modification.

Two years may not be sufficient to show progress in acquiring a new vowel system. A similar study using a longer time frame may provide additional insight into the L2 vowel acquisition process.

ACKNOWLEDGEMENTS

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CHAPTER 1: INTRODUCTION

To one listener, hearing the hint of a foreign accent may evoke a pleasant memory of a grandparent who came to this country long ago. Yet to another, that same accent may conjure up notions of an uneducated foreigner who is just too difficult to understand.

I have always been fascinated by foreign accents, and how these accents impact others. As a child, I often tried to imitate the Swedish and Russian accents of my grandparents, and as an adult, I am trying to understand why they spoke the way they did. What is it about a person's first language that gives them a particular way of pronouncing their second?

My grandparents began learning English when they arrived in the United States as young adults. In the beginning, there wasn't much incentive or need to speak English like an American, because they were, for the most part, immersed in communities from their homelands. My Russian-Jewish grandparents spoke Yiddish at home, at work, and in the neighborhood, and my father didn't need to learn English until he entered kindergarten. For very different reasons, my Swedish grandfather's second wife, Dagmar, also found no need to speak exactly like an American. In fact, she benefited greatly by keeping her accent strong. She was an importer of Swedish gifts, and what better sales tool than that "charming" Swedish accent? My grandparents were all educated and could speak English quite well later in life, but they never achieved native-like pronunciation.

Such accented pronunciation often activates stereotypes held by native speakers. For example, with my own relatives, I often witnessed the attention lavished on my step-grandmother as she enchanted listeners with her accent. They showered her with questions about Europe and Swedish culture. On the other hand, I also witnessed reactions towards my Russian-Jewish grandparents. Their accent brought up images of impoverished immigrants arriving at Ellis Island with the masses. I'm sure that strangers never asked about the beauty of their country or culture. People are often judged on the way they pronounce a second language.

As learners acquire a second language, they go through many stages. Each stage is a unique language system. Each learner's system, at any point in time, can be considered an *interlanguage*. It is created by each learner using transfer from their first language (L1), input from their second language (L2), and influences attributable to neither L1 nor L2, sometimes characterized as "universals." At any moment, this interlanguage system is related to both the L1 and the target language. The learners' *interlanguage phonology,* or evolving L2 sound system, also changes over time and relates to the L1 and L2 target sound systems (Gass & Selinker, 2001).

To master the pronunciation of a second language, according to Major (2001), the learner must master its parts (segments; combinations of segments; and stress, intonation, and rhythm) as well as coordinate those parts into an integrated whole. If a speaker masters native-like pronunciation of some, but not all, of the components, the speaker will have a foreign, or non-native, accent. An adult learner may master the vocabulary and grammar of an L2, but may never achieve native-like control of the phonology of the language. (Henry Kissinger, for example, was well known for his eloquent speech, as well as for his strong German accent.) There seems to be a critical period for learning L2 phonology, usually considered to be around puberty, after which native-like pronunciation is highly unlikely. Teaching professionals ask whether teaching native-like pronunciation is valuable or whether intelligibility should be the goal (Leather, 1999), and second language acquisition researchers ask what makes native-like pronunciation so unlikely (Flege, Frieda, & Nozawa, 1997; Flege, Munro, & MacKay, 1995; Piske, MacKay, & Flege, 2001). The difficulty learners face in mastering second language phonology has inspired researchers to investigate.

The methods used to study second language phonology have generally taken two different perspectives. Pronunciation can be viewed through the lens of either the listener's perception or the speaker's production. A foreign accent is something which is perceived by listeners: its degree of accentedness, comprehensibility, and intelligibility are not absolutes. In listener perception studies, native speakers of a language listen to non-native speakers and judge how native-like the speech sounds to them (eg: Bongaerts et al., 1997; Derwing & Munro, 1997; Munro, Flege, & MacKay, 1996; Piske et al., 2001).

The second view of pronunciation is through the lens of production. Production can be described in physical terms with measurement of such things as frequency and duration (eg: Bohn & Flege, 1992; Chen et al., 2001; Simões, 1996). In this type of analysis, speech is recorded and then analyzed acoustically using spectrograms. In a spectrogram, vowels appear as bands of sound intensity at particular frequencies. These boosted frequencies, or vowel *formants,* can be measured and plotted to serve as a visual tool to compare vowel production of different speakers, of different languages, or of a speaker over time.

While both consonant and vowel segments play a role in creating the global sounds of a language, this study focuses on the vowels. Vowels form the most sonorous parts of a word and register prominently on a spectrogram as bands of intense frequencies, extending over a relatively long stretch of time. This makes them easy to measure and quantify. Measuring the formant frequencies follows a standardized process, increasing the likelihood of reliability, and the resulting formant frequencies are distinct numerical values, which can be placed on a formant chart as a representation of vowel production. Mapping the vowels onto formant charts is a standard and accepted practice in the fields of phonetics and dialectology. This methodology reduces linguistic features to physically observable phenomena, which are quantifiable and easy to duplicate (Simões, 1996). There is less listener bias introduced into the analysis than there is with native speaker accentedness ratings or with phonetic transcription. Additionally, acoustic analysis can detect the minute pronunciation changes of a speaker sampled at different intervals, which might go unnoticed by a listener (Simões, 1996).

Changes in pronunciation take place slowly as learners acquire the L2. Many of the studies conducted on segment pronunciation have been cross-sectional, looking at groups of speakers at varying levels in order to draw conclusions as to how development occurs. Longitudinal studies of learners are not as common, with a few studies lasting six months (Morrison, 2002) or a year at most (Aoyama et al., 2004). This study is a longitudinal analysis spanning two years to capture the development in a learner's pronunciation.

Following a student over such a time span to gather data might be impractical for a thesis. For this reason, I used data collected by Portland State University's Multimedia Adult ESL Learner Corpus (Lab School)[1]. This unique corpus contains 4,000 hours of video- and audio-recorded classroom activity spanning four years, and allowed me to gather prerecorded speech from a single learner for the two-years that he participated in the Lab School ESL project.

I investigated how the learner's interlanguage phonology changed over time. One area of interest was the learner's phonological starting point, or *initial state.* Is the

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[1] The National Labsite for Adult ESOL (known locally as the Lab School) is supported, in part, by grant R309B6002 from the Institute for Education Science, U.S. Dept. of Education, to the National Center for the Study of Adult Learning and Literacy (NCSALL). The Lab School is a partnership between Portland State University and Portland Community College. The school and research facilities are housed at the university while the registration, curriculum, and teachers of the ESL students are from the community college.

new learner limited to the sounds in the L1? I was also interested to see how the learner handled the pronunciation of vowels that are either *new* or *similar* to those in his L1. If the learner initially has only the L1 vowels available to him, he would have to substitute L1 vowels for all of the L2 vowel sounds. Would the learner be able to pronounce or approximate vowels that are not found in his native language, or alternatively, would he substitute a close one from his L1 inventory? For vowels that are similar to the L1 vowels, would he modify his pronunciation to match the target, or continue to pronounce them as in his native language? Finally, at the end of the learner's participation in the Lab School project, how would his L2 pronunciation compare to the local target pronunciation? These questions were answered by an acoustic analysis of the Lab School data.

To perform an acoustic analysis that gauges a learner's progress in the production of the L2 vowels, the learner's native language and target language vowels need to be documented. These baseline- and target-vowel systems are either gathered from study participants or taken from previously published studies. Once they are in place, the speaker's own L2 production can be sampled and compared to the documented L1 and L2 (Flege, 1987a, 1987b).

While it would be most appropriate to use the learner's own speech for the L1 vowel system, the Lab School does not permit the researcher to contact the participants, making elicitation of an L1 speech sample impossible. The participants sometimes speak with classmates in their L1 during the Lab School session; however, the amount of L1 speech is limited, and these L1 conversations usually occur during break times when the students remove their personal microphones. The ambient ceiling microphones pick up the speech, but the acoustic signal is not as clear as when the personal microphones are used. Because of the limited quantity and quality of the L1 speech in the classroom, I chose to use published data as my L1 phonetic norm.

For the phonetic norm of the target language, I used data from Portland, Oregon, native-speakers of English. Because dialects and vowel realizations vary widely over the many regions of the United States and are continually evolving and changing, dialect differences must be considered when choosing a target. An immigrant ESL learner lives and learns in a specific region of the United States, which presumably has its own local dialect. The Portland Dialect Survey, under the direction of G. Tucker Childs of Portland State University in Portland, Oregon, seeks to create a database documenting the character of Portland-area speech (Ward, 2003). Previously collected vowel data from this project served as my L2 target for the local dialect of American English.

With the L1 and L2-target language documentation in place, the learner's interlanguage vowel pronunciation was compared with the L1 and the L2, and then assessed over the time he participated in the Lab School project. Using the unique resources available at Portland State University, I was able to investigate a beginning adult second language learner's vowel acquisition process.

To assess the learner's vowel acquisition, this study generally followed methods described by Flege (1987a), which are used with his Speech Learning Model (1995). The model, which hypothesizes that *new* and *similar* vowels are acquired differently, serves as a framework for the investigation; however, this study focuses on a relatively inexperienced learner rather than an experienced bilingual as the model intended. This study also documents the learner's approximate *initial state,* which may or may not support the model's supposition that an L2 learner begins with only L1 perceptual categories.

Speech Learning Model studies are usually cross-sectional, using groups to simulate actual progress; however, the Lab School setting allowed me to perform a longitudinal case study, which is uncommon in the literature, making the study methodologically important. A longitudinal study is essential to investigate L2 developmental processes, which can only be inferred in cross-sectional studies. Longitudinal studies also put the focus on individual variation, which may be obscured in group-averaged data (Leather, 1999). Another benefit of the Lab School is that it offers "naturalistic" classroom speech data which may be more representative of the speaker's actual pronunciation than elicited words in carrier sentences (Labov, 1991). This study seeks investigate L2 vowel acquisition based on a known model; however, it utilizes data and methodology not commonly found in the literature.

The motivation for this study was based primarily on my interest in acoustic phonetics and foreign accents. I wanted to use acoustic phonetic analysis as a tool to investigate and document pronunciation change over time, with the Speech Learning Model providing a theoretical framework to guide the investigation. Further motivation rested on the opportunity to use the Lab School's unique data, which had never been analyzed acoustically, and to add to the project's pool of microgenetic studies of language development.

CHAPTER 2: LITERATURE REVIEW

This chapter opens with background information on interlanguage phonology, the study of a learner's developing L2 sound system. This sets the stage for discussing Flege's Speech Learning Model, which hypothesizes that learners acquire L2 vowels differently, depending on whether they are *new* to the learner, or *similar* to existing vowels in the L1 system. I then discuss the basics of articulatory and acoustic description of vowels and show how the acoustic data maps onto vowel formant charts. I end by describing the American English and Spanish vowel systems and by comparing the two.

2.1. INTERLANGUAGE PHONOLOGY

In this section, I define *interlanguage* and *interlanguage phonology*, and touch on some of their constraints, namely, transfer and universals. I then discuss a theory of why adults are less likely than children to acquire native-like pronunciation of a second language, especially with reference to the Speech Learning Model. I conclude by describing a type of study, representing a gap in the literature, which would shed light on learners' initial state of interlanguage phonology as well as on the acquisition of the vowels of the target language.

In the field of second language acquisition, it is generally accepted that when acquiring a second language, learners create their own language system, called *interlanguage*. Interlanguage is a grammatical system, considered to be a natural language formed by the language learner. It is an ever-evolving system, changing over time as the learner acquires an L2, composed of transfer from their first language, input from their second language, and "universals." While the interlanguage is often peppered with forms transferred directly from the L1, the learner's language system change as they receive new input from the L2, analyze it, and incorporate it into actual language use (Gass & Selinker, 2001). The learner's interlanguage also contains forms that are present neither in the native language nor in the target language, often referred to as *universals.* Universals are said to account for forms in the interlanguage which cannot be explained by L1 transfer or L2 input (Major, 2001). Universals also occur in *interlanguage phonology*, the study of language learners' L2 pronunciation patterns (Eckman, 2004).

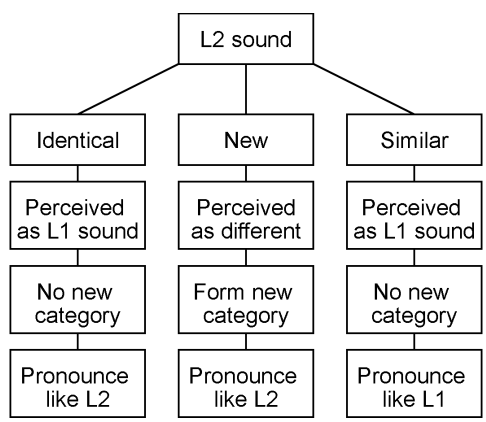
Universals and L1 transfer constrain the interlanguage phonology just as they constrain the grammatical aspects of interlanguage. L1 transfer can play a significant role in pronunciation and is manifested, for example, in foreign accent, which stems from a lack of mastery of the L2 phonology. A learner must master the segments (for example, pronouncing English /æ/), the segmental conditions (for example, the consonant clusters of words such as *straight* or *sixths)*, and the prosody (including stress, rhythm, and intonation) (Major, 2001).

On the segmental level, beginning learners often transfer the L1 sound system directly into L2 speech. This is thought to occur because people have established *perceptual categories* of *phonemes* (language sounds) from their L1. These mental categories are formed as infants hear language in their environment and develop their L1 sound system. As children learn to talk, they base their own phonetic output on those categories, and over time the categories evolve and solidify as they learn the phonology of the native language (Flege, 1987b, 1996). This leads to the supposition that the initial state of L2 learning is limited to L1 categories. The perceptual categories established for L1 sounds affect how the second language learner will perceive and produce the sounds of the L2.

L2 phonology learning may be possible for the adult, but it is generally accepted that adult learners do not achieve a native-like pronunciation (Gass & Selinker, 2001). The Critical Period Hypothesis suggests that there is a sensitive period for second language learning, usually puberty, after which the learner cannot achieve native-like pronunciation (Gass & Selinker, 2001). Flege's (1995) Speech Learning Model posits that speech learning continues throughout the lifespan of the learner and that the mechanisms and processes of L1 sound system learning remain available for L2 learning. Any time the learner encounters new phonetic speech sounds, even into adulthood, phonetic learning takes place. While there are studies that report adult learners passing for native speakers (for example, Bongaerts, van Summeren, Planken, & Schills, 1997, and Moyer, 1999), the literature indicates that this is rarely accomplished.

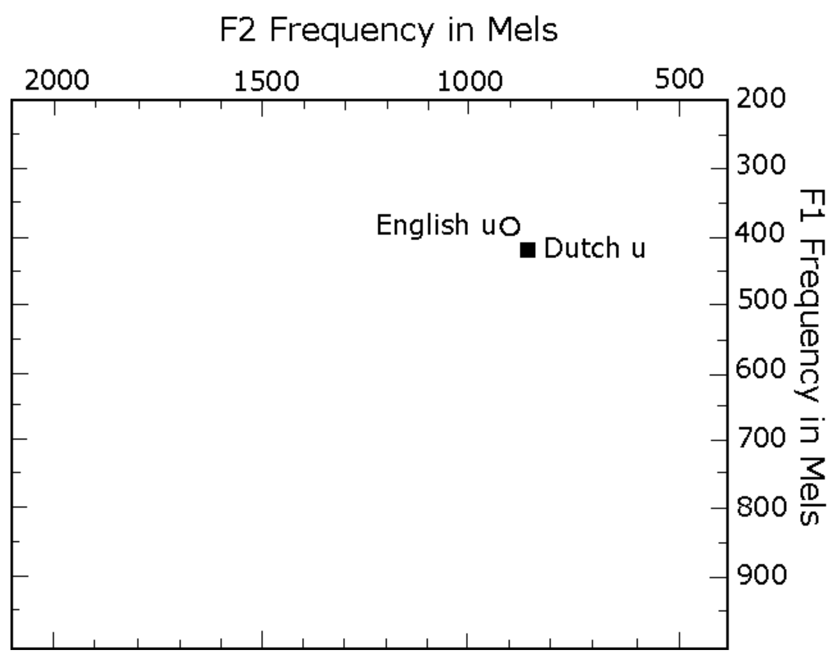
The Speech Learning Model breaks down the L2 sounds that the learner hears into three distinct groups: *identical* (sounds in the L2 which are acoustically the same as the sounds in the L1); *new* (sounds which are not found in the L1); and *similar* (sounds which are close, yet not identical, to sounds in the L1). As Figure 2.1 below illustrates, if sounds are identical, the speaker will pronounce the L2 sound in a native-like manner. If a sound is similar to a sound in the L1, the learner will perceive it as part of an existing phonetic category. Once associated with established L1 categories, the learner will continue to pronounce the sound the same as in his L1, with little modification. If an L2 sound does not correspond to any of the L1 phonetic categories, a new category will be created. Production of these *new* sounds will eventually match the new phonetic category representations. In general the model is concerned with ultimate attainment of L2 pronunciation, and studies using its framework have generally focused on *experienced* bilinguals, who have spoken the L2 for many years.

Figure 2.1. Model of learners' acquisition of L2 sounds



Since no universally accepted method exists for measuring the distance between sounds of two languages to determine if they are *new* or *similar,* Flege (1996) suggests using a "phonetic symbol" criterion. Sounds are *similar* if the L1 and L2 sounds in question are represented by the same IPA symbol, even if the there are statistically significant audible differences between them. An example of a *similar* sound is Dutch /u/ and English /u/ *(boot)*. See Figure 2.2 below (adapted from Flege (1996)). Acoustically, they differ as the Dutch /u/ is lower in the acoustic space than its American English counterpart, but use the same phonetic symbol. (The values in Figure 2.2 are presented in mels, a perceptual scale of pitches which are equal in distance from one another as determined by listeners.)

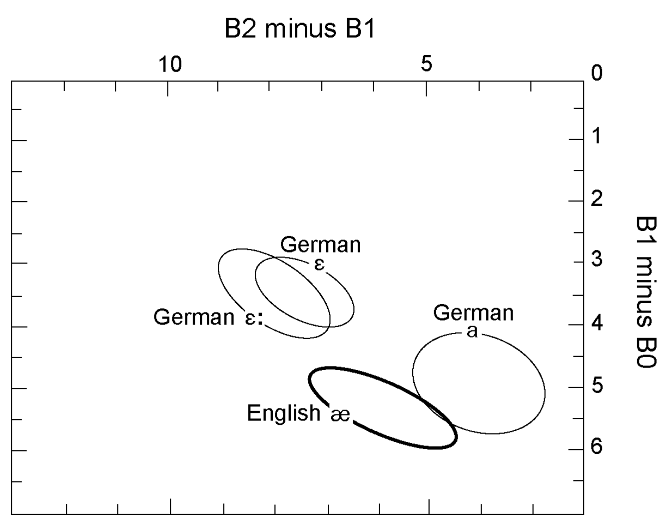
Figure 2.2. *Similar* vowel /u/ for Dutch speakers of English



A *new* L2 sound is represented by an IPA symbol not found in the L1, and should differ acoustically and perceptually from L1 sounds. It is further suggested that a *new* L2 vowel occupies acoustic space which is not already occupied by an L1 vowel (Flege, 1996).

Figure 2.3 below (Bohn & Flege, 1992) illustrates an example of a *new* vowel for native German speakers: English /æ/ *(cat)*. German has no equivalent phoneme and does not use the IPA symbol *æ*. The acoustic realization of English */æ/ (cat)* shares virtually no acoustic space with any other German vowel. To determine this, the researchers measured native English speakers' production of /æ/ and native German speakers' production of the German vowels which are acoustically close to English /æ/ (/ɛ, ɛ:, and a/). (In Figure 2.3, the formant frequency values are presented on a Bark-difference scale, based on the subjective perception of sounds, for the purpose of normalizing the gender difference in the data.)

Figure 2.3. *New* vowel /æ/ for German speakers of English



While the IPA-symbol method is generally used, García de las Bayonas (2004) suggests that a clearer pattern be established for classifying *new* and *similar* vowels:

> When working with synthesized stimuli, this pattern can be based on spectral distance between vowels. That is, "new" vowels can be defined as those that do not have a counterpart in the L1 within 150 Hertz of F1 or F2. "Similar" vowels can be defined as the vowels which have a spectral "neighbor" within these 150 Hertz of F1 or F2 of spectral space. This is the minimum spectral distance (150 Hertz) that seems to distinguish pairs of vowels in previous studies. These types of patterns can be applied to all languages or can be modified depending on the languages being cross linguistically analyzed. (pp 104–5)

While this proposed method of classifying *new* and *similar* vowels is not currently in use, further development and test could be conducted to establish its validity.

Many studies using the traditional method of *new* and *similar* vowel classification have shown support for the Speech Learning Model (Aoyama et al., 2004; Bohn & Flege, 1992, 1996; Flege, 1987b, 1996). For example, Flege (1996) found that adult Dutch learners of English regardless of strength of accent, did not show significant differences in the pronunciation of the *similar* vowels /i/, /u/, and /ʌ/ *(beat, boot, cut).* This supports the Speech Learning Model's prediction that new category formation for *similar* vowels is blocked by *equivalence classification;* the similar vowels are perceived to be equivalent to the existing phonetic category. In the same study, the Dutch learners with mild or moderate foreign accents (*experienced* speakers) were able to produce the *new* vowel /æ/ *(cat)* authentically, whereas those with strong accents (*inexperienced* speakers) did not.

Bohn and Flege's (1992) study of experienced and inexperienced German learners of English also found support for the Speech Learning Model. The primary difference between the groups was exposure to native English speakers. Both groups had studied English in school for about the same amount of time (inexperienced: 6.6 years; experienced: 7.6 years), but had considerably different amounts of time living in an English-speaking environment (inexperienced: 0.6 years; experienced: 7.5 years). As predicted, the amount of experience did not affect the production of the *similar* vowels /i/ *(beat)* and /ɪ/ *(bit):* neither group achieved the phonetic norms of native-English speakers. However, experience did affect the pronunciation of the *new* vowel /æ/ *(cat),* as the experienced German speakers, but not the inexperienced, were able to produce /æ/ in a native-like manner. This supports the premise that experienced L2 learners will form new phonetic categories and eventually produce those sounds corresponding to the new category. Additionally, these studies support the model's premise that phonetic learning takes place into adulthood.

2.2. VOWELS

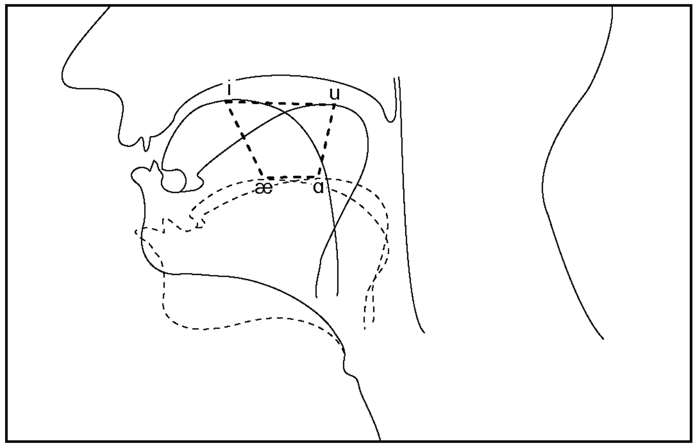
In this section I discuss vowels, the focus of much interlanguage phonology research. I begin with the articulatory description of vowels showing how they are formed in the vocal tract and how they are described in the literature. I then show how the articulatory description relates to the acoustic description. The acoustic description provides discrete values for the vowels, which can undergo quantitative analysis and be charted for a visual depiction of vowel systems. Next, I describe the American-English and Spanish vowel systems and then compare the two.

2.2.1. Articulatory and Acoustic Description of Vowels

Vowels are produced as air comes up from the lungs, passes through the vibrating vocal folds, and resonates in the vocal tract, which is shaped by the *articulators.* The shape determines which resonances will be boosted or damped, and the resulting sound patterns are perceived as a specific vowel.

The articulators that shape the vocal tract are most notably the tongue and lips, and vowels are often described based on their general position. Lips can be rounded or unrounded depending on the vowel. The tongue can vary in two dimensions—height (high, mid, or low) and frontness/backness (front, central, or back). For example: the vowel /i/ *(beat)* is formed with the tongue in a front and high position; /u/ *(boot),* with the tongue in a back and high position; /ɑ/ *(pot),* with the tongue in a back and low position; and finally, /æ/ *(bat),* with the tongue in a front and low position. If these most-extreme vowel positions are joined by a line, the resulting shape is roughly a quadrilateral. The other vowels in the American English system fall within this quadrilateral, produced with various tongue height and frontness/backness combinations. Figure 2.4 below shows a side view of the mouth, with the tongue positions associated with particular vowels (adapted from Delattre (1964)).

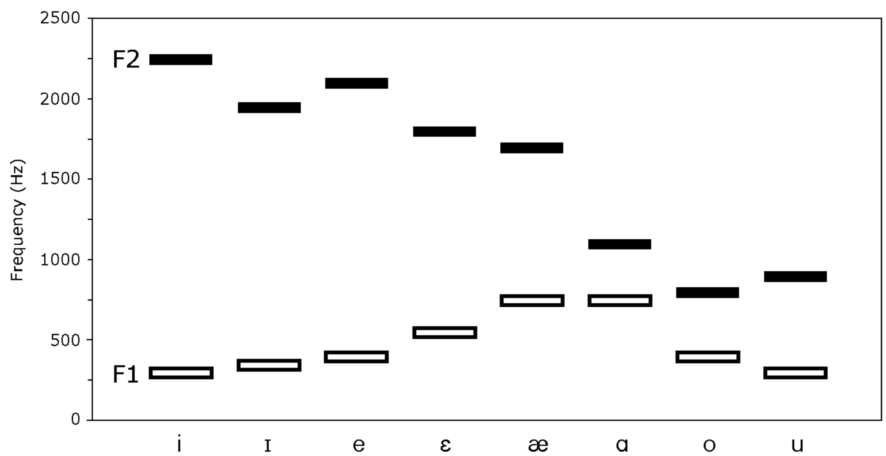
Figure 2.4. Tongue positions and vowel quadrilateral



The vowel quadrilateral is a means of illustrating the relative positions of the vowels within the mouth; however it is not able to depict the actual production of the vowels by real speakers. A more accurate system is the acoustic description of vowels, plotted onto a *formant chart.* As noted earlier, each vowel has a unique combination of boosted and damped resonances, the boosted ones being called *formants.* The frequencies of the formants can be measured in Hertz (Hz), or cycles per second. The first two formants, F1 and F2, minimally describe the vowel. To illustrate, a particular speaker's production of /ɛ/ (bet) may have an F1 value of 550 Hz and an F2 value of 1800 Hz. *(Vowel measurement is fully characterized in Chapter 3.)*

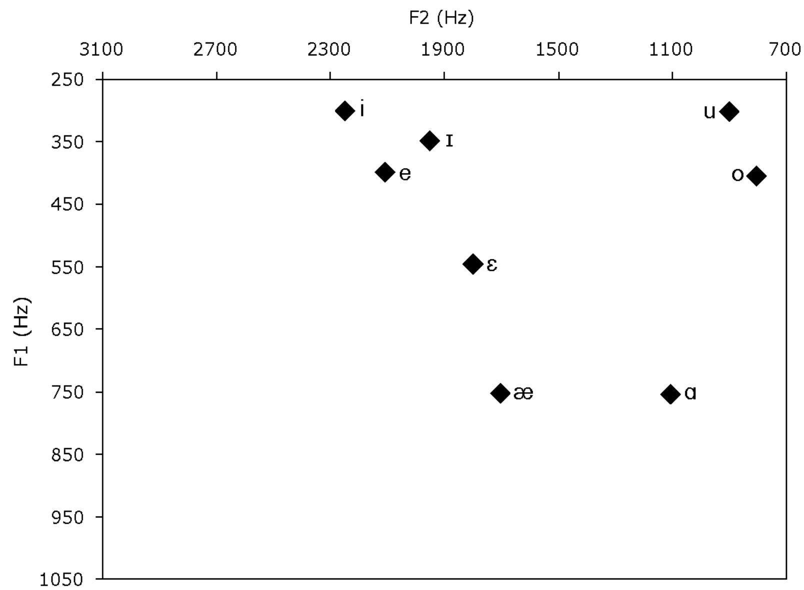
Each of the two formants corresponds to a dimension of the tongue's position. Figure 2.5 below (adapted from Delattre (1964)) illustrates the general relationships between F1 and tongue height, and between F2 and tongue frontness/backness. F1 corresponds inversely to tongue height. A vowel such as /ɑ/ *(pot),* produced with the tongue in a low position, has a high F1 value. The vowels /u/ *(boot)* and /i/ *(beat),* which are produced with a high tongue position, have correspondingly low F1 values. F2 relates directly to tongue frontness/backness, such that a vowel produced with the tongue in the front of the mouth, such as /i/ *(beat),* has a high F2, whereas /u/ *(boot),* a back vowel, has a low F2.

Figure 2.5. Relationship between F1 and F2



The F1 and F2 values are plotted onto a formant chart to show the actual production of vowels in terms of formant frequency. Figure 2.6 below illustrates this concept with an example formant chart (adapted from Delattre (1964)).

Figure 2.6. Example formant chart of American English vowels



The chart is arranged to resemble the vowel quadrilateral, which represents the positions of the tongue in the mouth as each vowel is produced. This is achieved by plotting the vowel height, F1, on the vertical axis to represent the tongue's vertical position in the mouth. The axis values are inverted, with the highest frequency value at the bottom because a high F1 value corresponds to a vowel produced with low tongue height. The horizontal axis represents tongue backness/frontness, showing how F2 relates to the horizontal position of the tongue in the mouth. As the tongue moves forward, the F2 value increases. Since the convention is to represent the front of the mouth on the left, the F2 axis values are inverted.

Because forming vowels is a fluid process, which can be affected by such factors as coarticulation, surrounding sounds, and the nature of the articulators, there will always be some variation in the formant frequencies. A vowel, then, occupies an area, rather than a point, on the formant chart. In general, multiple *tokens* (representative samples) of the same vowel are collected and analyzed to delineate the phoneme's acoustic space on the chart. A vowel may be represented on a formant chart, then, as a single mean of the tokens collected, or as an ellipse, encompassing the range of tokens. Once all the vowels are plotted, a speaker's vowel system can be defined. The speaker's vowel system can be used to compare his pronunciation at different sampling periods as well as with the L2 target, in a quantifiable and standardized format.

2.2.2. American English Vowels

The American English vowel system is relatively large, consisting of 16 vowel sounds (depending on the dialect), three of which are true diphthongs. The vowel sounds generally fall into a quadrilateral pattern, with /i/ *(beat)* and /u/ *(boot)* forming the top corners, and /æ/ *(bat)* and /ɑ/ *(pot)* the bottom corners. In the American English vowel system, each vowel can be defined by tongue position alone, because the system has no contrast due to lip rounding. There is also a tense/lax feature ([±ATR], *advanced tongue root*) in this vowel system, but is an unnecessary distinction when using acoustic descriptions, because acoustic measurement takes into account all articulatory information, including ATR and lip rounding.

The American English vowel system includes diphthongs, which start with one sound and then glide to a second. For example, the pronunciation of the /o/ in *coat* is [oʊ] and the /e/ in *gate* is [eɪ]. This type of diphthong is considered homogeneous because both phases of the vowel are close in articulatory position and the lip rounding is the same. A second type of diphthong is heterogeneous (or true diphthong). They glide from one sound to the other moving up and across the vowel space. Lip rounding may not be the same in both phases. American English has three such diphthongs: /aɪ/ *(eye);* /aʊ/ *(cow);* and /ɔɪ/ *(boy)* (Roca & Johnson, 1999). Table 2.1 below shows the vowels used by American English speakers.

Table 2.1. Vowels used by American English speakers

/i/ *(beat)*
/ɪ/ *(bit)*
/e/ *(bait)* usually produced with a glide [eɪ]
/ɛ/ *(bet)*
/æ/ *(bat)*
/ɑ/ *(cot)* in some dialects, /ɑ/ and /ɔ/ have merged
/ɔ/ *(caught)* in some dialects, /ɑ/ and /ɔ/ have merged
/ʊ/ *(book)*
/o/ *(boat)* usually produced with a glide [oʊ]
/u/ *(boot)*
/ʌ/ *(but)*
/aɪ/ *(bite)* a true diphthong
/aʊ/ *(out)* a true diphthong
/ɔɪ/ *(boy)* a true diphthong
/ɝ/ *(bird)* this rhoticized vowel is acoustically identified with the addition of F3
/ə/ *(**a**bout)* found in unstressed syllables, doesn’t contrast with the other vowels

Figure 2.7. American English vowel quadrilateral

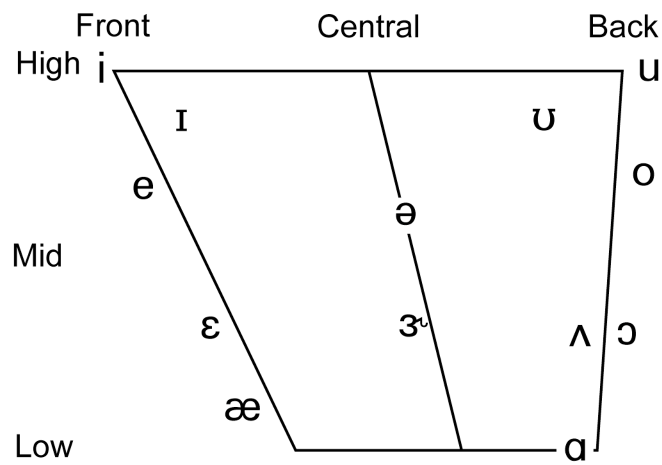


Figure 2.7 above shows the relative positions of 13 American English vowels in the vowel quadrilateral (the steady state onset of /eɪ/ and /oʊ/). The vowel list in Table 2.1 and vowel quadrilateral diagram represent a generalization about American English vowels and their pronunciations; however, it must be noted that there are many dialects of American English, and that each dialect has its own acoustic realizations of the vowels, which can vary greatly. Vowel documentation, therefore, which is based on data from specific dialects, is much more useful than referring to a generic "General American" (Hagiwara, 1997).

To distinguish the boundaries of regional dialects, dialectologists have traditionally focused on speakers' use of lexical items and phonological variation. Impressionistic transcription, used to record the latter, often misses speech variations because of previous expectations. That is to say, once the meaning of the utterance is understood, the perceived difference in the sound diminishes, resulting in a transcript which does not capture the true phonetic production. Acoustic analysis can more objectively describe the speaker's actual vowel sounds. With the general availability of computers and speech analyzing software, acoustic analysis has become more common in dialectology.

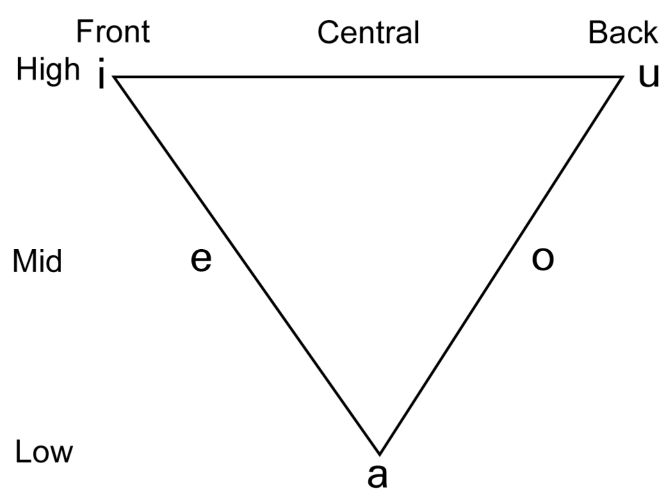
Acoustic analysis of different regions' speech has shown how radically and how differently whole vowel systems have shifted over time. Labov (2005) uses acoustic analysis to define the major American dialects, most notably: the Southern Shift area, the Northern Cities shift area, the Midlands, and the West. The West is not defined by active shifts in vowels as in the Southern or the Northern Cities Shifts, but rather by an absence of shifts. In part, the West differs from other dialects because it has *low back merger,* where /ɑ/ *(cot)* and /ɔ/ *(caught)* are pronounced identically, and *strongly fronted /u/, but not /oʊ/.* However, the West eludes simple definition, and Labov concludes that it is a dialect area in formation. More research is needed to accurately define the region's dialect or dialects.

One such research project is the Portland Dialect Survey, under the direction of G. Tucker Childs of Portland State University in Portland, Oregon. The Portland Dialect Survey is an ongoing project which seeks to create a database documenting the character of Portland-area speech (Ward, 2003). To date, three Masters-level theses contributing to the project have been completed. The first of these investigates pitch upswing in the Portland dialect (Wolff, 2000), and the other two focus on the vowels of native Portland-area speech. *The Story of /æ/ in Portland* (Conn, 2000) studies the stability of the single vowel /æ/ to see if it is raising. The results, however, counter his prediction, showing that the pronunciation of /æ/ in Portland is lowering instead. *The fronting of /ow, u, uw/ in Portland, Oregon* (Ward, 2003) looks at the high back vowels to determine their pronunciation, taking into account phonetic and social factors. He found that these vowels are fronting, as in some California dialects (Hagiwara, 1997), and that the change is being led by young people. These studies provide a view into the Portland dialect, but because of limited data, a definitive description is not yet possible.

2.2.3. Spanish Vowels

In contrast to American English, the Spanish vowel system consists of only five monophthongal vowels, which form a vowel "triangle" as shown in Figure 2.8 below. Of note, however, are the allophones /ɛ/ and /ɔ/ which can occur in certain contexts in some dialects (Madrid Servín & Marín Rodríguez, 2001).

Figure 2.8. Spanish vowel triangle



Each vowel is pronounced as a short, tense ([+ATR]) monophthong. The tongue holds its position without tendency toward diphthongization or gliding, and the vowels are never reduced to schwa in unstressed syllables. Although there are just five vowels in the system, two consecutive vowels are pronounced as a monosyllabic diphthong, resulting in 14 diphthongs (Teschner, 2000). Table 2.2 below lists the vowel sounds available in Spanish.

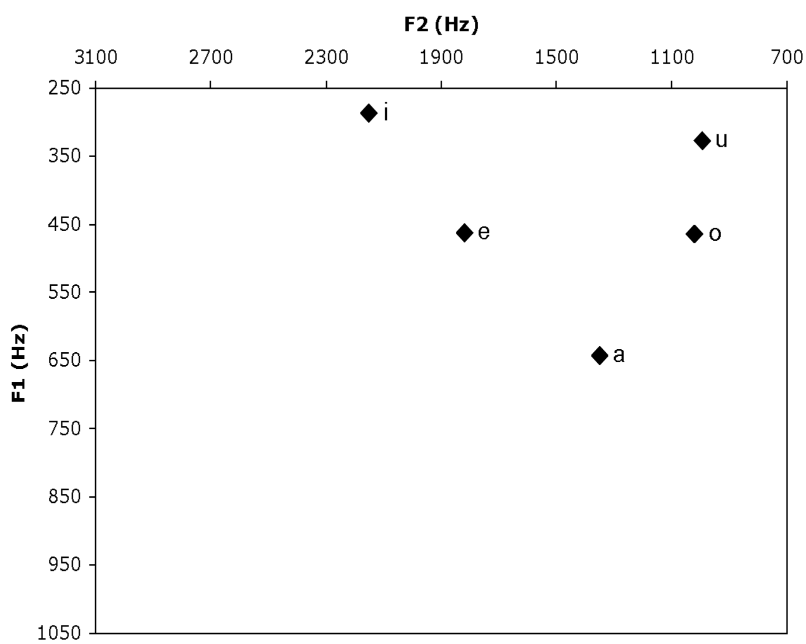
Table 2.2. Spanish monophthongs and diphthongs

Monophthongs	Diphthongs	
/i/	/ie/	/ui/
/e/	/ei/	/ue/
/a/	/ia/	/eu/
/o/	/ai/	/ua/
/u/	/io/	/au/
	/oi/	/uo/
	/iu/	/ou/

Figure 2.9 below shows a formant chart of male Spanish speakers from Madrid (using data from Bradlow (1995)). While Spanish consonants are generally considered to be more variable across dialects, there are some regional dialectic variations of vowel pronunciation; therefore, this sample will serve as one possible realization of the Spanish vowels. A review of the literature shows that very little research has been conducted on vowel variance across Spanish-speaking regions. Quilis and Esgueva (1983) conducted an acoustic analysis on 22 Spanish speaking informants from Spain and Latin America, which documented the production of Spanish vowels; however, they did not go so far as to compare the speakers from different regions. Godínez

(1978) compared vowel production from different Spanish-speaking regions and found variation between the speakers from Mexico (Tijuana), Argentina (Buenos Aires), and Spain (various locations). Moreno de Alba (1994) characterized the dialects within Mexico including local vocalic variations. Just as with American English, it is important to consider Spanish regional dialect when conducting vowel production studies. Unfortunately, to date there is a lack of acoustic studies of Mexican Spanish (Herrera Z., 2001).

Figure 2.9. Example Spanish formant chart



2.2.4. Comparison of American English and Spanish Vowels

Given the large size of the American vowel inventory as compared to Spanish, Spanish-speaking learners of English must acquire several new vowel sounds. If the learners' perceptual categories consist of only five vowels, there will be an absence of categories for many English vowels. According to Flege, the learners will perceive the difference of these sounds and begin to create new categories, eventually producing the sounds to match them. In the case of Spanish speakers learning English, this would involve adding a tense/lax distinction since Spanish vowels are all tense. Further, in order to achieve native-like pronunciation, Spanish speakers would need to modify vowels that already exist in their system (/i, e, o, u/). In addition to changes in tongue position or in amount of lip rounding, the speakers may need to add an offglide to certain vowels, such as /eɪ/ and /oʊ/.

Figure 2.10 below shows a formant chart comparing Spanish vowels to American English vowels. The Spanish data come from male Madrid speakers of Spanish (Bradlow, 1995) and the English data come from Hagiwara's (1997) collection of vowels produced by male Southern California English speakers. The Southern California dialect may have more in common with the Portland dialect than others, since both dialects show fronting of the high back vowels /u, ʊ, o/ (Hagiwara, 1997; Ward, 2003).

Figure 2.10. Comparison of American English and Spanish vowel systems

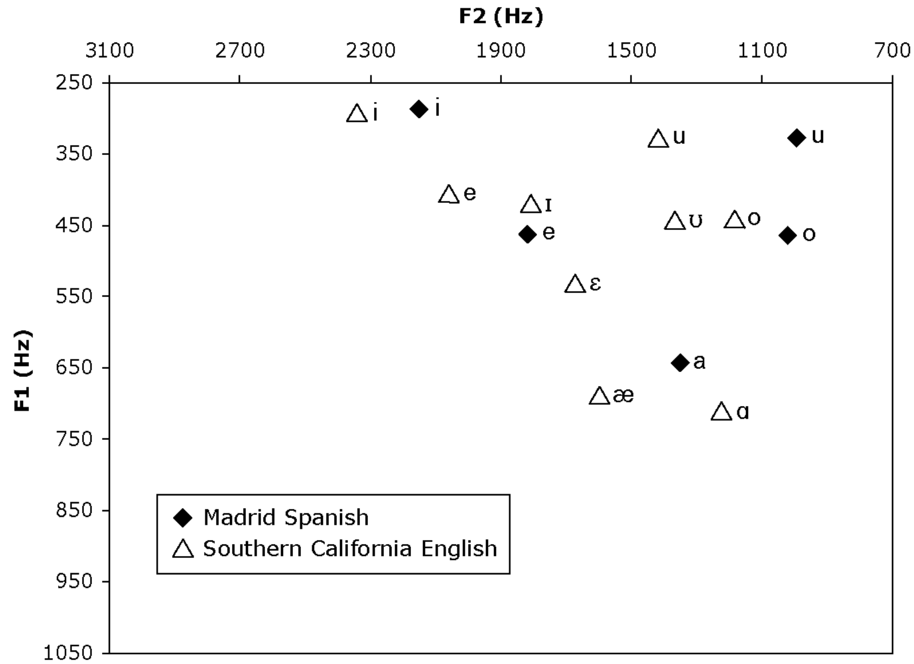


Figure 2.10 gives a general sense of which vowels are *identical, new,* and *similar* for Spanish speaking learners of English. As the figure illustrates, no sounds of the two vowel systems are identical. The *new* sounds are all of the lax English vowels, /ɪ, ɛ, ʌ, ɑ, ʊ, æ/, which have no corresponding IPA symbol in Spanish, and differ acoustically from any Spanish vowel. However, with this data, it is not possible to determine if they share acoustic space with any of the Spanish vowels, or how the Spanish speakers perceive them. The tense vowels of English, /i, e, o, u/, are *similar* as the Spanish versions of these vowels use the same IPA symbol, but are different acoustically. Table 2.3 generally summarizes the *new* and *similar* American English vowels for Spanish-speaking learners.

Table 2.3. ***New*** **and** ***similar*** **vowels, based on IPA symbols**

English	New / Similar	Spanish
i	Similar	i
ɪ	New	—
e	Similar	e
ɛ	New	—
æ	New	—
ɑ	New	—
ʌ	New	—
o	Similar	o
ʊ	New	—
u	Similar	u

The American English vowel inventory is quite large compared to that of Spanish, which provides ample opportunities to test the Speech Learning Model's hypothesis of acquiring *new* and *similar* vowel sounds. For this study, the vowels /æ/, a *new* vowel, and /o/ and /u/, *similar* vowels, were investigated.

Since a perception test on my subject was not possible, I consulted another source to confirm the *new* and *similar* classification of /æ/, /o/, and /u/. Using spectral distance between vowels and the results of her perception study, García de las Bayonas (2004) concludes that for a native speaker of Spanish learning English, the *new* vowels are /æ/ *(bat),* /ɑ/ *(pot),* and /ʌ/ *(but),* and the *similar* vowels are /i/ *(beat),* /ɪ/ *(bit),* /ɛ/ *(bet),* /eɪ/ *(bait),* /u/ *(boot),* /ʊ/ *(book),* and /oʊ/ *(boat).* The spectral-distance method provides a different set of *new* and *similar* vowels than the IPA symbol alone. However, this method confirms the classification of /æ/ as a *new* vowel and /u/ and /o/ as *similar* vowels.

2.3. CONCLUSION AND RESEARCH QUESTIONS

The field of second language acquisition seeks to explain how people learn second languages. In the study of interlanguage, an adult learner's L2 phonology is of particular interest since an adult learner rarely acquires native-like pronunciation of the second language. On the segmental level, the Speech Learning Model provides the framework with which to investigate how a second language learner changes his pronunciation as he acquires the L2. While Flege's model was intended to study ultimate attainment by experienced L2 speakers, it might also be used to investigate pronunciation change, or lack of change, of a beginning L2 speaker. The model predicts that a learner will perceive and eventually pronounce *new* vowels, but will not modify sounds which are *similar* because of equivalence classification.

A few longitudinal studies have been conducted, but most studies referencing this model are cross-sectional designs. These studies compare groups of experienced and inexperienced L2 speakers to simulate what might happen over time to a single group of learners. More long-term longitudinal studies, which follow learners as they progress in their L2 acquisition, will be useful to investigate different stages of pronunciation development.

Previous studies of *new* and *similar* vowels used elicited data, usually in the form of words containing the vowel under study in carrier sentences. Labov (1991) finds that this type of data does not capture the same rich dialect-driven sounds of spontaneous speech, which is much more revealing than the controlled speech of elicitation. Unfortunately, naturalistic data is rarely used.

A longitudinal study using more naturalistic data provides unique insight into a learner's acquisition of an L2 vowel system. This study capitalizes on Portland State University's ESL Lab School, a corpus that contains 4,000 hours of archived video- and audio-taped classroom data over a four-year period. The recorded language is naturalistic classroom data: spontaneous speech intermingled with typical task-oriented responses to teacher directed activities.

In this study, one student is followed through his participation at the Lab School. I elected to focus on a single learner for several reasons. The first reason was in the interest of time since collection of vowels using prerecorded, unscripted naturalistic classroom material is a lengthy task. Second, because the Lab School's research strands include in-depth studies of individual students over time, this study adds to the research pool. Finally, case studies are lacking in the literature of *new* and *similar* vowel acquisition.

The learner selected for this case study is a native speaker of Spanish. This choice was made because I am familiar with the Spanish language, because there are many Spanish-speaking learners in the Lab School from which to choose, and because the Spanish vowel inventory is small compared to English, providing several vowels that will be either *new* or *similar.*

In order to narrow the choice of vowels for the study, I turned to the Portland Dialect Survey. The Portland dialect studies by Conn and Ward provided detailed information on specific vowels (/æ, ʊ, o, u/). Three vowels were selected, representing one *new* (/æ/) and two *similar* (/o, u/) sounds for a native speaker of Spanish.

Although this is a case study of one learner, and so only cautiously generalizable, it offers a unique glimpse into a learner's actual acquisition progress over time using more naturalistic speech than elicited sentences. The study will focus on, and answer the following questions:

1. Is the learner limited to previously established L1 categories in the initial stage of L2 learning?
2. At the end of the study, how does the learner's pronunciation of the *new* vowel /æ/ and the *similar* vowels /u/ and /o/ compare to the L2 target?
3. Do the data support Flege's Speech Learning Model concerning *new* and *similar* vowels?
    a. Does the learner create a category for the *new* vowel /æ/ and eventually pronounce the vowel in a native-like manner?
    b. Does the learner continue to pronounce the *similar* vowels /u/ and /o/ as in his L1 with little modification?

CHAPTER 3: METHODOLOGY

This is a longitudinal case study of one learner's progress in acquiring an L2 vowel system. In particular, the focus rests on three vowels, which may be acquired in different manners. In the sections that follow, I describe the setting for the study as well as the criteria for subject selection. I then describe the methods and procedures used to conduct this study.

3.1. SETTING

Portland State University is home to the Multimedia Adult ESL Learner Corpus (Lab School) (Reder, Harris, & Setzler, 2003), a project providing a unique view into the low-level ESL instructional environment. For the duration of recording phase of the project, the university hosted a regular non-academic adult ESL program, administered by Portland Community College. The Lab School offered integrated English skills at four levels: Level A beginning; Level B advanced beginning; Level C low intermediate; and Level D intermediate. Table 3.1 below describes the ESL skills for each level (*ESL Levels*, 2004).

Table 3.1. Description of ESL levels at Portland Community College

Level A	This level is for beginners. Students at this level usually can say their names and addresses. They need help to conduct day-to-day business and usually have trouble giving or writing personal information independently. (Student Performance Level SPL 0–2)
Level B	This level is for high beginners. Students at this level usually can give information about themselves. They can use common greetings but usually cannot engage in fluent conversation. (Student Performance Level SPL 2–3)
Level C	This level is for low intermediate students. At this level, students can satisfy common communication needs in daily life. They can ask and respond to questions and initiate conversations. They may need repetition for unfamiliar topics or when talking about abstractions. (Student Performance Level SPL 3–4)
Level D	This level is for the intermediate students. Students at this level can initiate conversations on a variety of topics. They can express their opinion about immediate surroundings and about more abstract ideas and concepts. (Student Performance Level SPL 4–6)

Lab School classroom sessions were video- and audio-taped using multiple cameras and microphones. During each class, two students (on a rotating basis) and the teacher wore lavaliere microphones for individual audio recording. Students generally wore the microphone at least two times per term. Of the six video cameras, two followed the microphone-wearing students as they participated in the classroom activities, and the remaining cameras and their corresponding ceiling microphones captured activity throughout the rest of the classroom. The Lab School project contains 4,000 hours of recorded classroom activity over the collection period ending in 2005.

Because of the length of the project, researchers have the opportunity to follow the progress of students through their learning process. Since the students' language is already recorded, a longitudinal study may be conducted on a learner without having to wait for time to elapse. Samples of a student's speech can be collected over the entire length of enrollment in the Lab School's recorded classes.

The Lab School serves as the setting for my study solely because of its corpus of recorded learner speech. Pronunciation is not specifically taught in the Lab School classes and the learner may be forming his L2 pronunciation based on many targets both inside and outside the classroom. It is my intention to describe the learner's pronunciation progress, not to analyze external influences or to draw inferences about the learner's progress from any classroom activities.

3.2. SUBJECT SELECTION

In this section, I describe the ideal participant for my case study. I set out some desirable characteristics that I considered in selecting a subject from the general student population. Each of these choices may have influenced my findings to some degree; however, since I had no control over the recording process at the Lab School, making ideal choices was necessary to ensure that I would have enough data to work with. Although this is a case study of one individual's developmental process and the results not generalizable to the learning population as a whole, the results will have implications for other L2 learners. Below, Table 3.2 provides a summary of the characteristics considered in selecting the ideal candidate.

Table 3.2. Ideal subject characteristics

Characteristic	Justification
Spanish speaker	Researcher is familiar with Spanish language Vowel inventory difference Large Spanish-speaking population at Lab School
Male	Low-pitch voices are easier to analyze acoustically
Time associated with the Lab School: > one year / 3 terms	Longitudinal study lasting more than one year Examining 3 separate terms
Recent arrival to the country	Best approximation of initial state of pronunciation
No previous English classes	Best approximation of initial state of pronunciation
Labsite Student Study participant (A yearly, in-home interview of some Lab School participants)	For additional information about students
Wears microphone multiple times per term	Maximize opportunities for recorded speech
Talkative	Maximize speech from which to collect data
Loud, deep voice	Maximize audible data
Previously studied learner	Additional information available

To conduct an acoustic analysis on a vowel system, multiple tokens of each vowel must be collected and analyzed. In an elicitation scenario, a list is provided to the speaker, which contains as many ideal examples as needed for proper analysis. However, since the Lab School data is pre-recorded, appropriate tokens must be identified within the student's speech. Not only must the student provide a sufficient quantity of speech, but also it must be clear enough to identify individual words from the context. Additionally, with regard to acoustic analysis, a male's voice is easier to analyze than a female's (e.g., Boberg, 1996). Because of these considerations, a male student who is talkative, speaks fairly loudly, and who wears the personal microphone multiple times was selected. This student may not be an average representative of the Lab School population or of any particular group.

Ideally, the subject would be a recent arrival to the United States with no previous English classes in order to collect speech which might approximate his initial state of pronunciation. In choosing a student who arrives at the Lab School with minimal time in the United States and minimal English instruction, the possibility of L2 learning influencing L1 pronunciation might be avoided. To determine the arrival time of the potential subject, the pool of students was narrowed to those also participating in the Labsite Student Study, a yearly in-home interview study conducted in various L1s. Each participant has a file containing personal information including self-reported time of arrival in the United States and previous language study.

An additional criterion, essential to conducting a longitudinal study, is the student's Lab School enrollment. The participant must have been associated with the Lab School over the span of more than one year and must have participated in at least three terms, since data for this study include collection from his first term, his most current term, and a term about halfway in between. The Lab School offers four terms per year (three ten-week terms and one eight-week term). The learners' progress as measured by class level is relatively unimportant since I am not concerned with instruction in this study.

In order to find a student who met all or most of these ideal characteristics, several resources were consulted. Most notable were: the Lab School Student information files; the Labsite Student Study; conversations with the Lab School research principals; and my own previous research experience with some of the Lab School participants. In the pool of Spanish-speaking participants, only two met most of the criteria, and one of the two candidates was eliminated on the realization that his first language is Mayan. The final choice was “Valerio” (a pseudonym).

Valerio was 27 years old at the time of his enrollment in the Lab School. During classroom conversation, he reported that he is from Puebla, Mexico (about 75 miles from Mexico City). He has 12 years of education and worked in accounting before coming to the United States. Here in the United States, he has worked in housekeeping at a department store and in customer service. He reported that he married his American wife while in Mexico and came to live in the United States when their baby was due to be born. He lived with his in-laws until he and his wife moved into their own home.

He began Lab School ESL courses during his first year of living in the United States. He tested into ESL Level B, showing that he had some experience with English, but he reported that he had not taken any English classes before enrolling in the Lab School. He was enrolled in classes at the Lab School, on and off, between 2003 and 2005 providing a two-year span of data for this longitudinal study. He continues to take classes at the Lab School facility, but the recording phase of the project is complete.

Valerio was very talkative in class and generally spoke loud enough for clear recording. He wore the microphone three times in both the first and the intermediate terms, but only once in the last term (most likely due to sporadic attendance), which did compromise the quantity and variety of data for my acoustic analysis. While he had previous exposure to English through his wife, in-laws, and job in the United States before entering the Lab School, his initial state of L2 learning was still investigated in this study.

3.3. DATA COLLECTION

In this section, I describe the data collection procedure and the computer programs used for data preparation, processing, and analysis.

3.3.1.Term Selection

Valerio was enrolled in the Lab School for five terms: Summer 2003; Fall 2003; Winter 2004; Spring 2004; Summer 2004; and Summer 2005. The Summer 2003 serves as *Term A,* his first Term at the Lab School and Summer 2005 serves as *Term C,* his last term. During the Summer 2004 term, Valerio wore the microphone for only half of one class session, and didn't say enough for adequate data collection. As a result Spring 2004 was selected for *Term B.*

3.3.2. Speech Collection

Valerio's speech was most audible and intelligible when he was wearing the microphone, affording the best opportunity for acoustic analysis. For the class sessions where he wore the microphone, I compiled a total of over 400 short clips of video in which he is speaking. The audio from the clips was recorded using the sound-editing program *Audacity,* and these recordings were saved as *.wav* files, a standard audio file type. The recordings served as the data source for analysis.[2]

3.3.3. Token Selection

To investigate Valerio's emerging American English vowel system, token words were identified and extracted or *segmented* from the longer audio clips. *Tokens* are words containing specific vowels or vowel-consonant combinations, which constitute the data to be analyzed. I collected instances of all of the American English vowels in order to depict his full vowel system.

One reason for collecting the entire vowel system is to provide adequate representation the entire vowel space for the normalization system used by *Plotnik,* a vowel graphing and analysis program designed for dialect studies.[3] Another reason for examining whole vowel systems is to provide insight into the effects of newly added

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[2] To protect the anonymity of the Lab School participants, I have reviewed all audio files recorded from the video to ensure that no personally identifying information has been recorded and removed from the protected Lab School media. See Appendix D.

[3] To normalize, *Plotnik* compares a subject's vowel system against vowel data of 345 participants in the TELSUR project (Labov, 2005), and then adjusts the subject's data in relation to the larger sample. This procedure allows different speakers' vowel systems to be compared to each other.

categories. For example, if a new category is formed for a vowel, it may affect how the speaker produces the neighboring vowel categories. Flege (1996) suggests that system pressures may have affected the results in his study of *new* and *similar* vowels for Dutch speakers. He found that there was a decrease in correct scores of pronunciation of English /u/ as foreign accents improved. He speculates that the addition of the /ʊ/ category (which was not examined in the study) may have produced a shift in the pronunciation of /u/.

In selecting the tokens for my study, I followed the general procedures delineated in Ward (2003) and Conn (2005). I consulted further with Jeff Conn, who was a research assistant on the TELSUR project for the *Atlas of North American English* (Labov, 2005). I collected all tokens of intelligible, audible words that Valerio spoke in the clips, with some exceptions. I did not collect words with the true diphthongs (/aɪ, aʊ, ɔɪ/) or words with the vowel appearing after liquids or glides (/l, ɹ, w, j/) as these phonetic contexts affect the vowel, creating measurement difficulty. I collected tokens in stressed positions within a sentence, with the vowel in the stressed position within the word to best assure full realization of the vowel (there were some exceptions to this when Valerio misplaced the stress). Some words with secondary stress were included in the analysis after ensuring that they were behaving in the same way as those with primary stress. Function words (for example, *but*) were analyzed only when the vowel was fully realized. Valerio, being new to the language, spoke less fluidly than a native speaker and thus many of his function words contained fully realized vowels and were often followed by a short pause.

I utilized a check-list to track the count of each vowel needed to map an entire vowel system. I collected all allowable instances of each vowel, carefully including various phonetic contexts to provide additional insight into how vowel pronunciation was affected by the surrounding sounds. Table 3.3 below shows the vowels and subcategories representing specific phonetic contexts analyzed for this study. The symbols are presented here as a guide to the study's resulting formant charts.

Table 3.3. Vowels and phonetic contexts collected

Vowel category	Subcategory/Phonetic Context	Symbols
ɪ	before nasal, all other contexts	ɪ^{N}, ɪ
ɛ	before nasal, all other contexts	ɛ^{N}, ɛ
æ	before nasal, all other contexts	æ^{N}, æ
ɑ	before nasal, before lateral, all other contexts	ɑ^{N}, ɑ^{L}, ɑ
ʌ	before nasal, before lateral, all other contexts	ʌ^{N}, ʌ^{L}, ʌ
ʊ	before lateral, all other contexts	ʊ^{L}, ʊ
i	word final, before consonant, before r	iF, iC, i^{r}
e	word final, before consonant, before r	eF, eC, e^{r}
u	after coronal, after non-coronal, before lateral, before r	Tu, Ku, u^{L}, u^{r}
o	word final, before consonant, before r, before lateral, before nasal	oF, oC, o^{r}, o^{L}, o^{N}
ɔ	before lateral, before r, before nasal, all other contexts	ɔ^{L}, ɔ^{r}, ɔ^{N}, ɔ
a	before r, all other contexts	a^{r}, a

Since the data in this study were not generated from a controlled list of ideal token words, extra care was taken to reduce bias in token selection. Valerio is a low-level learner of English and there were many instances of mispronunciation, but I generally had no trouble understanding what he said. I collected all of the instances of each token regardless of pronunciation. When I categorized or *coded* the vowel, the expected American English category was used. For example, if he pronounced *but* as both [but] and [bat], I collected both instances and coded them as /ʌ/. This provided a clear picture of how he pronounced each vowel category. I speculate that some of his mispronunciation is due to: English orthography (*month* pronounced [monθ], *other* pronounced [oθer]); L1 transfer (*construction* pronounced [konstr**u**kʃon], *mom* pronounced [mam] *(mama)*); over generalization of American English phonological rules (*since* pronounced [saɪns]); and lack of American English categories (/ɪ/ and /ɛ/ tokens pronounced as [i] and [e]). His naturalistic classroom speech included free speech, modeled speech, text-supported speech, and read speech. In some instances pronunciation varied depending on the style. For example, in one instance he read the word *but* and pronounced it [but]; however, generally in free speech he pronounced it [bat]. I collected tokens from all styles. Because much of the talk in the classroom was task oriented, the variety of tokens was sometimes limited. For example, in Term C, a large amount Valerio's speech centers on asking fellow students to compare "driving to school" and "taking the bus to school." This resulted in many *school, take* and *bus* tokens for the term.

3.3.4. Token Analysis

As tokens were identified, I extracted them from the long speech file, saving them as individual .wav files. These token files were then analyzed in the sound analysis program *Praat (version 4.4.13).* A log file was created to insure relocation of the words within the full speech stream and video clips if necessary for reanalysis.

Praat is an acoustic analysis program, which creates a spectrogram from the .wav file's soundwave. The vowel formant frequencies present as dark bands of relatively long duration within the spectrogram. I measured the vowels' first and second formant frequencies (F1 and F2) following the procedures used in Ward (2003), set forth in Boberg (1996), and as advised personally by Jeff Conn. In *Praat,* default settings were used except for the number of formants that *Praat* would locate, which were adjusted based on the token's spectrogram. For each token, I evaluated the best location to represent the vowel, taking many factors into consideration. For example, after listening carefully to the sound, I located the point where the vowel sounded most like what was expected while avoiding points where the vowel might be affected by preceding or following sounds. I also looked for a point where F1 was at its highest (indicating maximum mouth opening). I took the measurement by placing the cursor on a "dot" (on *Praat's* step size display) which was also within a darkened pulse on the spectrogram (a point of high amplitude). While some American English vowels are usually pronounced with a glide (for example [eɪ] and [oʊ]) I measured only the nucleus ([e] and [o]). As the formant frequencies were measured for each token, the relevant information was entered automatically into a data log via a script program. The data log served as the input for the graphing and analysis program, *Plotnik.*

3.4. DATA ANALYSIS

After the tokens were selected and the formant frequencies measured, I plotted the vowel systems collected from the three terms. I cleaned the data by first identifying outlier tokens which plotted far from the cluster of other tokens in the same vowel category. I then referred to the comments I had made earlier when measuring the formant frequencies to see if there was an obvious cause. These comments included such things as: “overlapping voice”; “too much background noise”; “might be too quiet”; or “messy spectrograph.” With that information, I reopened those tokens in *Praat* and reevaluated. If a second measurement solved the problem, I entered that data and replotted the token. If not, I eliminated the token from the plot.

After this first round of cleaning, I then removed tokens which were approximately two standard deviations from the mean. This additional cleaning reduced the amount of skewing caused by these stray pronunciations. The 1,132 remaining tokens became the data for this study: 303 tokens for Term A; 592 tokens for Term B; and 237 tokens for Term C. The vowel systems for each term were then normalized in *Plotnik.*

For the Portland dialect, I used data from the Portland Dialect Study. In this case it consisted of analyzed tokens from interviews of two native Portland men aged 29 and 32, close to the same age as Valerio. The data are 913 tokens collected, analyzed, and normalized by Jeff Conn for his thesis (2000). A larger sample of speakers would have been used to establish a Portland dialect, but with just two informants matching Valerio's gender and age, I will refer to the data as *Portland speakers* rather than *Portland dialect.*

For the L1, Mexican dialect, I used published study data from Mexico City (Madrid Servín & Marín Rodríguez, 2001). An ideal sample would have been of speakers from Puebla, Mexico to match Valerio's dialect, but the availability of acoustic data from Mexico is quite limited. While Puebla is about 75 miles from Mexico City, it is not the metropolis that Mexico City is, and there are likely to be dialect differences; however, no vowel variation between the regions was noted in Moreno de Alba's (1994) Mexican dialect study. The published Mexico City sample consisted of two men between the ages of 28 and 35 each providing 30 tokens: six different words using each of the five Spanish vowels.

To make the data of this study comparable to the Portland speakers' and Valerio's data, the words and formant values were entered into *Plotnik* just as the other data had been. I coded the words with the same vowel subcategories so that *Plotnik* could normalize the data. These subcategories are artificial. For example, the effect that an American English /ɹ/ has on a preceding vowel is going to be different than that of a Spanish /ɾ/. This artificial subcategorization has no effect on the plotting of the vowel system except that there will be reported means for the subcategories instead of for the vowel as a whole. As with the Portland data, I will refer to the L1 data as *Mexico City speakers.*

Plotnik's strengths are its ability to provide strong visual representation of vowel systems and its ability to code the tokens for various phonetic contexts. It breaks down vowel classes into allophonic groups based on preceding or following sounds, allowing the researcher to see the effects of the phonetic contexts on the vowels. Means calculated for the subcategories are more realistic than those calculated for an all-inclusive group because it demonstrates the variance due to phonetic context, and these effects are visually evident in the formant charts. Using *Plotnik,* a program designed for studying dialects, adds value to the study because most L2 vowel acquisition studies do not break down the vowel classes into different phonetic contexts.

The *Microsoft Excel* spreadsheet program was used to analyze the data because of its mathematical ability and its flexibility. I used *Excel* to sort and combine data, run statistics, and to create charts. To analyze the data statistically, *Excel X for Mac*'s t-test function in the *Analysis ToolPak* add-in program was used to calculate the level of significance between various means related to each research question. I used a two-tailed distribution and two sample unequal variance, with the significance level set at $p < 0.05$ and a minimum sample size of 20. In order to perform statistical analysis, I pooled vowel subcategories to create groups with enough samples required for proper analysis. There were instances where the number of tokens in a particular vowel category was not large enough to perform the statistical analysis. In those cases, a discussion of the visual representation illustrates what might be occurring to the subject's pronunciation.

3.5. SUMMARY

The goal of this study is to provide a longitudinal case study to the field of *new* and *similar* vowel acquisition. The data source is two years of prerecorded naturalistic classroom speech. Additionally, this study establishes the importance of using local dialects in both the L1 and L2-target vowel systems. After setting the baseline L1 and the target vowel systems, I analyzed how my participant's vowels changed over the course of the study with particular attention to /æ/, /o/, and /u/.

CHAPTER 4: RESULTS AND DISCUSSION

This chapter presents and discusses the study results. The tokens of the Mexico City Spanish speakers, the Portland English speakers, and Valerio have been collected and measured. The F1 and F2 means for each vowel class of each group, or school term, have been calculated and charted using *Excel.* The charts presented in this chapter provide a visual representation of each vowel system and along with the statistical analysis, provide the answers to the three research questions first introduced in Chapter Two. Refer to Table 3.3 for a key to the symbols used in the charts.

4.1. RESEARCH QUESTION ONE: INTIAL STATE

To answer the first research question: *Is the learner limited to previously established L1 categories in the initial stages of L2 learning?,* the vowel systems of the Mexico City Spanish speakers and Valerio's American English in his first term, Term A, were compared, as shown in Figures 4.1 and 4.2 below.

Figure 4.1. Formant chart for Mexico City Spanish speakers

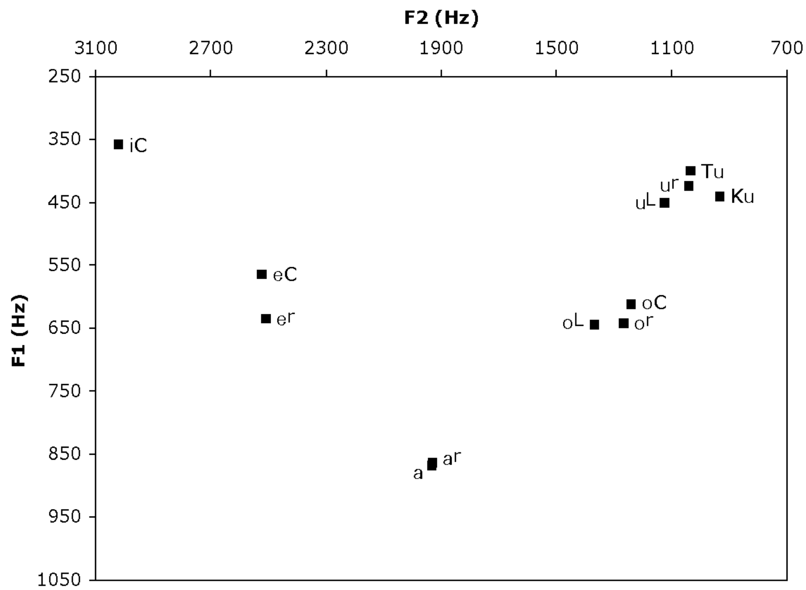
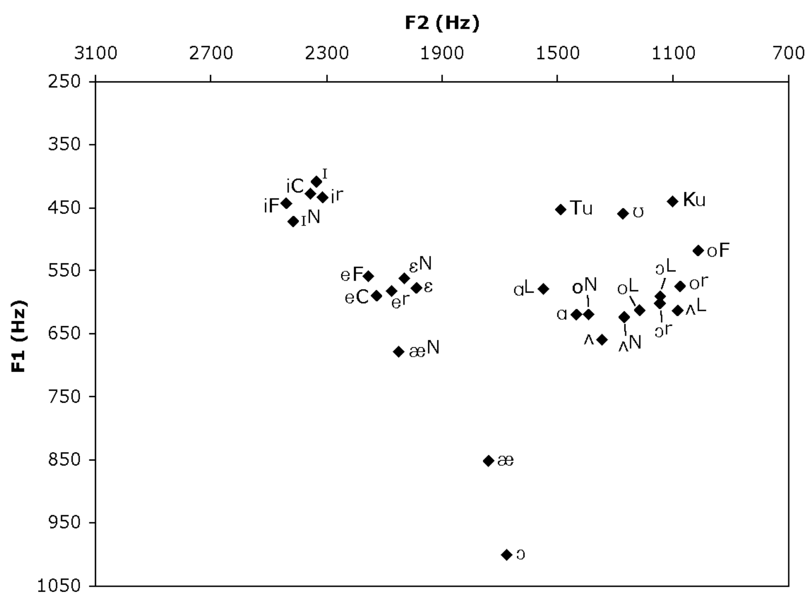


Figure 4.2. Formant chart for Valerio Term A, American English



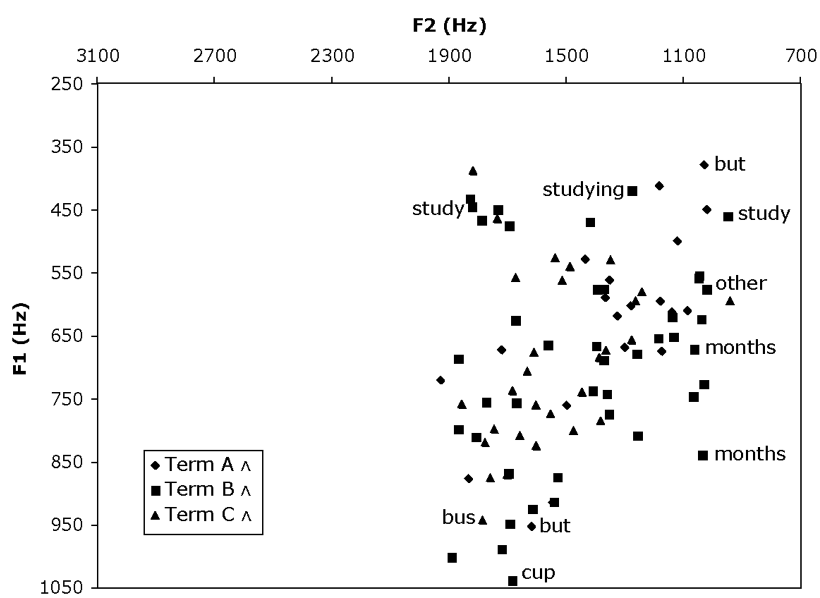
4.1.1. Formant chart analysis

A review of Valerio's American-English vowel system suggests that he is limited to his previously established L1 vowel categories. The chart shows clusters of vowel categories forming a similar pattern to the 5-vowel system of Spanish. The /ɪ/ and /i/ token means are grouped together in the high-front region of the chart sharing the space where only American English /i/ would be expected. The /ɛ/ and /e/ token means are similarly grouped together in the /e/ region.

On the other side of the chart, the back vowels continue the pattern. While the front vowels cluster closely, there is more variation with the back vowels, perhaps due to the effects of the phonetic context. The /ʊ/ and /u/ token means both occupy the high-back position usually reserved for /u/. A large group of token means is found in the mid-back area where /o/ is expected. These are the various subgroups of /o/, /ʌ/, and /ɑ/, and the subgroup /ɔ/^{L}. The token mean for /æ/ completes the vowel triangle. When /æ/ is followed by a nasal, /æ/^{N}, the expected effect is a raising and fronting of the vowel. Valerio is showing this effect, but there are no corresponding Mexican Spanish data available to determine if /æ/^{N} is a new category, or one that would similarly occur with Spanish /a/^{N}. The mean of the only two tokens of /ɔ/ plots in a very low-central position, below /æ/. The overall pattern for the vowel system is a triangle.

The vowel /ʌ/, is an interesting case. In Valerio's chart, the location of the /ʌ/ mean looks reasonable; however the mean alone is rather deceiving. In this term as well as in Term B and Term C, the pronunciation of /ʌ/ varies widely. For example: *months* and *other* plots with the /o/ tokens; *study* with /u/; and *but* was pronounced in both the /u/ and /æ/ regions. In Figure 4.3 below, all of the /ʌ/ tokens from the study are plotted with a few tokens labeled to illustrate this point. In the case of *but* pronounced as [bat], Valerio may be perceiving /ʌ/ as Spanish /a/. In the case of *months* and *other* pronounced with /o/, he may be relying on spelling to form his pronunciation. In the case of *study* and *but* pronounced with /u/, he may be transferring from his L1: relying on the cognate *estudio*; and using the Spanish pronunciation of *u* when the word *but* was read. It seems that perception, orthography, and L1 transfer may be playing a part in Valerio's pronunciation of this *new* vowel.

Figure 4.3. All tokens for /ʌ/ in Terms A, B, and C



4.1.2. Statistical analysis

T-tests were conducted to determine if the means of the tense/lax pairs of vowels are significantly different, that is to say: if Valerio is pronouncing the tense and lax vowels differently, is it a statistically significant difference? In the case of the vowel /æ/, which has no tense counterpart, Valerio's /æ/ was compared to the Mexico City speakers' /a/ to see if there is a significant difference between the two. Table 4.1 below shows the statistical results.

Table 4.1. Statistical results for comparison of vowel categories in Term A

Formant	Pooled Vowel Category			Pooled Vowel Category			t-statistic	p-value
	mean	SD	n	mean	SD	n		
	ɪ			i			ɪ/i	
F1	416	29	35	433	56	40	-1.700	0.094
F2	2334	117		2375	143		-1.374	0.174
	ɛ			e			ɛ/e	
F1	569	48	38	578	40	58	-.0974	0.334
F2	2008	150		2140	184		-3.856	<0.001
	ʊ			u			ʊ/u	
F1	457	36	6	444	59	21	n/a	n/a
F2	1271	228		1298	303		n/a	n/a
	ɑ			o			ɑ/o	
F1	599	33	11	589	81	12	n/a	n/a
F2	1523	201		1163	152		n/a	n/a
	æ (not pooled)			Mexico City a			æ/(Mex)a	
F1	850	126	16	867	58	12	n/a	n/a
F2	1746	237		1932	185		n/a	n/a

Comparing the means of the pooled subcategories of /ɪ/ and /i/ shows that Valerio is pronouncing them as if they were the same vowel category. The *p*-value for

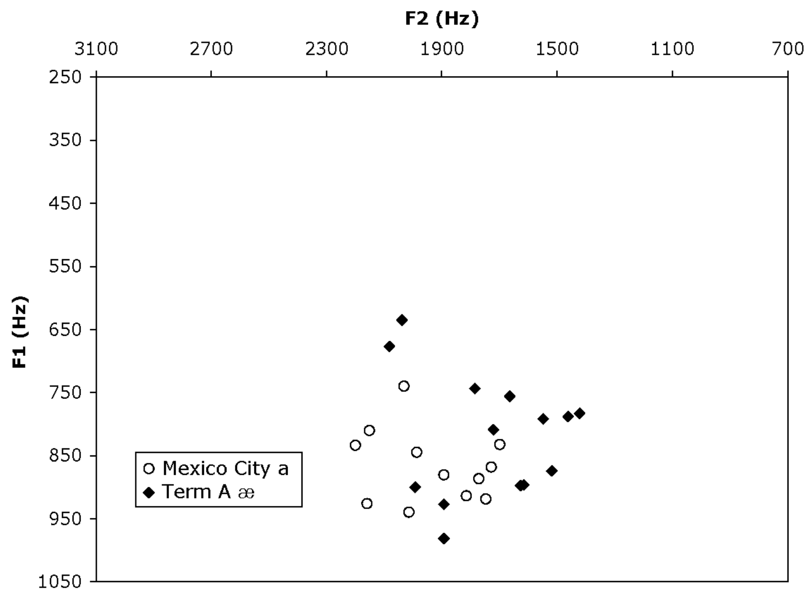
F1 is 0.094 and for F2 is 0.174, both greater than the significance level of 0.05 ($p < 0.05$). This does not rule out the null hypothesis that the means are the same.

For the /ɛ/ and /e/ pooled subcategories, the F1 means are not significantly different, but the F2 means are. The *p*-value for F1 is 0.334, which is greater than the 0.05 significance level, thus not allowing for the rejection of the null hypothesis. The *p*-value for F2 is <0.001, which is less than the significance level. This allows for the rejection of the null hypothesis in favor of the alternate, which states that there is a difference between the means. The chart shows that the /e/ vowels are pronounced more forward in the mouth than the /ɛ/ counterparts, but they are about the same height.

The t-tests for /ɑ/ and /o/ (not traditionally considered a pair, but in this case, they are grouped) and for /ʊ/ and /u/ could not be completed due to low sample size. The mean and standard deviation are presented on Table 4.1 for non-statistical comparison.

Due to insufficient sample size, no statistical analysis was performed for the comparison of Valerio’s pronunciation of /æ/ with the Mexico City speakers’ pronunciation of /a/; however, for a visual comparison, Figure 4.4 below presents the tokens of Valerio’s /æ/ (less two outliers) in Term A and the Mexico City speakers’ /a/. It is clear that the vowel spaces overlap, showing that Valerio is essentially using his L1 /a/ vowel for /æ/.

Figure 4.4. Tokens of Valerio's /æ/ in Term A and Mexico City speakers' /a/



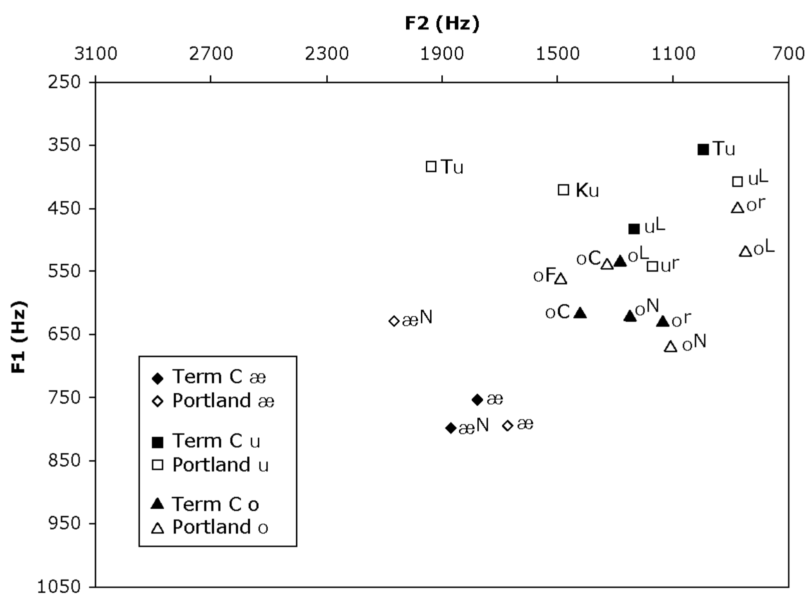
4.1.3. Summary

While the statistical evidence is lacking due to inadequate sample size, visually, there is a strong suggestion that Valerio is limited to his L1 categories; his *initial state* is his L1. He is not distinguishing between tense and lax vowels. Additionally, he has no vowel in the low-back position, which would form one corner of the American English vowel quadrilateral. Further, he apparently has no low-front vowel since he is pronouncing English /æ/ in the same vowel space as Mexico City /a/. However, while it looks as if he only has a low-central vowel forming the point of the five-vowel triangle, Research Question Two must be answered to determine if he is truly missing the vowel in the low-front corner.

4.2. RESEARCH QUESTION TWO: ULTIMATE PRONUNCIATION

To answer the second question*: At the end of the study, how does the learner's pronunciation of the new vowel /æ/ and the similar vowels /u/ and /o/ compare to the L2 target?,* the formant charts of the study-vowels of both Valerio's Term C and the Portland speakers were compared. Figure 4.5 below is a chart that combines the means from Valerio and the Portland speakers.

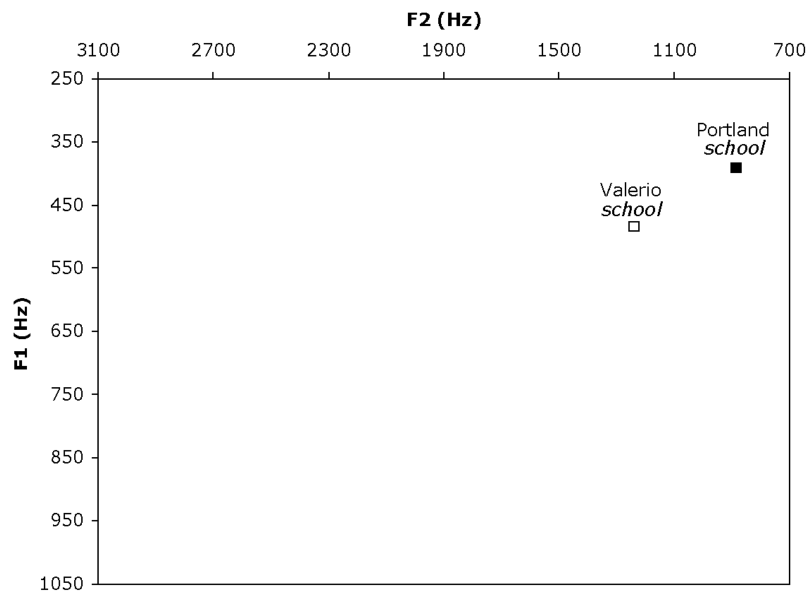
Figure 4.5. Valerio's Term C and Portland Speakers' /æ/, /u/, and /o/



4.2.1. Formant chart analysis

In Term C, the number and variety of /u/ tokens was very low. Valerio used only two of the subcategories: T/u/ and /u/^{L}. He said only one token in T/u/, and only 12 in /u/^{L} (which were all the word *school*). Having such little variety skews the results, as it is not possible to assume that the mean reflects the way he pronounces each subcategory, but only how he pronounces a particular word. The Portland speakers had only eight /u/^{L} words, three of which were the word *school*. Comparing their pronunciation of *school* to Valerio's, Figure 4.6 below shows that the Portland speakers are pronouncing *school* higher and further back than Valerio is.

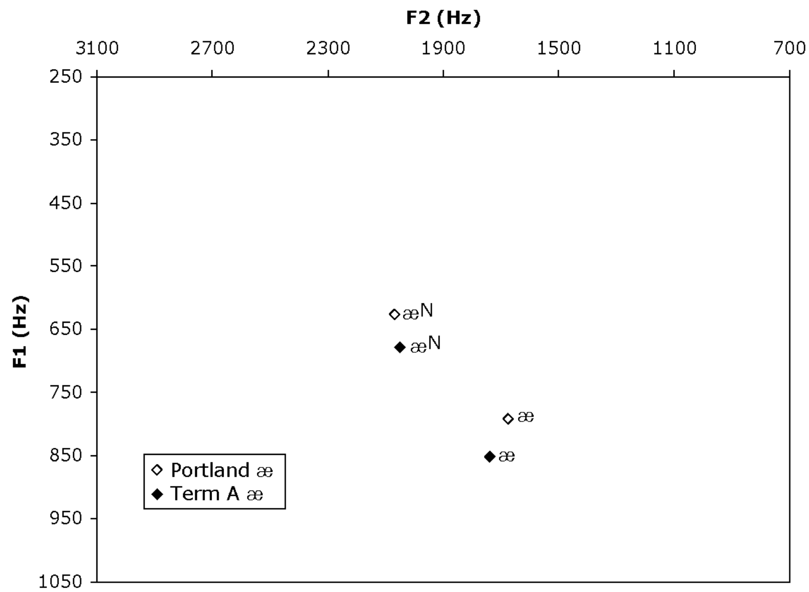
Figure 4.6. Valerio's Term C and Portland speakers' *school* tokens



As Figure 4.5 above shows, the /o/ subcategory means for the Portland speakers are spread out over a wider region, suggesting that the vowel is affected by the phonetic context. Valerio's means are clustered more closely to one another.

Valerio's /æ/ subcategory mean is fairly close to the Portland speakers' mean, as shown in Figure 4.5 above. The /æ/^{N} is not as raised and fronted as the Portland speakers'; however, it was in Term A. See Figure 4.7 below.

Figure 4.7. Valerio's Term A and Portland speakers' /æ/



4.2.2. Statistical analysis

T-tests were conducted to determine if the means of Valerio's Term C and the Portland speakers' pronunciation of /æ/, /o/, and /u/ were significantly different. Vowel subcategories were combined where possible to increase the sample size. A sample size of 20 tokens was set as the minimum.

The /o/ category contains enough tokens to meet the sample-size requirement. To make the samples more comparable, the Portland speakers' /o/F subcategory was not used in the calculation. Valerio does not have tokens in that subcategory and there are enough Portland-speaker tokens without it. The /u/ sample size is not large enough for statistical analysis; however, the /æ/ category was. Since Conn's Portland dialect study focused on the vowel /æ/, there are a large number of tokens for the Portland speakers. The large sample size discrepancy is not an issue because both groups meet the minimum sample requirement of 20. The statistical results are presented in Table 4.2 below.

Table 4.2. Statistical results for comparison of Term C and Portland speakers

Formant	Pooled Vowel Category			Pooled Vowel Category			t-statistic	p-value
	mean	SD	n	mean	SD	n		
	o Valerio Term C			o Portland Speakers			o V/P	
F1	619	71	23	532	84	64	4.761	<0.001
F2	1215	205		1095	253		2.250	0.029
	u Valerio Term C			u Portland Speakers			u V/P	
F1	475	56	13	411	51	42	n/a	n/a
F2	1218	151		1484	488		n/a	n/a
	æ Valerio Term C			æ Portland Speakers			æ V/P	
F1	772	131	31	750	116	302	0.905	0.372
F2	1814	230		1780	224		0.769	0.447

Comparing of the means of the pooled subcategories of /o/ (less the /o/F subcategory) shows that Valerio's Term C pronunciation is significantly different than the Portland speakers. The *p*-value for F1 is <0.001 and for F2 is 0.029, both less than the significance level of 0.05 ($p < 0.05$). This allows ruling out the null hypothesis in favor of the alternate, which states that the means are significantly different.

The means of the pooled subcategories of /æ/ in Term C were compared to the Portland speakers. The *p*-value for F1 is 0.372 and for F2 is 0.447, both greater than the significance level of 0.05 ($p < 0.05$). The null hypothesis that there is no difference between the means cannot be ruled out. Valerio is pronouncing /æ/ in Term C without any significant difference from the Portland speakers.

4.2.3. Summary

No statistical inference could be drawn for /u/, and with such a small and unvaried group of tokens, not much could be determined from the charts. However, it could be determined that Valerio's pronunciation of /o/ is significantly different than the Portland speakers'. The phonetic context seems to have less effect on the realization of this vowel than it does for the Portland speakers. But most interesting is Valerio's pronunciation of /æ/, which is not significantly different from the Portland speakers.

If Valerio is creating a new category for the American English vowel /æ/, one might expect to see a fronting from his initial pronunciation of the vowel, which is in low-central position. In Term C, the chart shows that Valerio is pronouncing his /æ/ close to the Portland speakers' and a statistical test shows that the means are not significantly different. Reasearch Question One showed that Valerio is pronouncing /æ/ similarly to the L1 /a/ in Term A. Research Question Three will determine if he changes his pronunciation over time.

4.3. RESEARCH QUESTION THREE: *NEW* AND *SIMILAR* VOWELS

The final question, *Do the data support Flege's Speech Learning Model concerning* new *and* similar *vowels?,* is answered in two parts: the case for the *new* vowel and the case for the *similar* vowels.

To determine if an additional category has been established for the *new* vowel /æ/, an assessment of Valerio's Term A pronunciation must be made. If at Term A, he is pronouncing this vowel as an existing L1 vowel, then it can be assumed that he has no category /æ/. The sample size of Mexico City Spanish tokens (12 for each vowel) is too small to use in a statistical analysis, so a description of the data suffices. Next, a comparison of his Term A and his Term C pronunciation must be made to determine if he is changing his pronunciation over time. If Term C's pronunciation has moved away from the L1 vowel, into a previously unoccupied acoustic space on the chart, a new category has been established for this vowel. However, if in Term A he is already pronouncing /æ/ in unoccupied acoustic space, close to the target L2 /æ/, then he may have already established a new category before entering the Lab School. The Speech Learning Model posits that a new category will eventually be established. The model is designed to study bilinguals who have spoken the L2 for many years (Flege, 1995), and so this learner, a beginner, may not show any evidence of new category formation.

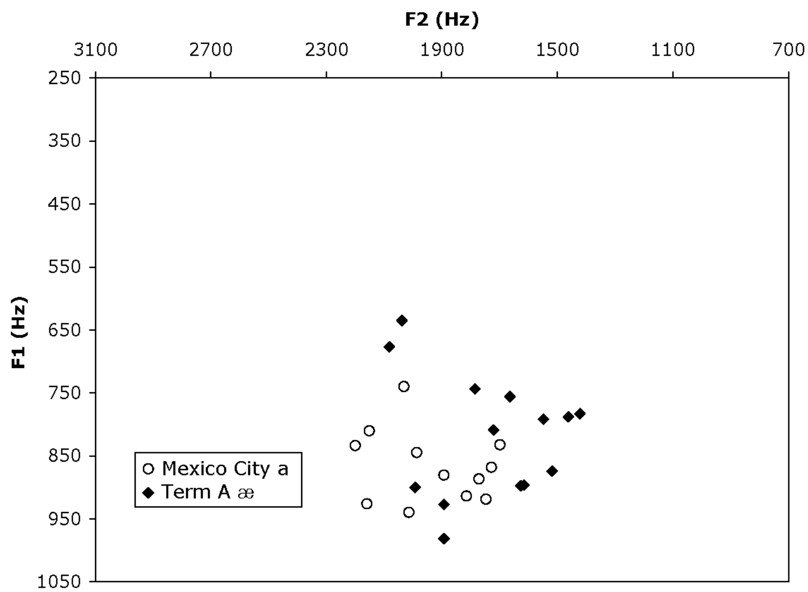
The second part of the question concerns the *similar* vowels /u/ and /o/. The Speech Leaning model predicts that the learner will not make modifications to these vowels over time because they are perceived as equivalent to the L1 versions. To determine if Valerio has modified these vowels over time, the pronunciation of the vowels in Term A is compared with Term C.

4.3.1. *New* vowel

Research Question One compared Valerio's Term A /æ/ tokens to the nearest L1 category, the Mexico City /a/ tokens. It was determined that the vowel spaces of Valerio's Term A /æ/ and the Mexico City /a/ overlap, strongly suggesting that

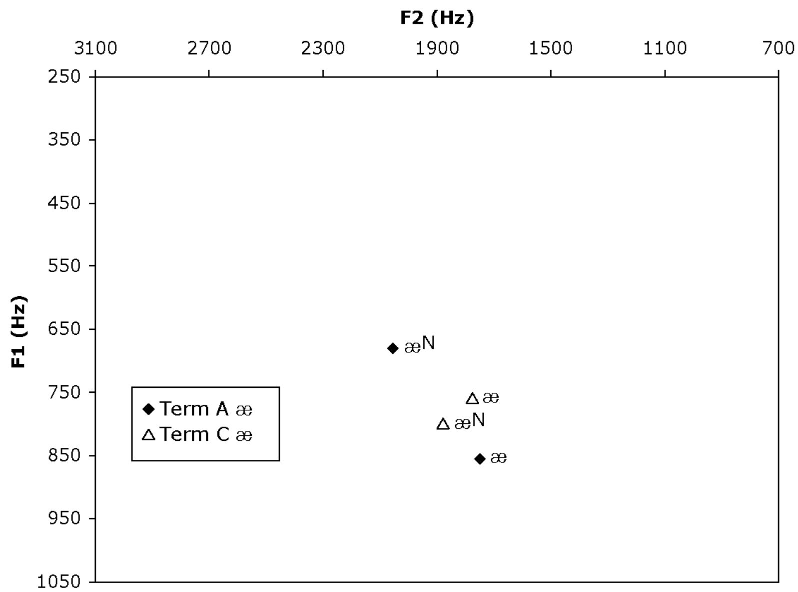
Valerio is pronouncing English /æ/ the same as Mexico City Spanish /a/. The formant chart is presented again, below, as Figure 4.8 for convenience. Since the L1 /a/ category is the same as his /æ/ pronunciation in Term A, it appears that he did not create a new category for /æ/ before entering the Lab School. A comparison of Term A to Term C will show if he has created a new category by the end of the study.

Figure 4.8. Tokens of Valerio's Term A /æ/ and Mexico City speakers' /a/



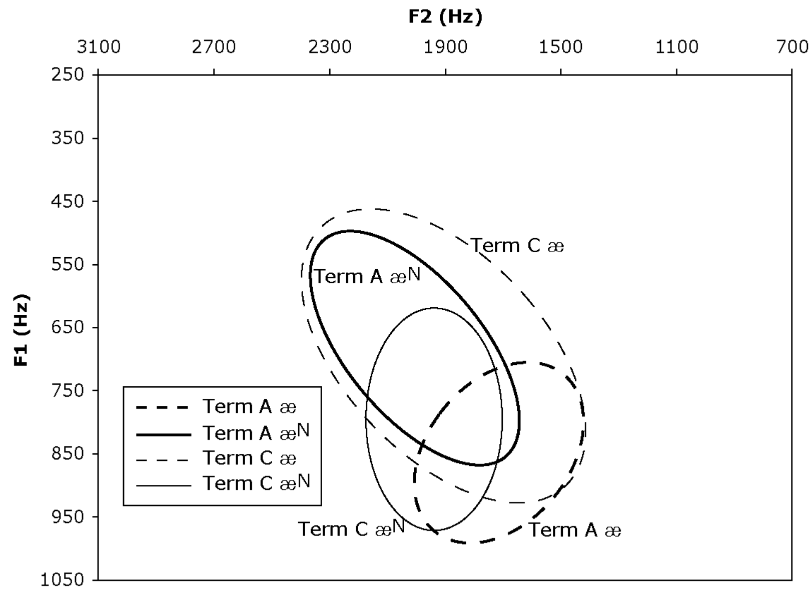
To determine if a new category is formed over his two-year enrollment at the Lab School, Term A is compared to Term C as seen in Figure 4.9 below.

Figure 4.9. Vowel /æ/ means for Term A and Term C



The mean of Term C /æ/ is higher than the mean in Term A while the mean of /æ/[N] is lower and further back than the mean in Term A. A closer look at the vowel spaces in Figure 4.10 below shows large overlap in pronunciation.

Figure 4.10. Vowel spaces for /æ/ in Term A and Term C



Statistically, with /æ/ and /æ/^{N} subcategories pooled for adequate sample size, there is no significant difference between the means of Term A and Term C. Table 4.3 below shows the statistical data for this comparison.

Table 4.3. Statistical results for comparison of the *new* vowel

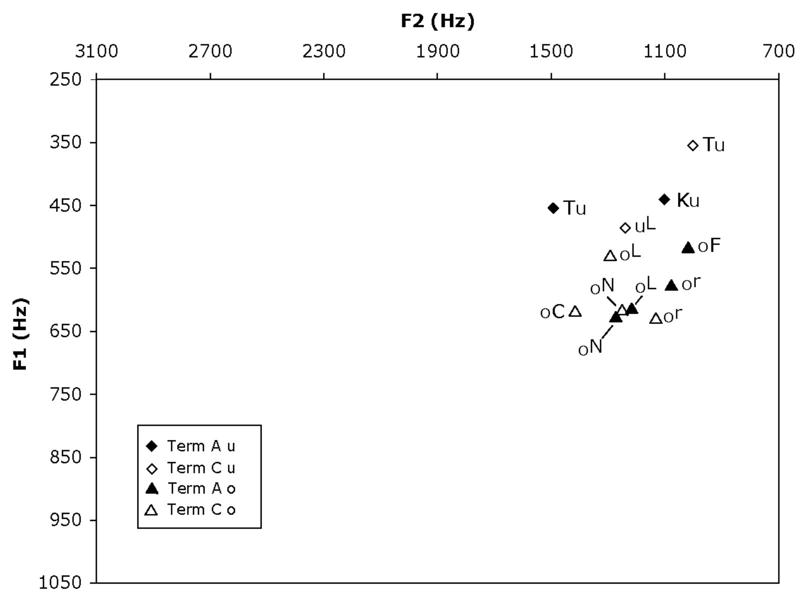
Formant	Pooled Vowel Category			Pooled Vowel Category			t-statistic	p-value
	mean	SD	n	mean	SD	n		
	æ Valerio Term A			æ Valerio Term C			æ A/C	
F1	776	160	28	772	131	31	0.110	0.913
F2	1877	258		1814	230		0.995	0.324

The means of the pooled subcategories of /æ/ in Term A were compared to Term C. The *p*-value for F1 is 0.913 and for F2 is 0.324, both greater than the significance level of 0.05 ($p < 0.05$). The null hypothesis that there is no difference between the means cannot be ruled out. Valerio is pronouncing /æ/ in Term C without any significant difference from Term A. This suggests that he has not created a new category.

4.3.2. *Similar* vowels

The /u/ means from Term A and Term C could not truly be compared. See Figure 4.11 below. In Term A there are no $/u/^L$ tokens, but in Term C, all (except one) are of that subcategory and are all are the word *school*. In Term A, there are 11 T/u/ tokens, but only one in Term C. It is inconclusive if he is modifying the /u/ vowel or not over the course of the two year study.

Figure 4.11. *Similar* vowels /u/ and /o/ in Term A and Term C



Similarly, with /o/, it is difficult to determine if he is or is not modifying the vowel. One reason is that he has a limited variety of tokens. For example, in Term A, the two $/o/^L$ tokens are both *gold,* the five $/o/^N$ tokens are all *home,* and the two $/o/^r$

tokens are both *more.* Another reason is that he does not have congruent subcategories in both terms: he has no /o/C tokens in Term A and no /o/F tokens in Term C. Of the comparable subcategories: $/o/^N$ appears to be nearly the same in Term C; $/o/^r$ is raised and backed slightly in Term C, and $/o/^L$ is raised and fronted in Term C.

A statistical analysis was not possible due to small sample size. However, the data are presented in Table 4.4 below for a non-statistical comparison. With this lack of variety and quantity, it is not possible to conclude whether he is continuing to pronounce /u/ and /o/ the same way as in Term A.

Table 4.4. Statistical results for comparison of the *similar* vowels

Formant	Pooled Vowel Category			Pooled Vowel Category			t-statistic	p-value
	mean	SD	n	mean	SD	n		
	u Valerio Term A			u Valerio Term C			u A/C	
F1	446	60	21	475	56	13	n/a	n/a
F2	1304	309		1218	151		n/a	n/a
	o Valerio Term A			o Valerio Term C			o A/C	
F1	589	81	12	619	71	23	n/a	n/a
F2	1163	152		1215	205		n/a	n/a

4.3.3. Summary

This investigation can neither support, nor contradict the Speech Learning Model. Valerio did not form a category for the *new* vowel /æ/. This may have been due to his beginner status in learning English, or it may be due to the local dialect. Valerio may not need to form a new category for /æ/ if the target is close to his own L1 pronunciation of /a/. The Portland target of this study comprises only two members of the Portland dialect and so may not necessarily represent the dialect as whole. Conn's (2000) study shows the /æ/ mean of the Adult Men group (from which the Portland speakers are drawn) to be F1 = 768, F2 = 1605. Other groups, which included younger and older men and women, plotted differently. He discusses how age, gender, and class can contribute to different pronunciations of the vowel /æ/ among Portland natives.

The investigation into the acquisition pattern for the *similar* vowels was inconclusive. It was not possible to determine or speculate if Valerio is modifying his pronunciation of *similar* vowels or not.[4]

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[4] Term B data were collected to provide insight into the learner's L2 vowel acquisition progress. Since no progress was shown at the end of the study, the data were not introduced; however, the formant chart of Term B can be found in Appendix A.

CHAPTER 5: CONCLUSION

This chapter reviews the findings and presents possible implications of the results. This chapter also presents some limitations of the study and ideas for further research.

5.1. RESEARCH QUESTION REVIEW AND IMPLICATIONS

5.1.1. Is Valerio's initial state his L1?

Valerio's Term A formant chart looks very much like a 5-vowel system triangle, similar to the Mexico City Spanish speakers' chart. First, he is not distinguishing between tense/lax vowel pairs. The vowel space usually reserved for /i/ contains both /i/ and /ɪ/ tokens, and similarly, the /e/ vowel space contains tokens from both /e/ and /ɛ/. Statistical analysis was limited due to sample size, but did show that the means for /i/ and /ɪ/ were not significantly different, and that F1, but not F2, for /e/ and /ɛ/ were not significantly different. The high-back region of the vowel chart shows both /u/ and /ʊ/. The /o/ area attracts several different vowel categories including /o/, /ɔ/, and /ɑ/. No statistical tests were performed due to insufficient sample size. The vowel /æ/ sits in low-central position on the chart, and because it has no tense counterpart, it was compared to the Mexico City speakers' /a/. Insufficient sample size did not permit a statistical analysis; however, a chart of the /æ/ and the /a/ tokens together reveals that the vowel spaces overlap. Overall, based on visual and some statistical evidence, it is clear that Valerio is limited to his L1 categories.

One vowel, which is not in the L1 system, reveals possible strategies that Valerio may be using to form the pronunciation of a specific *new* vowel. The tokens of the vowel /ʌ/ are widely distributed across the right side of the chart; the tokens plot from high-central, to high-back, to mid-back, and down to low-central. The tokens that plot in his /æ/ vowel space, which is also the L1 /a/ vowel space, are most likely the result of perception. To him, /a/ and /ʌ/ probably sound quite similar. He maps the perceived sound onto his established perceptual categories and settles on /a/. The second strategy is orthography. He has pronounced *but* as [but] when reading the word. Also, there are many instances of /ʌ/ being pronounced in the /o/ vowel space in words spelled with *o,* for example *month* or *other*. A third strategy is L1 transfer. He pronounces some cognates with an L1 vowel, for example *color* or *study*.

Recognizing these strategies may provide low-level ESL teachers with valuable insight into why Spanish speaking L2 learners may be forming various pronunciations of this *new* vowel. Teachers might use this knowledge to create innovative learning tools.

Valerio is an educated young man who is married to an American. When he came to Portland, he lived with his in-laws for many months and he reported that he spoke only English with them. Despite his exposure to English, he retained his L1 vowel categories in Term A. Further, while not part of this study's focus, a review of his Term C chart in Appendix A shows that he has not made much change to his vowel system in the two years of the study.

In his two years at the Lab School, Valerio has progressed from Level B to Level D, and he is considered to be at an intermediate level. The next level would be academic English. Even with his progress in the subjects covered at the Lab School: reading, writing, speaking, and listening, his vowel system remains close to his L1. This opens the question to teachers: Since he has not progressed in American-English vowel pronunciation, should pronunciation be emphasized in the instruction? Or, since he is intelligible, is focused instruction unnecessary given the fact that adult learners rarely achieve native-like pronunciation?

5.1.2. Does he acquire the target pronunciation?

Research Question Two asks how Valerio's pronunciation of /æ/, /u/, and /o/ at the end of the study compares with the Portland speakers. While the results for /u/ were inconclusive, /o/ was shown to be significantly different. The most interesting of the three vowels under study was /æ/. A statistical analysis shows that he is pronouncing it with no significant difference from the Portland speakers. Valerio is still pronouncing /æ/ as a low-central vowel. This means that these Portland speakers are also pronouncing /æ/ as a (relatively) low-central vowel.

5.1.3. The *new* and *similar* vowels over time

The Speech Learning Model posits that a learner will not modify the pronunciation of *similar* vowels due to equivalence classification. The learner perceives the vowel to be the same as the corresponding L1 vowel, and so makes no changes to the pronunciation. In this study, it was inconclusive if Valerio modified his pronunciation of the similar vowels /u/ and /o/. A larger and more varied sample of tokens is needed to make the comparison and to perform a statistical analysis.

Valerio has not created a category for the *new* vowel /æ/. Statistical analysis shows no significant difference between his pronunciation in Term A and in Term C. Research Question One showed that in Term A he is pronouncing /æ/ as L1 /a/, and Research Question Two showed that, at the end of the project, he is pronouncing the vowel like the Portland speakers. With no significant change in pronunciation, we can conclude that the Portland speakers are pronouncing the vowel like the Mexico City speakers. Based the criteria of a *new* vowel, the L2 /æ/ should not share vowel space with an L1 vowel, therefore /æ/ should be considered a *similar* vowel rather than a *new* vowel for these particular speakers of these particular dialects.

Had the *new* and *similar* classification in this study been determined using spectral distance, such as that proposed by García de las Bayonas (2004), then /æ/ may have been considered a *similar* vowel and /u/ may have been considered a *new* vowel. The Portland /u/ can be quite fronted. Ward (2003) finds the F2 means (representing frontess/backness) for the Young Adult group as follows: /u/F (open syllable) F2 = 1987, /u/C (post-vocalic consonant exclusive of liquids /l, ɹ/) F2 = 1596. The Portland /u/ may be so fronted that it might be perceived as a *new* vowel to the Mexico City speakers (K/u/ F2 = 933; T/u/ F2 = 1035).

The implication is that using the IPA symbol alone for classifying *new* and *similar* vowels is not accurate when considering specific dialects. Vowel pronunciation can vary widely in different dialects, rendering the IPA symbol too general to express the actual pronunciation. It was not anticipated that the L2 vowel /æ/ would share vowel space with L1 /a/. Additionally, García de las Bayonas' perception study found /æ/ to be a *new* vowel for Spanish-speaking learners of English. As shown in the present study, the symbol did not predict the actual realization of the vowels. Further research using a perception-based method for determining *new* and *similar* vowels may be appropriate at this point. While not possible in this study, testing the learner's own perception of the specific target-dialect vowels would be the most effective method for determining which vowels are *new* or *similar.*

5.2. LIMITATIONS

For this study, there were a few factors that posed limitations. Because the Lab School media is pre-recorded, I had no control over the quality of the recording. The classroom setting had background noise and overlapping voices that did not provide the ideal recording setting. There were also unexpected technical difficulties, such as in Term C when an audio problem produced a low frequency hum from about 0–200Hz. Fortunately, *Praat,* the sound analysis program, was able to show strong formants in even the noisiest samples. Tokens with interference too great to be avoided were removed from study.

Additionally, there was no control over the quantity and variation of the tokens. The quantity is dependent on how talkative the students are and how often they wear the microphone. The language of the classroom can be limited due to the tasks and the level of the students.

5.3. FURTHER RESEARCH

A *new* and *similar* vowel study could be conducted using García de las Bayonas' (2004) proposed spectral basis for classifying vowels in light of the Portland speakers' pronunciation of /æ/ and /u/ (Conn, 2000; Ward, 2003). I would propose a cross sectional study, which includes experienced learners.

Studying the same learner over a longer period of time would add to the knowledge of how L2 vowels are acquired over time. Valerio continued his enrollment at the Lab School facility in Fall 2005; however, the recording phase of the project was complete. If the Lab School resumes recording in the future, or if future in-depth interviews provide additional speech data, this research could be conducted.

Some of the vowel categories had wide variation in pronunciation. The most noted example was /ʌ/. A study that assesses the change in deviation over time would provide a focused look at how the L2 learner may hone in on the target pronunciation.

5.4. SUMMARY

This study provides a unique look at one L2 learner's progress in acquiring American English Vowels over a two-year time period using naturalistic classroom data and dialect-specific L1 and target-L2 data. It was shown that the subject was limited to his L1 vowel system in his first term at the Lab School and he did not make much change to his pronunciation over the two years of the study. It was inconclusive if he continued to pronounce the *similar* vowels as in his L1, but he did not create a category for the *new* vowel. The study shows that he pronounces /æ/ as an L1 vowel and as the Portland Speakers do, which shows that the Portland speakers are essentially pronouncing /æ/ as Mexico City Spanish /a/. With this discovery and with the findings from Ward (2003) showing that Portland /u/ has a tendency to be strongly fronted, it may be necessary to reevaluate whether this dialect's /u/ is a *similar* vowel and /æ/ is a *new* vowel for Spanish speakers.

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APPENDIX A: VOWEL SYSTEM CHARTS

Figure A.1. L1 baseline: Mexico City Spanish speakers' means

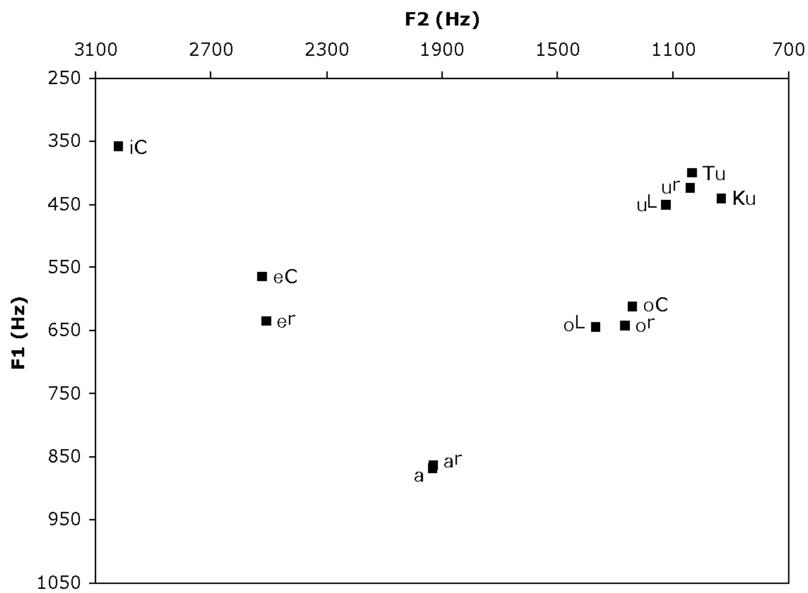


Figure A.2. L2 target: Portland English speakers' means

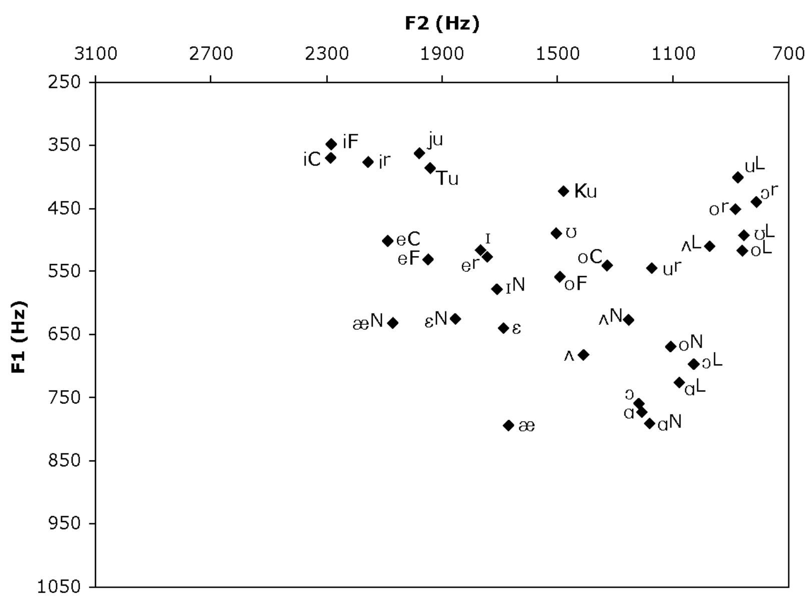


Figure A.3. Valerio's Term A English means

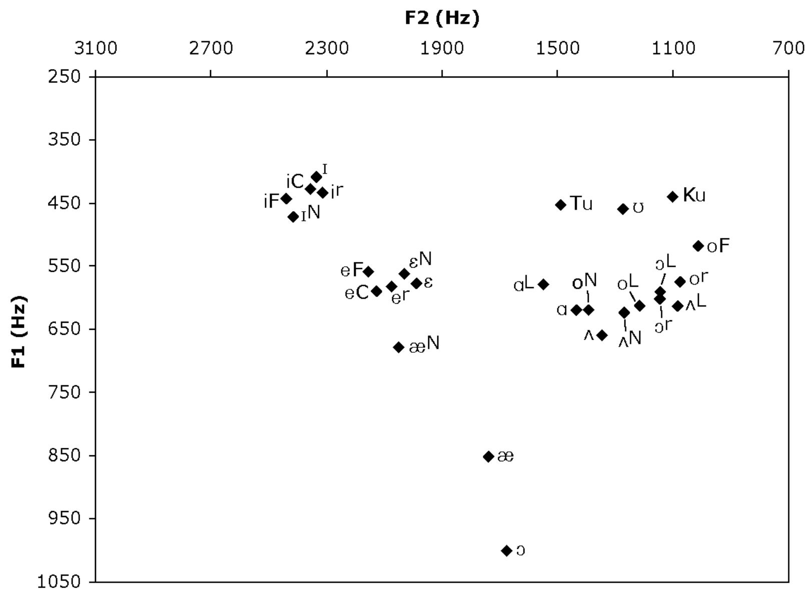


Figure A.4. Valerio's Term B English means

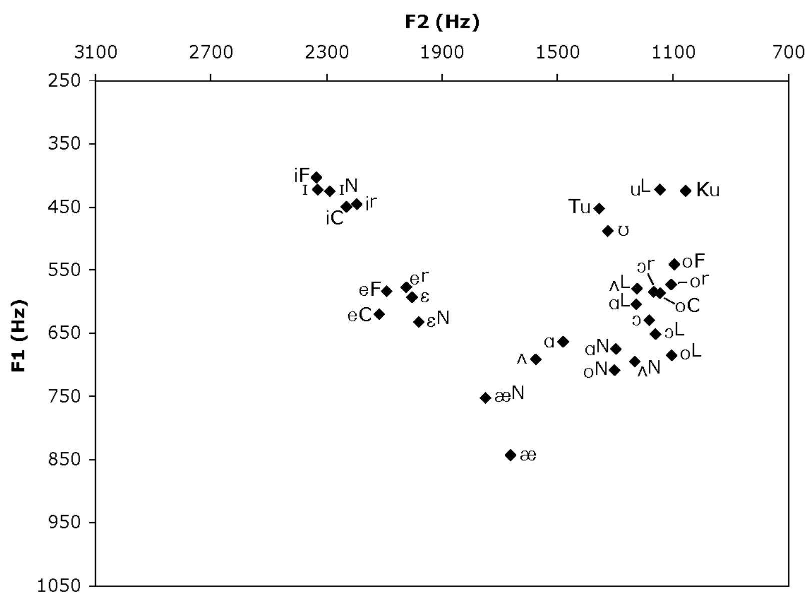
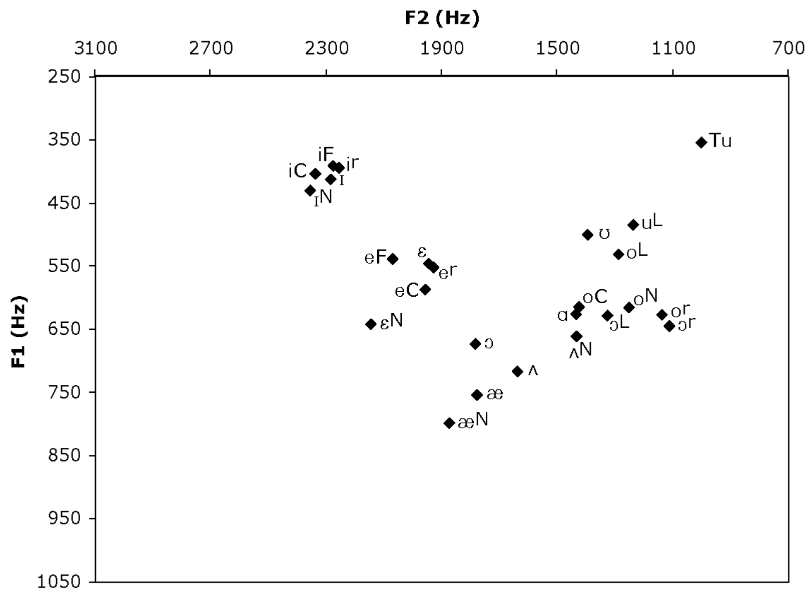


Figure A.5. Valerio's Term C English means



APPENDIX B: RELIABILITY CHECK

To check formant measurement reliability, five tokens were randomly selected from each of the three terms. These tokens were then independently measured by an experienced person. As shown in Figure B.1 below, both measurements for most tokens are quite similar. Only two tokens, *me* and *make* show a difference in formant values worth comment. In the case of *me,* it was noted in the log that the spectrogram was not clear. *Praat* may not have been able to accurately locate the formants due to background noise or other interference. It may have been difficult to choose a "best" measurement location on the spectrogram. In the case of *make,* it was originally noted in the log that this vowel was pronounced as a glide ([eɪ], coded with *{f}*). With a glide, the formants change as the articulators move from one vowel configuration to another: from /e/ towards /ɪ/. It could be that notably different formant values resulted from a slight change in the point of measurement. Table B.1 below shows the formant frequencies and log-comments for the 15 tokens.

Figure B.1. Reliability check tokens

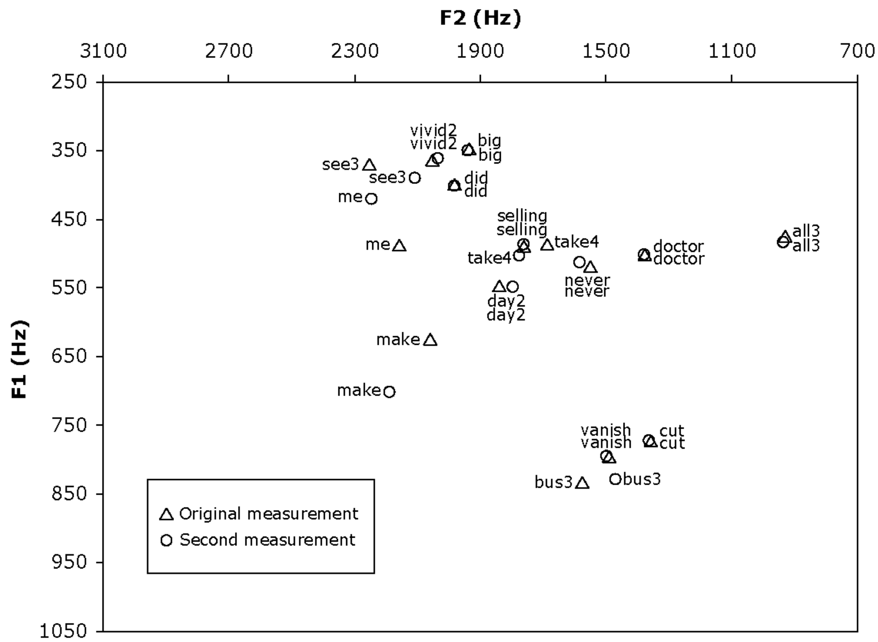


Table B.1. Formant values and comments for tokens used in the reliability check

Token	Original measurement			Second measurement		
	F1	F2	Comment	F1	F2	Comment
all3	477	932		485	937	
big	394	1938		349	1938	sounds like 11 (/i/)
day2	549	1838		550	1794	ugly spg (spectrogram)
did	401	1979		401	1979	
me	488	2147		417	2245	very ugly spg/LPC
cut	776	1355		774	1360	
make	630	2058	{f} (glide)	699	2187	
see3	371	2249	good example	390	2113	
doctor	501	1376		502	1379	
vanish	799	1482		796	1490	
bus3	832	1575		823	1465	sounds like 5 (/ɑ/)
never	525	1546		510	1585	
take4	488	1682		502	1777	
vivid2	367	2049		362	2026	
selling	493	1770		487	1767	

APPENDIX C: EXAMPLE TRANSCRIPT AND TOKENS

Token Log/Speech from video Clips: 01jul03
Conventions:
- *The pound symbol, #, is used to indicate the beginning or end of an utterance, or a short pause in speech.*
- *Words in bold are tokens used in the study, a number after the token indicates a different token of the same word. Tokens that were eliminated from the study are in regular italic.*
- *Comments are in curly brackets, { }.*

Clip1
ok # what is your **favorite holiday** # **February** # **February2** what **day**
Clip2
November # nine # why # yes
Clip3
teacher what did you **say for**
Clip4
wedding # wedding ah yeah wedding is **here** # uh huh # wedding **anniversary** # it's wedding **anniversary2**
Clip5
ah yes jueves {Spanish} # {none}
Clip6
today Tuesday {v.c. 82 iw, not presented} not thursxx
Clip7
Wedneday # will be {overlapping voices} # will **be** {fully realized} # **tomorrow** will **be2** # Wednesday # july {said [ˈdʒju.li]} # july {too quiet}
Clip8
teacher2 # xxx # **ask** for the questions *here2* {removed} **is for2** # **is2** # what is your **favorite2 holiday2** *no* {removed}
Clip9
for **me** # twenty **six** years # En Puebla {Spanish}
Clip10
country {said quiety, self talk}
Clip11
what date {overlapping voices, self talk} # what is your favorite holiday {very quiet, self talk} # {none}
Clip12 {last clip measured for this date: tokens *day*, and *days* numbered correctly}
what is your **day9** # what is your **days2** your **favorite3** *holiday3* {don't use, teacher's voice is louder than students, measures teacher's vowel}# is your question

what is your **day10** # **favorite4** *holiday4* {don't use, other student's voice louder than his}
Clip13
no2 {removed} # *is3* {removed} **names** and **days** of **holidays** in your **partner's** {"partnet's"} **country2** # xxx # **teacher3** one question xxx *this* {removed}{fully realized} for my **partners2** {"partnet's"}this question for my **partners3** {"partnet's"}#
Clip14
tienes rason #{Spanish}
Clip15
ok # {none}
Clip16 {teacher's voice overlaps, louder than student's}
Easter # no is the xxx Easter {overlapping voice} # it's religious {overlapping voice} for semana santa {Spanish}# and ai ai ai
Clip17 {teacher's voice overlaps, louder than student's}
ah d'you **say2** twenty xxx
Clip18
Teacher4 this2 {fully realized} is **for3** {fully realized} um # *Mexico* {removed}{[mehiko]} # for **mexico2** {[mehiko]} is **all** one **day2** {day said quietly}#
Clip19
acompañero {Spanish} # {none}
Clip20 {teacher's voice overlaps, louder than student's, and student is talking quietly}
no pero {Spanish} is national {overlapping voice, can't measure}# *no3* {removed} he's for **independence** {overlapping voice} # **independence2** # xxx {dates in Spanish}
Clip21
España {Spanish}
Clip21A {noise on mic}
xxx {Spanish}
Clip22 {speaking quietly with partner while teacher talks to class}
he's from Spain {don't use, poor token quality, can't hear clear vowel for measuring} {name cut}'s from **Spain2** *independence3* {removed} from xxx # franceses {Spanish} # España {Spanish} # xxx {Spanish}
Clip23
no la revolución es en noviembre {Spanish} # **November2** {overlapping voice} **November3** is # what **day3** is revolution{speaks quietly/overlap Don't use, /l/V} what **day4** # what **day5** # twenty # no twenty # yes xx
Clip24
revolution2 {Don't use, /l/V}# *no4* {removed} {raises voice like question, overlapping voice} # wow

Clip25
buddahs # **teacher5** # what **day6 is4** {fully realized} for Thailand # what **day7** # is Thailand # um # **for4** {fully realized} Thailand # the **national2 day8** # xx {Spanish} # queen's # **august** {overlapping voice} twelfth
Clip26
thank {overlapping voice} you
Clip27
the United **States** {overlapping voice}# belonged to England {don't use, overlapping voice during vowel}#
Clip28
false {overlapping voice} # xx

APPENDIX D: PRIVACY STATEMENT

STATEMENT OF COMPLIANCE WITH LAB SCHOOL POLICY REGARDING SUBJECT ANONYMITY

No student personal information (including, but not limited to: last names; social security number; phone number, address) shall be included in authorized exported audio files from the Lab School multi-media archives.

Because exported audio files are separated from the user-restricted Lab School media, there is a risk that speaker identifying information would be out of the control of the Lab School and the approved researcher. Therefore, to protect the subjects of the Lab School project, all speaker-identifying information must be removed from the exported material.

I, Andrea Vergun, attest that no student personal information, as determined by the Lab School Management Team, has been included in the following exported sound files, which will be used as data for my thesis. All data will be handled in accordance with both Lab School and Human Subjects Committee guidelines.

Signed: ____________________________________ Date: _______________

List of Exported Sound Files:

APPENDIX E: CONSENT FORMS

The Adult ESL Lab School
Consent Form

At the lab school teachers will study how ESL teachers teach and ESL students learn. Steve Reder and Kathy Harris from Portland State University and Reuel Kurzet from Portland Community College will study language learning.

•Your teacher will be from PCC.

•There will be very small cameras and microphones in the ceiling. The cameras will be on (recording) all of the time.

•The videos and related materials will be used to train teachers and do studies on language learning. Videos and related materials will be shown at professional conferences and over the internet.

•Sometimes people will watch the classes from behind the windows. They want to learn how to be better teachers and learn more about language learning.

•Sometimes your teacher may try out a new way to teach to see if it works better.

•Sometimes we will take copies of papers that students write during the term. These copies will help us and other professionals to understand language learning and to teach better.

•Your name will never be used in the studies. No one who uses the study information will know your last name.

•If you do not like the lab school you can leave and go to another PCC class, as long as there is space for you. You will be first on the waiting list.

•There will be no problem for you if you leave the lab school.

•You will get a copy of a textbook to use in class and take home for being in Level A and Level B of the lab school.

•Your picture and voice from the camera recording will be used for studies and to teach teachers in Portland in many other places.

•At the lab school all students will be watched and recorded all of the time that classes are in session. If you do not want to be watched and recorded you can take ESL classes at one of the other PCC schools.

If you have any questions you can call Steve Reder or Kathy Harris at 238 East Hall, Portland State University, (503)725-8772. You can also call the Human Subjects Research Review Committee, Office of Research and Sponsored Projects, 111 Cramer Hall, Portland State University, (503)725-8182.

________________________________ _______________
Signature Date

____________________ _________________________
First name Last name

________________________________ _______________
Administrator Date

Student's Copy

Lab School Copy

PORTLAND DIALECT STUDY – INFORMED CONSENT

I, ______________________, agree to take part in this research project, the Portland Dialect Study.

I understand that the study involves a tape-recorded interview that will take approximately 45 minutes. I understand that my voice will be analyzed by speech analysis software, and that the results of this study may be published on an Internet web site.

Jeff Conn / Rebecca Wolff has told me that the purpose of the study is to learn about the experiences and speech of people in Portland, Oregon.

I may not receive any direct benefit from taking part in this study, but the study may help to increase knowledge that may help others in the future.

Jeff Conn at 725-4105 or connj@nh1.nh.pdx.edu / Rebecca Wolff at 295-1118 or wolffrebecca@hotmail.com has offered to answer any questions I have about the study and what I am expected to do.

He / She has promised that all information I give will be kept confidential to the extent permitted by law, and that the names of all people in the study will be kept confidential.

I understand that I do not have to take part in this study, and that this will not affect my course grade or my relationship with Portland State University. I understand that I may also withdraw from this study at any time without affecting my course grade or my relationship with Portland State University.

I have read and understand the above information and agree to take part in this study.

Date: _______________ Signature: _______________________________

Signature of Parent (if under 21 years) ______________________________

Date: _______________ Signature of Witness: ______________________

If you have concerns or problems about your participation in this study, please contact either the Human Subjects Research Review Committee, Office of Research and Sponsored Projects, 111 Cramer Hall, Portland State University, (503) 725-8182, or Jeff Conn at 1015 SE 17th, Portland, OR 97214 , (503) 736-9352/ Rebecca Wolff at 1110 SW Clay #55, Portland, Oregon, 97201, (503) 295-1118.