

## **Vowel Production in the Speech of Western Armenian Heritage Speakers**

Linda Godson, Portland State University, Heritage Language Initiative

### **ABSTRACT**

This study investigates whether the age at which English becomes dominant for Western Armenian bilinguals in the United States affects their vowel production in Western Armenian. Participating in the study were ten Western-Armenian bilinguals who learned English before age 8, ten bilinguals who did not learn English until adulthood, and one Western Armenian monolingual. Vowel production was measured using recordings from oral reading of a list of sentences.

Results showed that English affects the Western Armenian vowel system but only for those vowels that are already close to English. This bifurcation of vowel behavior indicates that a single across-the-board principle that governs the influence of a dominant language on a minority language is too general. Other forces such as universal tendencies, normal diachronic change, and sociolinguistic pressures must be considered. In addition, even though the influence of English was stronger for those exposed to English as children than for those exposed as adults, the latter group showed significant changes in the direction of English. This means that the effects of the dominant language extend over a lifetime.

### **INTRODUCTION**

#### ***Purpose***

This study concentrates on phonetic changes that appear in Western Armenian, a minority language in California, under the influence of English, the dominant language. Such changes are the result of interacting forces: incomplete learning of the minority language by immigrant children, use of the dominant language by adults outside their native community, and the normal processes of language change that are independent of the linguistic contact situation. The purpose of the experiment to be presented is to distinguish among these forces by measuring differences in the vowel production of Western Armenian-English bilinguals. Two main groups are compared: those whose acquisition of Western Armenian was interrupted in early childhood because of the transition to English as their dominant and primary language, and those who did not use English until adulthood. The former group will be referred to as interrupted acquirers and the latter as uninterrupted acquirers. Interrupted acquisition should not be understood as a complete halt in the learning of a language; rather, this notion entails the demotion of the primary language to a low secondary status. As a result, the acquisition of this language tapers off and does not reach the competence level of baseline speakers. For the baseline, the study uses a single monolingual speaker of Western Armenian. The baseline speaker acquired her Western Armenian without interference from any other language, and it remains her dominant language in adulthood even though she lives in Syria where Arabic is dominant. Such speakers are rare

because virtually all speakers of Western Armenian have emigrated from the Western portion of historical Armenia and live in countries where Western Armenian is a minority language (Vaux 1996, 1998, 2001, 2002). In spite of the limited data provided by this single speaker, it is hoped that comparing her speech with the uninterrupted and interrupted Western Armenian speakers will contribute to our understanding of the monolingual phonetics of Western Armenian. The hypothesis for the experiment addresses the effects both of language transfer from English and incomplete acquisition.

**Hypothesis:** There are differences between uninterrupted and interrupted acquirers of Western Armenian in their adult production of Western Armenian vowels; the interrupted acquirers produce vowels that are more like those of their second language, English.

The hypothesis does not specify the particular types of phonetic changes that are expected because little work has been done in this area.

We expect that there will be at least three potential sources of difference in vowel production between interrupted and uninterrupted acquirers. First, there may be variation between those vowels acquired early and those acquired later, and second, the frequency of occurrence of individual vowels may affect adult production. Third, individuals for whom English became dominant in early childhood are likely to show a greater influence of English on their Western Armenian than individuals who were first exposed to English as adults (Labov 1981, Labov 1982, Andersen 1989, Levelt 1994).

### *Phonetics in Studies of Language Change*

Although currently focused on lexical and morphosyntactic evidence, linguistic research has found all types of change in all grammar areas, including phonology, the lexicon, semantics (but only in connection with lexical change), and discourse. Phonology appears in few recent studies (Hamp 1989, Mithun 1989, Dressler 1991). There are studies of language attrition from the point of view of phonetics, but they have failed to address the possible differences between speakers who acquired the minority language fully before being exposed to the dominant language and those whose acquisition of the minority language was interrupted early.

Petrovic (2001) studied phonetic and phonological changes in modern urban Serbian in contact with both Balkan and Western European languages without considering the language histories of his subjects. Changes to classical Serbian have occurred in the eastern part of the country centering on Novi Sad and Belgrade, the prestige centers of Serbian cultural life. In these cities there is exposure to other Balkan languages and to the international media. These twin influences are responsible for simplification of the prosodic system and a large increase in the number of possible vowel and consonant clusters. The prosodic system has lost the classical Serbian tonal contrasts so that the younger speakers in Belgrade have no tonal accent but have an

accent like Bulgarian, Russian, or French. The new vowel and consonant clusters are attributed to the influence of foreign loan words introduced by the media.

Other phonetic studies of language contact have been done by Akka (1998) and Putzer and Barry (1998). Akka's (1998) analysis of two Arab speaking groups of Morocco shows phonetic changes in one of them to be influenced by contact with Berber, but those changes are not related to interrupted acquisition of Arabic. Generational differences are considered in Putzer and Barry's (1998) comparison of German dialects spoken in three areas of Lorraine, France. However, the primary mode of analysis is the mapping of social networks in relation to dialect differences. Putzer and Barry (1998) note that greater dialect loss has occurred in the youngest generation in two of the three regions, while in the third region the German dialect appears stable for all generations.

An attempt to use phonetic analysis directly in the study of language attrition is Sabino (1996). She presents the case of phonological simplification of Negerhollands (Black Dutch), a creole language of the Danish West Indies. This language was gradually replaced by Virgin Island English Creole (VIEC) when England became the dominant power in the Virgin Islands. By comparing the acoustics of the speech of a single bilingual Negerhollands speaker with a phonetically transcribed corpus from 1923, Sabino found that quantity distinctions for /a - aa/ and /e - ee/ that were present in the 1923 data were missing from the speech of her speaker. The speaker had, however, maintained all the other Negerhollands vowels and produced them as distinct from the VIEC vowels.

#### **A SPECIFIC CASE: WESTERN ARMENIAN**

This study focuses on the immigrant community in San Diego that speaks Western Armenian, a variety of Armenian originally spoken in the Middle East and in Turkey. The specific feature that is examined is vowel space, that is, the area in the oral cavity within which the tongue can move without creating friction. Variation in the position of the tongue within that space, along with lip position, produces the individual vowels. A particular oral configuration creates resonating chambers in the mouth and throat that will produce overtones along with the basic speech sound. These overtones are called formants. For acoustic analysis, the first two formants of each vowel can be charted, giving an abstraction of the relative positions of the vowels in the vowel space.

#### ***The Dialects of Armenian***

Armenian is a member of the Indo-European language family. It is the single living representative of its particular branch. There are at least 36 distinct dialects, which can be divided into two major groups, Eastern and Western. The Eastern dialects are spoken primarily in Armenia, Georgia, Azerbaijan, and Iran. The Western dialects are spoken west of the Turkish-Armenian border in Turkey, and in Saudi Arabia, Syria, Israel, Lebanon, Jordan, and Egypt and are widely dispersed around the world. Within Western Armenian, it is customary to distinguish a range of dialects and sub-dialects spoken in Syria, Lebanon, Jerusalem, Turkey, Jordan, and

Egypt (e.g., Vaux 1996, 1998, 2001, 2002). There are significant diaspora communities in Europe, South America, and the United States that speak Western Armenian (Vaux 1998).

For understanding the experimental parts of this study it is necessary to introduce the Western Armenian vowel inventory, syllable structure, and word stress patterns.

### ***Western Armenian Vowel Inventory***

Modern Western Armenian has 29 phonemes, 24 consonants and 5 vowels. The Eastern and Western dialects share a common five-vowel system as shown in Table 1.

**Table 1. Western Armenian vowel inventory (Vaux 1998)**

	front	central	back
high	i		u
mid	ε		o
low		a	

Although schwa is ubiquitous in both dialects, it is not included in this table because of its non-phonemic status. It is the epenthetic vowel that separates consonant clusters into the preferred Western Armenian syllable shape of CV(C).

### ***Word Stress***

Word stress in Western Armenian is normally on the final syllable regardless of word length. According to Vaux (1998), word stress in Western Armenian is largely rule-governed. The system allows schwas to carry stress on the initial syllable if the final syllable contains a schwa. To minimize variation in vowel production due to word stress, it was important to construct test words in which the vowel to be measured was in a stressed syllable. Schwa was not included, although it can occur in a stressed syllable.

## **FORCES IN LANGUAGE CHANGE**

The process of language attrition in an immigrant community can be studied from at least two points of view: (1) the changes in the language that are caused by pressure from the dominant language and (2) the linguistic changes introduced by individuals whose acquisition of their native language was interrupted before adulthood. These forces interact to produce results that vary from adaptations of the native language and its continued vitality in the community to weakening of the linguistic structure that ends in language attrition.

### ***The Influence of the Dominant Language***

Nearly everyone in an immigrant community is bilingual or multilingual. The influence of the surrounding dominant language and the cognitive pressure of using two or more languages has been shown to be related to several kinds of changes in the full minority language (Dorian 1981, Sasse 1992, Polinsky 1994). These changes depend on many factors; among them are the

structures of both the dominant and minority languages, the frequency with which various structures are used, the relative markedness of the structures in each language, their functional load, and pragmatics.

### ***Forces Affecting the Outcomes of Interrupted Acquisition***

Combined with the influence of the dominant language is the second force that operates in language attrition—incomplete acquisition of the minority language.

Sasse (1992) offers linguistic evidence for the difference between language change due to contact and change due to incomplete acquisition. The former, he claims, tends toward a one-to-one correspondence between the grammatical systems of the minority and dominant languages. The latter, in contrast, is characterized by a loss of functionality of the minority language, both as a tool for communication and as a system that can be transmitted to the next generation. Typical of this kind of loss is a breakdown in category systems (such as tense/aspect/mood), the loss of important distinctions, and confusion in the appropriate use of articles, agreement, verb tenses and syntactic rules. A further marker of functional loss is random variation in the application of rules, choice of verb tenses, and even word order.

### ***Language Attrition and the Individual***

Incomplete acquisition typically occurs in individuals in immigrant families that speak a minority language while surrounded by a majority language. Such individuals will vary in a number of ways, all of which affect their abilities in the minority language. Among these are their age when they left their native community, the number of years elapsed since leaving, and the age at which they switched to the dominant language as primary. It is also possible for speakers to have had a lapse period during which they did not speak the native language at all. Along with the differences in the age at which the majority language becomes dominant, speakers may vary in the frequency and type of their exposure to the minority language ranging from passive exposure as overhearers, but with no active use, to active use with a large number of interlocutors in multiple environments.

It is important to note that individuals who leave a native community for an immigrant community may not immediately switch to the new dominant language. Very young children living in a home where both parents speak the minority language may use it as their primary means of communication, their experiences of the dominant language limited to overhearing it or being spoken to. They will not actively use the dominant language until they go to school. Furthermore, children born in the immigrant community may have a similar experience. This is true for first-borns in the current study; later children preferred to use the dominant language that their siblings had learned in school. Similar to this latter group are second-generation immigrants growing up in homes where the native language is not actively used. The children of such families may be passively exposed to the minority language as overhearers or by being spoken to; they may understand but never speak it.

Before introducing some individual examples of the subjects in the current study, it will be useful to describe the Western Armenian situation in diaspora.

### ***The Armenian Diaspora and the Armenian Community in Southern California***

As a land-locked country sharing borders with Turkey, Georgia, Azerbaijan, and Iran, Armenia has suffered centuries of invasions, migrations, deportations, and massacres. In the twentieth century, Armenians were scattered worldwide as the result of several major world events, primarily World War I and the expansion of the Soviet Union (Djahukian 1986). While historians disagree about the causes of the actions taken by Turkey during and after World War I, there is little doubt that there were massive deportations and massacres of Armenians by the Ottoman Empire. The culmination of the Turkish aggression in the Western portion of historical Armenia was a coordinated and brutal movement to remove the Armenians from their homeland by forced emigration and mass slaughter (Suny 1991). Those Armenians who were not killed either directly or indirectly by prolonged deprivation either emigrated to the West or stayed in the Eastern part of Armenia. The Western emigrees traveled to Saudi Arabia, Jordan, Syria, Israel, Lebanon, and Egypt, from which points many continued to Western Europe, Canada, the United States, South America, and Australia. Those who remained in Armenia became, in 1920, citizens of what the USSR called 'an independent socialist republic' (Suny 1991). The linguistic experiences of these two groups of Armenians were a consequence of the necessity to survive in their new circumstances. The Western emigrees adopted many different languages including Turkish, French, and English, as well as various dialects of Arabic. In Soviet Armenia, Russian was taught, along with Armenian, in the schools and was the language of the occupying government.

The Armenian community in Southern California includes immigrants from all the European countries mentioned earlier. They speak a wide variety of languages besides Western Armenian and English including Turkish, French, and several dialects of Arabic. In San Diego, community life revolves around the church, which is Armenian Orthodox Christian. Church services are held in a combination of classical Armenian and English using a bilingual hymnal and liturgical manual.

### ***Examples of Incomplete Acquirers***

Some examples from subjects in the current study illustrate the diversity of factors affecting the language of incomplete acquirers. An extreme case of interrupted acquisition is AC (names are coded for anonymity). Her parents, both native speakers of Western Armenian from Lebanon, moved to an Armenian neighborhood in Detroit, Michigan before she was born. They continued to use their native language at home so that AC began acquiring it from birth. However, when she was 3, the family moved to a new neighborhood where there were no Armenians and her parents began to introduce English at home. They quickly abandoned Western Armenian entirely, feeling that using English would help them adapt more easily to their new situation. AC thus used English exclusively with her parents, in the surrounding community, and with her friends and schoolmates before she was four years old. She did not

speak Western Armenian again until age 23, when she met and married an Armenian man who preferred speaking it. Since then she has learned enough to communicate with him and with acquaintances at their church.

A very different example of a child also born in the US to Armenian parents is CS, now age 21. She was exposed to Western Armenian from infancy, and her parents have continued speaking it at home, with relatives and friends, and at church. CS was sent to Armenian schools in Pasadena, California where she learned to read and write in Western Armenian; she learned English along with Western Armenian both in classes and from friends. Today she is fluent in both Western Armenian and English although she has used Western Armenian very little since she left home to attend college.

SL is typical of immigrants born outside the US in Armenian communities who moved here as children. Her parents lived in Istanbul, Turkey as bilingual speakers of Western Armenian and Turkish. They moved to New York City when she was three; between the ages of 3 and 5 she was sent to an Armenian day school where both English and Western Armenian were spoken. Unlike our previous examples, her parents spoke two languages at home—Western Armenian and Turkish—in addition to English. SL, now 22, continues to speak Western Armenian with her parents and friends and has used Turkish on several vacation trips to Turkey.

Diverse as these language histories are, the three individuals are alike in that the acquisition of their first language was interrupted, but not necessarily terminated, early in life. We would expect that in spite of their subsequent linguistic experience they would exhibit some limitations in their adult language production and that these should be similar because of their shared experience of interrupted acquisition.

### ***First Language Acquisition of Vowels***

The effects of interrupted first language acquisition depend in large part on the developmental stage at which the interruption occurred. In the case of vowels, it is important to understand the sequence in which the acquirer learns to produce them and at what age the vowel system is mastered. Such a sequence may not be linear nor consist of discrete steps. Nevertheless, we assume that not all articulations are mastered simultaneously and that we might expect those not mastered before acquisition is interrupted to be produced differently in adulthood than those produced by individuals whose acquisition was not interrupted.

There are no studies of language acquisition for Western Armenian. However, since language acquisition studies of many languages show that vowels are acquired early (Smith 1973, Lieberman 1980, Irwin and Wong 1983, Stoel-Gammon and Herrington 1990, Levelt 1994), it is likely that this also applies to Western Armenian.

Studies that have examined vowel acquisition include Lieberman (1980), Irwin and Wong (1983), and Levelt (1994). In a longitudinal acoustic study of English-speaking children from birth to age 15 months, Lieberman (1980) observed that early vowels may not be distinct. He found that as children mature, the positions of the vowels in their vowel space become increasingly differentiated. At 16 weeks, the vowels have a high degree of overlap, while at 66

weeks the overlap is much reduced. The study does not discuss at what age the process of differentiation might be completed.

Standing alone in quantifying the pattern of acquisition for English phonemes is a group project led by Irwin and Wong (1983) in which five graduate students studied 100 children representing five age levels from 1.5 to 6. The results demonstrate the variability in acquisition among children, showing that 87% of the children had acquired a complete vowel system by age 4 and 98% had acquired it by age 6.

Variability among acquirers is a significant problem in predicting the course of language acquisition in general, including vowel acquisition. Clearly one might expect cross-linguistic variation, but variability also occurs within a single individual and across individuals within a single language (Menn and Stoel-Gammon 1995, Rice 1995).

Lacking Western Armenian acquisition studies, we turn to some other factors that play a role in the order of vowel acquisition. These are the child's physical development, phoneme frequencies, and the pressure to produce contrasts.

Since speech production requires complex motor coordination, we would expect that this skill is subject to limitations of physical development. Young children and infants have an immature vocal tract and limited motor control of both articulation and phonation (Menn and Stoel-Gammon 1995). In addition, young children lack the experience of the link between oral-motor movements and the sounds they produce. To develop this link requires maturation of the brain and practice. Knowing this, it is still not possible to attach an age to the full maturation of the physical organs of speech production because there is wide variability in the rate of physical development (Kent and Miolo 1995).

To apply these findings for Western Armenian, we can assume that the vowels that are the easiest to articulate will be acquired first. That is, those vowels requiring the least motor control would be expected to be acquired before those requiring closer control of the articulators. Therefore, we would predict that /a/, for which neither lip rounding nor spreading is required, would be acquired first. However, neither lip rounding, required for /o/ and /u/, nor lip spreading, needed for /i/ and /e/, can be claimed to be more difficult than the other. Thus the order of acquisition after /a/ cannot be predicted based on what we know about physical maturation of the speech organs.

A number of claims have been made that more frequently occurring phonemes are acquired earlier. It is important to point out that there are at least three ways in which phoneme frequency may be defined. First, within a single language, phoneme frequency may be the relative number of times the phoneme occurs regardless of context. Second, the frequency of a phoneme within a language could be the number of times it occurs in either unique words or contexts such as word initially, medially, or finally. Third, from a cross linguistic point of view, phoneme frequency can refer to frequencies across languages, the most commonly occurring phonemes being the most frequent.

A different notion of frequency is the relative number of times that a phoneme occurs in a single language regardless of context. A count of such frequencies in Western Armenian was

obtained from Tatoulian (2000), a story of about 100,000 characters written in colloquial style, giving the following percentages for vowels,

(1)	<u>Vowel</u>	<u>Count</u>	<u>% of total</u>
	/a/	14,691	13.62
	/i/	4,968	4.61
	/o/	5,063	4.70
	/ε/	3,485	3.23
	/u/	3,343	3.10

Computing the 95% confidence limits (using Butler 1985) for these percentages gives results for all vowels that show no overlap. For example, the calculation for /o/ at 4.70% of 100,000 tokens shows that the proportion of /o/ tokens in the sample is 95% certain to fall between 4.69% and 4.71%, outside the range for /i/ of 4.60% to 4.62%.

It is clear from the data in (1) that if frequency, regardless of context, predicts vowel acquisition order, /a/ would be acquired first. Following that would be /o/ and /i/; last would be /ε/ and /u/. Even though the differences in the frequencies for the vowels other than /a/ are statistically valid, it is still possible that larger differences are needed in order to affect acquisition order.

Rice (1995) presents a phonological view of the acquisition process that shows the kind of structure that can account for the commonly observed phenomenon of variability in child language. The basic claim of her proposal is that the driving force in the acquisition of phonemes is the need for contrasts. The child starts with an elementary contrast between consonant and vowel with utterances such as *pa-pa*, and builds a structured sound system by gradually adding contrasts.

For vowels, the child may choose to introduce height contrasts first, later adding front-back contrasts. Alternatively, front-back contrasts may precede height contrasts. Although Rice (1995) does not explicitly show this process for vowels, it would seem reasonable to assume that the two kinds of contrast could also be interleaved.

For Western Armenian, which has one low vowel, /a/, two mid vowels, front and back (excluding the non-phonemic central schwa), /ε/ and /o/, and two high vowels, /i/ and /u/ (see Table 1), there are several possibilities for the acquisition of contrasts. The first contrast possible for height is between the unmarked position, low, and either high or non-low (mid). For the former it would be /a/ contrasting with /i u/ and for the latter /a/ with /ε o/. The second step might be adding the missing contrast for either configuration, resulting in a three-way system of /a/, /i u/, and /ε o/. Subsequently, front-back contrasts would be added to separate /i/ and /ε/ from

/u/ and /o/. Were a front-back contrast introduced initially we would have /a/ and either /i ε/ or /u o/. The second step could be adding the missing place to give a three-place system of /a/, /ε i/ and /u o/ or central-front-back. Height contrasts would follow to separate /ε/ from /i/ and /o/ from /u/.

To summarize, the predictions for the order of vowel acquisition in Western Armenian made by the approaches discussed above are shown in (2).

- (2)
- |                          |                                                          |
|--------------------------|----------------------------------------------------------|
| a. Physical development  | $a > \varepsilon / i / o / u$                            |
| b. Phoneme frequency     | $a > o / i > \varepsilon / u$                            |
| c. Pressure of contrasts | $a > i-u > \varepsilon-o$ or $a > \varepsilon-o > i-u$ , |
|                          | then $\varepsilon / i / o / u$                           |
|                          | or                                                       |
|                          | $a > \varepsilon-i > o-u$ or $a > o-u > \varepsilon-i$ , |
|                          | then $\varepsilon / i / o / u$                           |

A conservative estimate for acquisition of the complete Western Armenian vowel system would be from ages 4 to 6 since the data in Irwin and Wong (1983) indicate that some of their subjects had not acquired all the vowels at age 4 while 98% of them had a complete system before age 6.

## VOWEL PRODUCTION EXPERIMENT

The purpose of this experiment was to determine whether there are significant differences between interrupted and uninterrupted acquirers in their production of the Western Armenian vowels, and whether the differences are due to the influence of English. The experimental hypothesis is:

- (3) There are differences between uninterrupted and interrupted acquirers of Western Armenian in their adult production of Western Armenian vowels; the interrupted acquirers produce vowels that are more like those of their second language, English.

## METHODS AND MATERIALS

### *Materials*

For each of the five phonemic Western Armenian vowels—[i], [ε], [a], [o] and [u] (Vaux 1998), a maximum of 11 words was chosen such that the stressed syllable in each was of the form C1-V-C2. For some vowels there were fewer than 11 test words so that there was a total of 42 words rather than 55 (5 vowels with 11 words per vowel). Most of the words had one or two syllables (two had three) with the stressed syllable always being word final. Using only stressed

syllables for measuring vowel characteristics reduces variation introduced by differences in syllable position within a word because in Western Armenian stress is normally word final. Also, unstressed vowels were not used because it was possible that they would be reduced.

The pattern for constructing the syllables was to use consonants having the same places of articulation, but not necessarily the same manner, across the set of five vowels. The assumption was that place of articulation has a greater influence on vowel quality than manner of articulation (Ladefoged 1993, Stevens 1999). Accordingly, consonants were grouped by place of articulation: labial, coronal, velar, glottal, and uvular. The syllable type coronal-V-coronal thus appeared as coronal-a-coronal, coronal-ε-coronal, coronal-i-coronal, coronal-o-coronal, and coronal-u-coronal.

Commonly used words were selected so that the subjects literate in Western Armenian could read the words in Armenian script while the rest could relatively easily translate them from English to Western Armenian. At the same time, an effort was made to use words that were likely to have been acquired by age 5. This would minimize variation among subjects introduced by age of lexical acquisition. To satisfy these two conditions for word choice, a modified Swadesh list of 100 words was used as a starting point (Swadesh 1971). With the help of a literate Western Armenian-English bilingual informant, words were chosen to represent the different places of articulation in the consonant pairs, while at the same time having tokens in which similar pairs occurred across the five vowels. Only words known to the relevant subjects were included in the individual statistical analyses.

Following construction of the word list, each word was placed in a frame sentence. There were two instantiations of each sentence, and the whole list was pseudo randomized. To minimize variation based on list position, two sentences were added at the end and were later discarded. This process created a total of 86 sentences. For the subjects who were literate in Western Armenian, the sentence list was written in Western Armenian orthography. A version in English was used for those not able to read Armenian script. Those subjects were asked to translate each sentence into Western Armenian as they read it.

### ***Subjects***

There were 21 female subjects in this study, all of whom learned Western Armenian as a first language. Only females were used to limit the variation in absolute formant values, known to be lower for males by as much as 400 Hz for F2 and F3 (Hagiwara 1997). There were 10 subjects who switched to English as their dominant language as children, 10 who maintained Western Armenian as dominant until adulthood and 1, the baseline, who was monolingual (possibly influenced by Arabic) in Western Armenian. The subjects were not paid for their participation.

Table 2 contains a summary description for each subject. They are grouped by acquisition status: baseline, uninterrupted acquisition, and interrupted acquisition. Except for the baseline speaker who is monolingual in Western Armenian, all the speakers are either dominant in English or bilingual.

**Table 2. Subjects by Acquisition Type**

	N	Subject ID	Age	Birthplace; Parents' Birthplace if Born in US	Age Armenian No Longer Dominant	Age Arrived in So. CA	Yrs in US	Yrs in So. CA	Languages Other than Armenian and English
Baseline	1	BV	51	Aleppo, Syria	Never	51	2 mo.	2 mo.	(no English) Arabic
Early interruption	1	AC	52	Detroit, MI, USA; Syria	3	26	52	26	None
	2	BR	45	Detroit, MI, USA; Turkey	6	27	45	18	Turkish, Arabic, Spanish
	3	CS	20	Burbank, CA, USA; Aleppo, Syria	5	0	20	20	Spanish
	4	JA	30	Detroit, MI, USA; Egypt	5	14	30	16	Spanish
	5	KS	21	El Cajon, CA, USA; Beirut, Lebanon	5	0	21	21	None
	6	MJ	40	Beirut, Lebanon	8	22	32	18	Arabic
	7	SL	20	Istanbul, Turkey	5	10	15	10	Turkish
	8	TL	22	Seattle, WA, USA; Heliopolis, Egypt	5	13	22	9	None
	9	TR	24	Dinuba, CA, USA; Beirut, Lebanon	4	0	24	24	French
	10	VL	33	Beirut, Lebanon	4	4	29	29	Arabic, Turkish (passive)
Uninterrupted	1	AS	59	Aleppo, Syria	26	26	33	33	Arabic, French
	2	BL	33	Beirut, Lebanon	21	21	12	12	Arabic, French
	3	CT	55	Aleppo, Syria	25	25	30	30	Arabic, French

	4	DA	30	Aleppo, Syria	22	22	8	8	Arabic, Turkish (passive)
	5	KV	56	Jerusalem (Palestine)	25	25	31	31	Arabic
	6	MA	34	Beirut, Lebanon	21	21	13	13	Arabic, Turkish, French
	7	MS	64	Damascus, Syria	52	52	12	12	Arabic, Turkish, French
	8	MM	52	Heliopolis, Egypt	18	30	28*	22	Arabic, French
	9	PM	38	Latakia, Syria	26	30	12	8	Arabic, French
	10	VK	56	Tripoli, Lebanon	26	26	30	30	Arabic, Turkish
							* six years in Canada		

### ***Procedures***

The subjects were interviewed in locations that were as quiet and convenient for them as possible. Each subject was instructed to read the list of sentences into a microphone for recording. The interviewer read the instructions in (4) to maintain uniformity in their understanding of the task.

(4) Please read each sentence in your usual speaking voice and at a normal pace. Try to maintain the same speed throughout. If you make a mistake, simply repeat the sentence. Read the number preceding each sentence and then the sentence itself. You may stop at any time to rest or drink some water. Do you have any questions?

All the instructions and explanations were given in English. For the baseline speaker, who did not speak English, the instructions were given through an interpreter. A WM-D3 Sony Walkman Professional Stereo Cassette-corder was used with a Sony PC-62 stereo lapel microphone for all interviews.

The subjects' language histories were gathered using a form developed specifically for this study.

### ***Measurements***

The recordings were digitized on a Kay 4100 Computerized Speech Lab (CSL), at a sampling rate of 22,500 Hz. The tokens containing the stressed vowels to be measured were extracted and their waveforms saved to individual sound files. This was done for the full set of sentences for each subject so that there were two tokens for each word. To obtain formant values, a spectrogram was generated for the word and a cursor placed at a position in the vowel that visually appeared to have steady state (constant frequency) formants. Then an LPC (linear predictive coding) frequency response spectrum was obtained for that position using 18 coefficients. Automatically generated numerical values in Hz for the first four formants were saved to disk for analysis.

For the comparisons with English, it was important to find data that represented the Southern California dialect. This dialect has been recognized as distinctive by Hagiwara (1997) and Ladefoged (2001). The particular formant values taken from Hickl (2000) were produced by nine monolingual English-speaking females from Southern California. The average values for F1 and F2 for the English vowels /a/, /ɛ/, /i/, /o/, and /u/ are close to the values reported by Hagiwara (1997) for females speaking California English.

The differences among formant values were also evaluated in terms of whether those differences were perceivable. It is possible that a statistical difference in quality between two vowels may not represent a perceivable difference. Such perceivable differences, even if not great enough to cause a hearer to misidentify one of the phonemes, may contribute to a distinctive 'accent'. Table 3, using data from Kewley-Port (2001), shows the perceivable threshold values converted from Barks to Hz at a range of frequencies.

**Table 3. Formant Discrimination (in Phrases) of 0.3 Barks Converted to Hz (after Kewley-Port 2001)**

Formant frequency	400	800	1200	1600	2000	2400	2800	3000
Perceivable difference	32	44	58	74	92	111	133	145

The values in the first column of Table 3 indicate, for example, that for a vowel sound to be perceivably different from a vowel sound with an F1 of 400 Hz (given no change in F2), it must have an F1 of at least 432 Hz.

### *Statistical Analysis*

A scatter diagram for each subject was generated showing F1 against F2 for all tokens of a given vowel. The patterns observed in the scatter diagrams were statistically analyzed using the Hotelling t-square test. This test measures the significance of differences across means for grouped cases and multiple dependent variables. It shows whether the means for each dependent variable are statistically different between the populations from which the sample groups were taken. In this analysis, the cases were grouped by acquisition status. The four groups were uninterrupted acquirers, interrupted acquirers, the baseline (one speaker), and Southern

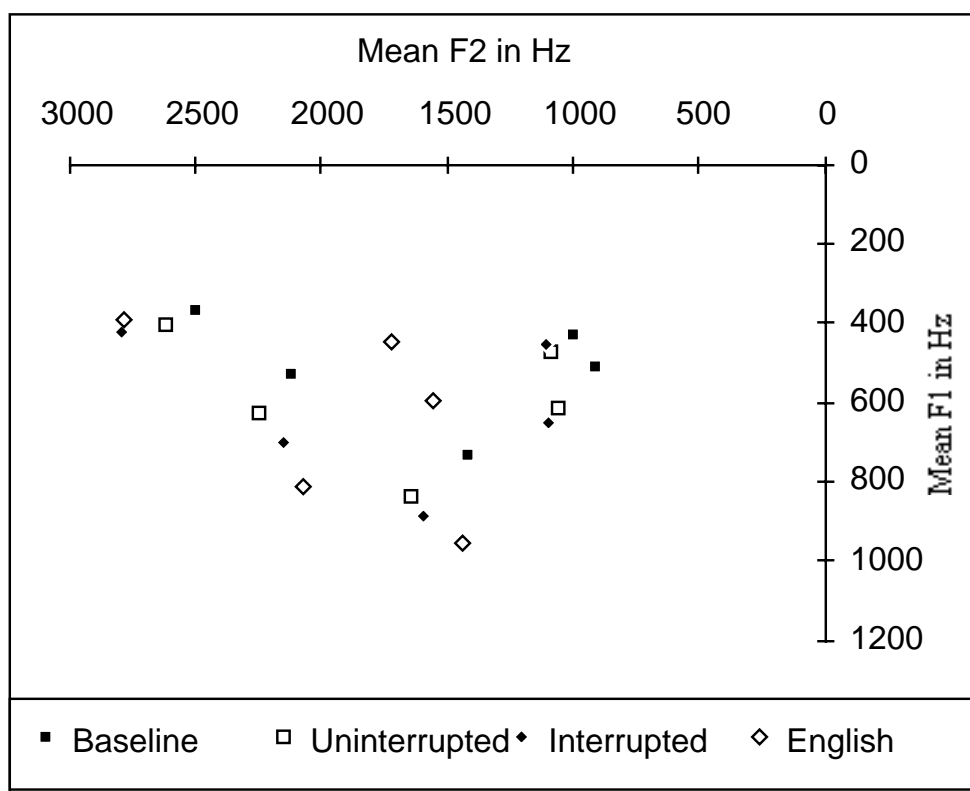
California English monolinguals. The dependent variables were the values in Hz for F1 and F2 for the target syllables.

In addition to identifying the statistically significant differences among speaker groups in their vowel production, the differences in the mean formant values for those showing such differences were evaluated for perceivability. The data from Kewley-Port (2001) shown in Table 3 were compared to the differences in F1 and F2 between subject groups by vowel. Any value for either F1 or F2 greater than the perceivable difference given in Table 3 for a given formant frequency was interpreted as indicating that the difference would be perceivable.

### Results

All the vowels showed different individual patterns, thus it was impossible to identify an overall pattern that applied to all of them. Some vowels showed little difference in quality across the acquisition types, while others differed widely. The diagram in Figure 1, drawn from the data in Table 4, suggests that the four groups of speakers produced /i/, /ɛ/, and /a/ with less variation among the groups than /o/ and /u/, where English was separate from the other three groups.

**Figure 1. Vowels by acquisition type. (Data are shown in Table 4).**



**Table 4. Mean Formant Values in Hz for Figure 1. Vowels by Acquisition Type**  
**B = Baseline Speaker, UA = Uninterrupted Acquirers, IA = Interrupted**  
**Acquirers, E = Southern California English Monolinguals**

	F1				F2			
Vowel	B	UA	IA	EM	B	UA	IA	EM
i	370	407	426	393	2499	2623	2797	2786
ε	527	630	704	810	2124	2252	2148	2072
a	733	839	888	957	1420	1640	1594	1437
o	510	617	650	597	910	1062	1099	1552
u	431	47	457	450	1000	1089	1108	1718

The detailed results of the statistical analyses done with the Hotelling t-square test are in the Appendix. They show for each vowel and each acquirer group the means and standard deviations of F1 and F2 along with the t-square test result for significant differences between groups.

#### *Differences among Acquirer Groups by Vowel*

For /i/, the interrupted and uninterrupted acquirers are different, with the latter being no different from the baseline for both F1 and F2. The interrupted acquirers are closer to English than the uninterrupted acquirers for F2, differing from English only in having a higher F1.

The interrupted and uninterrupted acquirers produce /ε/ differently, and the uninterrupted acquirers are closer in height to the baseline. The height of /ε/ for the interrupted acquirers is closer to English than are the other two groups, but is not significantly different from English for F2.

For /a/, the pattern for height is the same as for /ε/, with the baseline speaker highest, uninterrupted acquirers next highest, interrupted acquirers following, and the English monolinguals lowest. The interrupted and uninterrupted groups are both more forward than the English and baseline speakers.

There is no perceivable difference between the /o/ of the interrupted and uninterrupted speakers. These two groups have a lower /o/ (higher F1) than the baseline speaker. The English /o/ is more forward than that of the three types of Western Armenian speakers.

The pattern for /u/ is similar to that for /o/, with the three Western Armenian groups similar and the English monolinguals' more forward.

## DISCUSSION

### *The Influence of English*

The interrupted acquirers showed that their productions of /i/, /ɛ/, and /a/ were closer to English than those of the uninterrupted acquirers, but /o/ and /u/ were not. The former vowels were perceptibly different on at least one dimension from those of the uninterrupted acquirers and differed in all cases in the direction of English. This is consistent with observations made by most of the uninterrupted acquirers to the researcher that interrupted acquirers have a slight accent in their Western Armenian, which makes them easy to identify and differentiate from other speakers.

The back round vowels did not follow the pattern found for /i/, /ɛ/, and /a/. The interrupted and uninterrupted acquirers had no perceptible differences for /o/ or for /u/ while both were very different from English. The English /o/ and /u/ were much farther front (even farther front than the English /a/) than those of their Western Armenian counterparts. Since rounding lowers the value of F2 (Ladefoged 1993, Stevens 1999), this suggests that the Western Armenian /o/ and /u/ are rounded while the California English vowels are not. This characteristic of California English has been noted by Hagiwara (1997) and Ladefoged (2001).

These results support the hypothesis for this experiment for some vowels, but not for others. The hypothesis is confirmed for the vowels /i/, /ɛ/, and /a/, but not for /o/ and /u/. That is, the first three vowels are produced differently by uninterrupted and interrupted acquirers, and the interrupted acquirers are closer to English. For /o/ and /u/, however, it appears that not only do the two groups of Western Armenian bilinguals produce them similarly, but California English has not influenced either group.

The influence of English appears even more clearly when we include the monolingual Western Armenian speaker in the comparisons, keeping in mind the possible influence of Arabic. However, both the interrupted and uninterrupted acquirers produce all the vowels except /u/ differently from the baseline speaker and with qualities more similar to the English vowels. The pattern is that the interrupted speakers' productions are closer to English, while those of the uninterrupted speakers are between the interrupted speakers and the baseline. This observation confirms the English influence on the language of Western Armenian-dominant bilinguals, whose exposure to English begins in adulthood. This effect in bilinguals could result either directly from exposure to English or indirectly by linguistic accommodation to their children, whose Western Armenian might reflect English influence. Whatever the source of this effect, the continuous influence of a dominant language is certainly well attested for several other bilingual groups (Vago 1991, Silva-Corvalán 1994, Sabino 1996). Its presence in Western Armenian-English speakers, reported here for the first time, is an interesting reification of the tendency established by other researchers for different populations.

### *Why do Armenians Resist the California English /o/ and /u/?*

An explanation is needed for the finding that although the interrupted acquirers have been influenced by the English /i/, /ɛ/, and /a/, this influence is not apparent in their back vowels,

/o/ and /u/. One possibility is that the interrupted acquirers may perceive the unrounded California /o/ and /u/ as unrelated to the rounded Western Armenian /o/ and /u/. Hence we would expect Western Armenian acquirers to perceive them as independent phonemes and to maintain them as distinct.

If we consider the acquisition order of vowels in Western Armenian, we would expect that /a/, which we have shown is the vowel most likely to be acquired first, would be more stable than the other vowels. However, the two vowels that appear unchanged by English, /o/ and /u/, are predicted to be acquired later than /a/, and possibly later than /ɛ/ and /i/. Two observations are possible: all the vowels were completely acquired by the interrupted acquirers before their exposure to English, or the vowel acquisition order that was predicted is incorrect. We need Western Armenian acquisition studies to decide which is more likely to be the case.

## CONCLUSION

The hypothesis for this experiment, that interrupted and uninterrupted speakers of Western Armenian in an English dominant environment would produce their vowels differently, and that the interrupted acquirers' vowels would be more like English vowels was confirmed for three of the five Western Armenian vowels—/i/, /ɛ/, and /a/. This has a bearing on the nature of the accent that uninterrupted speakers observe in interrupted acquirers. Moreover, the uninterrupted acquirers' vowels were not the same as those of the Western Armenian monolingual baseline speaker, except for /u/. There are several implications for these findings.

It appears that exposure to English affects Western Armenian bilinguals even when English does not become dominant for them until adulthood. That the effect is smaller for uninterrupted than for interrupted acquirers does not diminish the significance of this finding. It supports the view that phonetic modification of a fully acquired language is a process that continues over a lifetime. In the case of Western Armenian-English bilinguals living in an English speaking community, this process happens as a result of continuing exposure to and use of a dominant language, either directly or indirectly through exposure to the Western Armenian of interrupted acquirers.

That the influence of English for both uninterrupted and interrupted acquirers on some vowels does not affect production of /o/ and /u/ may be due to the fact that the Western Armenian and Southern California /o/ and /u/ are acoustically distant in the F2 (backness) dimension. Acquirers of Western Armenian may categorize them as distinct phonemes within each system. This view is supported by the fact that even individuals born and raised in Southern California show no evidence of English influence in their Western Armenian /o/ and /u/ productions. Such bifurcation of vowel behavior shows that any principle that predicts an across-the-board effect of a dominant language on the phonetic realization of vowels in a minority language is too general. The experimental evidence for differential effects presented here points to larger issues of the representation of two languages in the mind of a bilingual and the awareness of contrasts between two languages or subsystems in those two languages.

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**APPENDIX : RESULTS OF STATISTICAL ANALYSIS**

**Table 1. Mean Formant Values in Hz, Standard Deviations and t-test Results for Interrupted and Uninterrupted Acquirers**  
(N = number of tokens for each comparison; n.s. = not significant)

	N			Uninterrupted acquirers	Interrupted acquirers	t-test result *p<0.05
/a/	74	F1	Mean	839	888	* -3.9
			Std. Dev.	81	72	
		F2	Mean	1640	1594	n.s.
			Std. Dev.	150	141	
/ɛ/	59	F1	Mean	632	704	* -5.1
			Std. Dev.	78	72	
		F2	Mean	2273	2148	* 3.7
			Std. Dev.	202	163	
/i/	48	F1	Mean	407	426	n.s.
			Std. Dev.	54	73	
		F2	Mean	2623	2797	* -4.5
			Std. Dev.	202	177	
/o/	82	F1	Mean	617	650	* -2.7
			Std. Dev.	90	66	
		F2	Mean	1062	1099	n.s.
			Std. Dev.	150	131	
/u/	54	F1	Mean	470	457	n.s.
			Std. Dev.	73	64	
		F2	Mean	1089	1108	n.s.
			Std.Dev <sup>1</sup> .	196	242	

**Table 2. Mean Formant Values in Hz, Standard Deviations and t-test Results for Interrupted Acquirers and Monolingual English Speakers**

	N			Interrupted acquirers	Monolingual English speakers	t-test results * p<0.05
/a/	50	F1	Mean	877	957	* -6.2
			Std. Dev.	66	63	
		F2	Mean	1621	1437	* 7.2
			Std. Dev.	144	111	
/ɛ/	42	F1	Mean	713	810	* -6.4
			Std. Dev.	73	65	
		F2	Mean	2118	2072	n.s.
			Std. Dev.	150	97	
/i/	48	F1	Mean	426	393	* 2.4
			Std. Dev.	73	60	
		F2	Mean	2792	2786	n.s.
			Std. Dev.	177	100	
/o/	54	F1	Mean	653	597	* 4.7
			Std. Dev.	60	64	
		F2	Mean	1108	1552	* -13.1
			Std. Dev.	145	203	
/u/	33	F1	Mean	450	450	n.s.
			Std. Dev.	57	55	
		F2	Mean	1107	1716	* -10.4
			Std. Dev.	250	225	

**Table 3. Mean Formant Values in Hz, Standard Deviations and t-test Results for Uninterrupted Acquirers and Monolingual English Speakers**

	N			Uninterrupted acquirers	Monolingual English speakers	t-test result *p<0.05
/a/	50	F1	Mean	826	957	* -9.6
			Std. Dev.	73	63	
		F2	Mean	1663	1437	* 8.9
			Std. Dev.	143	111	
/ɛ/	42	F1	Mean	630	810	* -11.1
			Std. Dev.	81	65	
		F2	Mean	2252	2072	* 5.0
			Std. Dev.	179	97	
/i/	48	F1	Mean	407	393	n.s.
			Std. Dev.	54	60	
		F2	Mean	2623	2786	* -4.1
			Std. Dev.	202	100	
/o/	54	F1	Mean	619	597	n.s.
			Std. Dev.	94	64	
		F2	Mean	1086	1552	* -13.8
			Std. Dev.	144	203	
/u/	33	F1	Mean	462	450	n.s.
			Std. Dev.	77	55	
		F2	Mean	1081	1717	* -12.0
			Std. Dev.	204	225	

**Table 4. Mean Formant Values in Hz, Standard Deviations and t-test Results for Uninterrupted Acquirers and Baseline Speakers**

	N			Uninterrupted acquirers	Baseline speaker	t-test result *p<0.05
/a/	74	F1	Mean	839	732	* 3.9
			Std. Dev.	81	41	
		F2	Mean	1640	1420	* 4.2
			Std. Dev.	150	147	
/ɛ/	59	F1	Mean	632	527	* 3.7
			Std. Dev.	78	37	
		F2	Mean	2273	2124	* 2.1
			Std. Dev.	202	66	
/i/	48	F1	Mean	407	370	n.s.
			Std. Dev.	54	11	
		F2	Mean	2623	2499	n.s.
			Std. Dev.	202	127	
/o/	82	F1	Mean	617	510	* 3.8
			Std. Dev.	90	50	
		F2	Mean	1062	921	* 3.1
			Std. Dev.	150	56	
/u/	54	F1	Mean	470	431	n.s.
			Std. Dev.	73	37	
		F2	Mean	1089	1000	n.s.
			Std. Dev.	196	138	

**Table 5. Mean Formant Values in Hz, Standard Deviations and t-test Results for Interrupted Acquirers and Baseline Speakers**

	N			Interrupted acquirers	Baseline speaker	t-test result *p<0.05
/a/	74	F1	Mean	888	733	* 6.3
			Std. Dev.	72	41	
		F2	Mean	1594	1420	* 3.5
			Std. Dev.	141	147	
/ɛ/	59	F1	Mean	704	527	* 6.7
			Std. Dev.	72	37	
		F2	Mean	2148	2124	n.s.
			Std. Dev.	163	66	
/i/	48	F1	Mean	426	371	n.s.
			Std. Dev.	73	11	
		F2	Mean	2797	2499	* 4.0
			Std. Dev.	177	127	
/o/	82	F1	Mean	650	510	* 6.7
			Std. Dev.	66	50	
		F2	Mean	1099	921	* 4.4
			Std. Dev.	131	56	
/u/	54	F1	Mean	457	431	n.s.
			Std. Dev.	64	37	
		F2	Mean	1108	1000	n.s.
			Std. Dev.	242	138	