Vowel dynamics of Mexican Heritage English: Language contact and phonetic change in a Chicago community

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1. Introduction

Immigration patterns over the last 20 years have changed the face of many American communities. Mexican immigrants in particular have developed ethnic heritage enclaves throughout the U.S., engendering unique speech patterns that in turn can become community norms. As an urban center known for its ethnic neighborhoods, the city of Chicago presents an opportunity to study the results of language contact in ethnic minority communities. Minority ethnic groups, especially non-Europeans, have not been seriously considered as loci for the initiation of language change, so it is no surprise that internally-motivated sound changes and the relationship between Spanish and English phonology have not received much attention (Fought, 2002). The current work applies a sociophonetic analysis to the speech of Mexican Heritage English (MHE) speakers in Albany Park, an ethnically diverse Chicago neighborhood on the Northwest side. A detailed analysis of their vowels shows that it is the dynamic characteristics of the vowels that show Spanish influence, not static vowel plots typically used in dialect characterization.

We define MHE speakers as English speakers whose parents emigrated to the U.S. from Mexico, and who were educated exclusively in Chicago schools (the region for this study). These speakers report English as their dominant language and vary in their Spanish proficiency from none to native-like fluency.

In this study we characterize MHE in relation to the regional dialect (Inland North) for Chicago (Labov, et al., 2006). The vowels of this Anglo dialect participate in the well-known Northern Cities Shift (NCS). In a standard vowel plot, the six vowels comprising the shift (ɪ, ɛ, ʌ, ɔ, ɑ, æ) are believed to participate in a coordinated clockwise movement, with adjacent vowels affecting the position of certain neighbors. Due to its distinctive spectral structure and its putative role as a historical chain shift in progress, the NCS has been well documented by a number of researchers on the dialect (Labov, 1994; Clopper & Pisoni, 2006).

In addition to comparisons to the regional norm, we will differentiate between MHE speakers and English learners of Mexican descent. In much of the early research on MHE, a distinction is not made between speakers born and/or raised in the United States and those who had immigrated and learned English later in life. This is problematic for the characterization of MHE since the range of language learning history for second language speakers has been shown to have a telling effect on the vowels ultimately obtained (see Piske, et al., 2001 for a review). It is for this reason that the current study set out to delimit two sets of

Mexican-American participants: English language learners (L2E) and native speakers of English (MHE). This issue has been addressed in more recent work on Chicano English (e.g. Godinez & Maddieson, 1985; Fought, 2003), but the focus is usually on the speakers' Spanish proficiency rather than their language history.

Traditional studies of dialectal variation rely heavily on the characterization of vowel system structure. Static plots of the first and second formants (F1 and F2) measured at the vowel nucleus provide insights into how dialects vary as a function of spectral position as well as inventory number (e.g. splits and mergers). However, in the language contact situation studied here, speakers are resolving two disparate vowel systems that vary not only in their numbers (5 for Spanish and 11+ for English) and spectral positions, but also in their durational properties (long and short subsystems in English) and spectral dynamics. This study indicates that MHE, unlike L2E, displays a well-differentiated vocalic inventory similar to Anglo English. However, consistent differences between MHE and Anglo patterns are found in vowel duration properties and formant trajectories. Vowel lengthening before voiced consonants varies significantly between the two groups, as do the duration ratios of long/short vowels. Correlations of accent ratings to temporal features of MHE indicate that it is the dynamics of vowel production, not static plots, that may play a role in listeners' perceptions of accent.

2 Methods

2.1 Participants

Fourteen female MHE speakers age 18-48 were recruited from the Albany Park neighborhood of Chicago. Twelve female English language learners (L2E) age 20-50 were recruited from the same community. These speakers began their formal training in English after the age of 16 and were recruited from the highest proficiency level ESL classes at the local community center. Twelve female Anglo participants were recruited from the same community. They are monolingual speakers of the Inland North dialect of American English, and were born in the U.S. to parents of European descent. Seven female native Mexican Spanish speakers age 24-50 were recruited from community ESL classes for Spanish wordlist reading. The majority of Mexican immigrants in the Albany Park community originate from the Mexican state of Michoacán, and while variation exists in the usage and vocabulary of Mexican Spanish, dialectal differences are not generally manifested in the vowels (Hualde, 2005).

Most studies of MHE refer to this English variety as "Chicano English" (e.g. Metcalf, 1974; Mendoza-Denton, 1997; Fought, 2005). We do not use this appellative since none of our participants used the term to describe themselves, and when asked about the term generally regarded it as a political term used in the Southwest U.S.

2.2 Stimulus materials

The first three English-speaking groups read 179 individual English words from a monosyllabic pseudo-randomized wordlist presented using computer presentation software. The wordlist consisted of consonant-vowel-consonant (CVC) words containing 11 vowels of American English (i, ɪ, e, ɛ, æ, ɑ, ʌ, ɔ, o, ʊ, u) in a variety of phonetic contexts. Words containing diphthongs or vowels in prenasal and preliquid position were excluded from consideration, leaving 92 tokens for the analysis. These tokens, arranged by vowel, are provided in Appendix A. Because the wordlist was constructed to include a variety of lexical frequencies and phonetic environments for each vowel, the number of words per vowel varies, with a minimum of six tokens available for each.

Applying the methodology of Bradlow (1995), the Mexican Spanish speakers read a Spanish wordlist composed of disyllabic (CVCV) Spanish words with the consonant preceding and following the stressed (first) target vowel either voiced or voiceless. The five Spanish vowels (i, e, ɑ, o, u) were preceded by bilabial stops /b/ or /p/ and followed by coronal stops /d/ or /t/. Five repetitions of each word were pseudo-randomized for a total of 100 productions per speaker (see Appendix A).

2.3 Recordings

Each speaker was recorded reading from a computer monitor while wearing a Shure WH20 dynamic head-mounted microphone. Using a directional head-mounted microphone controls the distance of the microphone from the speaker and eliminates much of the background noise found under field conditions. Participants adapted readily to the unobtrusive headset. Recordings were made using a Marantz model PMD 670 digital recorder at a 22.05 kHz sampling rate.

2.4 Phonetic analysis

Phonetic alignment of the productions was automated using Triggerwave, a tool developed at Northwestern University which incorporates SONIC automated speech recognition software developed at The Center for Spoken Language Research, University of Colorado at Boulder. The measures of interest are the vowel duration and the first and second formant frequencies at the 20%, 50%, and 80% temporal points. Formant tracking was computed using LPC analysis over a 50 ms window with a 12.5 ms frame interval. Values were extracted using a Praat 4.6.25 script. First and second formant values are reported in Bark units with no normalization for vocal tract length since all speakers were adult females.

Reliability of the automated formant extraction was assessed using a subset of the tokens analyzed by four Northwestern University Linguistics Department graduate students experienced in phonetic analysis. Sixty CVC tokens from each

of three speakers were analyzed by hand for first and second formant values and compared to automated results. Agreement within 10% of the formant frequency between the raters and the automated procedure was above 94%. This accuracy level is deemed acceptable since outliers (>1.5 interquartile range) were hand-inspected after the automated procedure.

Outliers were inspected and eliminated when judged to be misreadings or non-responses. Non-standard pronunciations not consistent with other productions for the speaker (often found in words of low lexical frequency) were considered misreadings and excluded from analysis. Outliers for all subjects that were not judged misreadings were inspected for anomalies and measured by hand. These values were included in subsequent analyses.

2.5 Accent ratings

In order to determine whether details of their vowel production correlate with their perceived accentedness, MHE speakers were rated for accent by 31 speakers of American English. The raters were undergraduate students from the NU Linguistics Department subject pool familiar with Chicago speech. Subjects were asked to rate randomized recordings of 16 speakers (14 MHE speakers, one L2E speaker, and one Anglo speaker) on a Likert scale from 1-9; from "no foreign accent" to "very strong accent." Each subject rated 3 sets of identical sentences from all speakers. Accent scores are the average rating of all subjects for that speaker. Samples used in the task were 3 SPIN sentences (Kalikow, et al., 1977) recorded with the wordlists during the sessions, and selected from 106 sentences based on the presence of the majority of the vowels under study.

3 Phonetic results

This section provides phonetic results for the Anglo, Mexican Spanish, L2E, and MHE populations. Results indicate that the vowels of MHE are unlike those of L2E which are clearly influenced by Mexican Spanish. While MHE vowels are very similar to the Anglo vowels in a static plot, a Spanish influence is apparent when the dynamic features are considered.

3.1 Anglo vowels

Figure 1 is a vowel space plot summarizing the CVC productions of the 12 female Anglo participants. The figure shows the average F1 and F2 values taken at the medial point of the vowel duration for each vowel across the set of speakers. The ellipses surround the individual speakers' average value for each vowel (excluding outliers), the size thus indicating the amount of inter-speaker variation. Outliers are not represented in the figure for visual clarity, but are included in all analyses. In addition to vowel positions, the plot includes connecting lines indicating the two subsystems of "long" and "short" vowels (Strange et al., 2007).

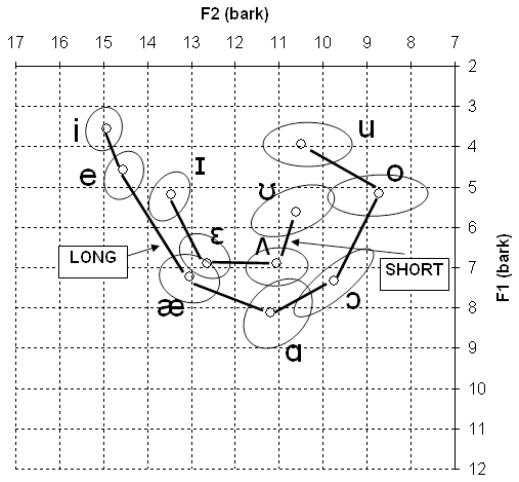

Figure 1: Anglo vowel plot. Small circles indicate average values, ellipses surround average values of individual speakers.

Given dialectal differences found in vowel durations (e.g. Clopper, 2004; Fox & Jacewicz, 2009), we investigated this feature for all our speaker groups. Since English monophthongal vowels comprise two subsystems based on duration while Spanish vowels exhibit no such distinction, duration is expected to be a component subject to the effects of language contact.

Vowel duration was measured in a variety of consonantal contexts, and measurements of vowel duration preceding oral stops are provided in Table 1. The data confirm the two durational subsystems; long vowels averaging .21 sec. and short vowels averaging .15 sec. The duration ratio (+voice/-voice durations) included in Table 1 shows the effect of the consonantal voicing on the length of the preceding vowel. This contextual conditioning is especially pronounced in English, with the proportion of lengthening ranging in our study from 30 - 85%.

Anglo	**Long vowels**							**Short vowels**			
Vowel dynamics	i	e	æ	ɑ	ɔ	o	u	ɪ	ɛ	ʌ	ʊ
+voice (sec)	0.253	0.268	0.277	0.255	0.277	0.269	0.195	0.183	0.166	0.178	0.183
-voice (sec)	0.157	0.157	0.180	0.173	0.200	0.149	0.117	0.109	0.123	0.137	0.099
dur avg (sec)	0.21	0.21	0.23	0.21	0.24	0.21	0.16	0.15	0.14	0.16	0.14
dur ratio	1.61	1.71	1.54	1.47	1.39	1.81	1.67	1.68	1.35	1.30	1.85
VISC (Bark)	0.90	1.45	1.80	0.81	1.05	1.83	1.68	0.87	1.04	1.21	0.93

Table 1: Anglo dynamic properties summary

Traditional research on vowel acoustics regards the vowel nucleus as that portion of the vowel relatively unaffected by the adjacent phonetic environment. This central portion of the vowel or "steady state" is often used to characterize vowels, implying that these formant values represent an invariant vowel target used in the production/perception process (Peterson & Lehiste, 1960). Excluding contextual effects, certain English vowels exhibit distinctive vowel inherent spectral change

(VISC) (Neary & Assman 1986). These vowels have characteristic on- and off-glides and spectral movement that aid in their identification (Watson & Harrington 1999).

VISC for the vowels of this study is defined as the vector length of the F1 and F2 movement in the central 60% (from .20 to .80) of the vowel duration. The vector length is not intended to be a precise mapping of the vowels' spectral change, but instead reflects formant movement independent of consonantal context. Figure 2 is a plot of the trajectory measurements for the Anglo speakers, with arrows indicating the average degree and direction of movement in the formant space. Vowels with minimal spectral change are denoted with circles.

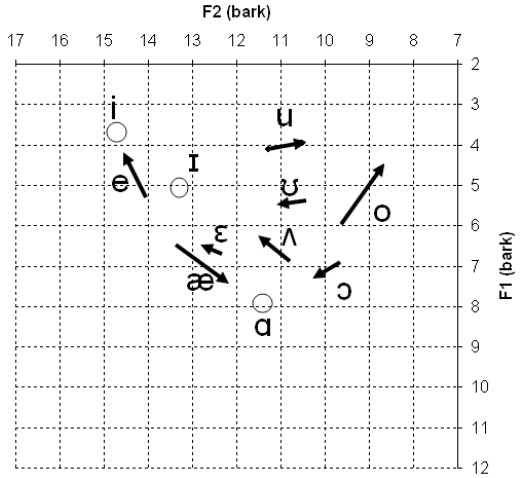

Figure 2: VISC for Anglo vowels (vowels preceding voiced consonants)

3.2 Mexican Spanish vowels

In this section we analyze the vowels of Mexican Spanish spoken in the Albany Park community. The Spanish system comprises a typologically common 5-vowel inventory (i, e, ɑ, o, u) and does not contain distinct sets of short and long vowels (Maddieson, 1984). In Spanish, limits on consonants in coda position severely restrict the number of single syllable words with the variety of consonantal environments that we find in English (Hualde, 2005). For this reason CVCV words were used for vowel elicitations (Appendix A). Vowels were measured as above, and formant analyses including trajectories for / u / and / o / are plotted in Figure 3.

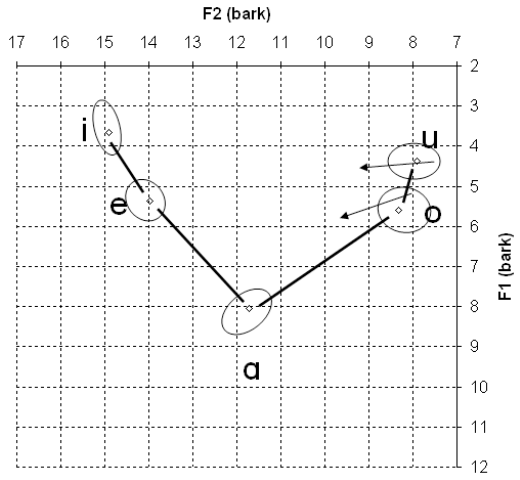

Figure 3: Spanish vowel plot with arrows indicating VISC

Table 2 provides vowel durations and duration ratios (+voice/-voice). Note the uniformity of the durations as well as the lengthening effect caused by consonantal context. The syllabic constraints of the Spanish CVCV words may have a mitigating effect on this phonological process, but in any event, a voiced consonant produces some lengthening of the preceding vowel, in this case by an average of 28% across all 5 vowels.

Mexican Spanish	**Vowels**				
Vowel dynamics	a	e	i	o	u
__+voice (sec)	0.169	0.158	0.146	0.163	0.151
__-voice (sec)	0.134	0.118	0.106	0.129	0.123
avg dur (sec)	0.152	0.138	0.126	0.146	0.137
dur ratio (+/- voice)	1.23	1.33	1.31	1.25	1.28
VISC (Bark)	0.69	0.67	0.55	1.84	1.69

Table 2: Dynamic features of Mexican Spanish vowels

Measurements of the trajectories illustrated in the vowel plot (Figure 3) are included in Table 2. Interestingly, VISC for the vowels is appreciably greater in the back vowels /o/ and /u/ than the others. Also, the trajectory direction is centralizing as opposed to the rising off-glide we see in Anglo English. This effect may be due to the elicitation materials, and requires further investigation to determine whether it is a distinct articulatory effect.

3.3 L2E vowels

The L2E vowel plot is presented in Figure 4. The extensive overlap of the ellipses indicates the degree to which L2E speakers as a group have not reconciled the differences between their native five-vowel Spanish system and that of American English (compare to the Anglo vowels in Figure 1). The results confirm our

expectation that Spanish-speaking learners of English make accommodations to the expanded inventory and display some category collapse.

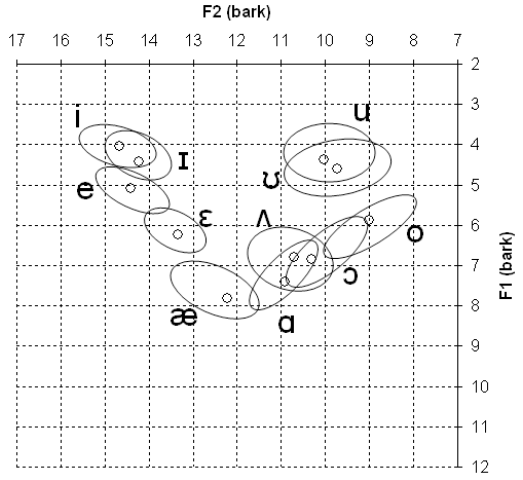

Figure 4: L2E vowel plot

Vowel durations for the L2E speakers are listed in Table 3. We find little evidence of English vowel duration subsystems, with the average long vowel at .20 sec. and the average short vowel .18 sec. This compared to Anglo .21 and .15 sec. respectively.

L2E	Long vowels							Short vowels			
Vowel dynamics	i	e	æ	ɑ	ɔ	o	u	ɪ	ɛ	ʌ	ʊ
+voice (sec)	0.219	0.279	0.234	0.206	0.213	0.244	0.192	0.188	0.206	0.203	0.195
-voice (sec)	0.178	0.238	0.178	0.169	0.154	0.194	0.163	0.147	0.145	0.183	0.155
dur avg (sec)	0.20	0.26	0.21	0.19	0.18	0.22	0.18	0.17	0.18	0.19	0.18
dur ratio	1.23	1.17	1.31	1.22	1.38	1.26	1.18	1.28	1.42	1.11	1.26
VISC (Bark)	1.33	2.33	1.15	1.03	1.33	1.35	2.10	1.21	1.20	1.31	1.09

Table 3: L2E dynamic properties summary

Values for L2E vowel VISC (Table 3) are consistent with the other English speakers in their relatively low values for VISC except for extraordinarily long UW and EY.

3.4 MHE vowels

The MHE vowels were analyzed as in the previous sections. In addition to the MHE vowels, the plot in Figure 5 includes points indicating the average values for the Anglo vowels to facilitate comparison. Ellipses surround averages for MHE vowels only. Contrary to the results for L2E speakers, MHE speakers have spectrally resolved their vowel productions resulting in very little overlap of adjacent vowels. Their vowel space is nearly identical to that of the Anglos with /i and ɪ/ slightly fronted for MHE ($p<.05$; 2-tailed t-test). The overlap we find between /æ/ and /ɛ/ is similar to that of the same Anglo vowels, and we find the

direction of VISC to be similar. The backing of /u / and /o/ relative to the Anglo vowels is not statistically significant. Over all, the static positions of MHE vowels differ little from Anglo English, and show no discernible influence from the Spanish vowels.

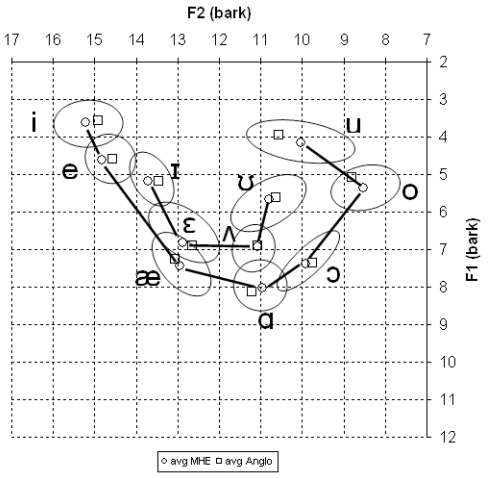

Figure 5: MHE vowel plot

Vowel durations for the MHE speakers are summarized in Table 4. Like Anglo speakers, these speakers possess vocalic subsystems based on duration. In addition, duration ratios of vowels preceding voiced stops to those preceding voiceless stops for all vowels are greater than 1 indicating lengthening before voiced oral stops.

MHE	Long vowels							Short vowels			
Vowel dynamics	i	e	æ	ɑ	ɔ	o	u	ɪ	ɛ	ʌ	ʊ
+voice (sec)	0.262	0.294	0.293	0.265	0.294	0.275	0.190	0.218	0.201	0.198	0.208
-voice (sec)	0.194	0.201	0.211	0.207	0.199	0.189	0.157	0.147	0.162	0.182	0.146
dur avg (sec)	0.23	0.25	0.25	0.24	0.25	0.23	0.17	0.18	0.18	0.19	0.18
dur ratio	1.35	1.46	1.39	1.28	1.48	1.46	1.21	1.48	1.24	1.09	1.42
VISC (Bark)	1.16	1.68	1.47	0.94	1.16	1.80	1.64	1.07	1.15	1.25	0.99

Table 4: MHE dynamic properties summary

Since the Spanish vowel durations are comparable to English short vowels (Spanish durations from .143 to .166 sec. preceding voiced consonants; Anglo short vowels range .166 to .183 sec.), a Spanish influence on MHE would be expected to cause shorter durations across the long vowel subsystem (as in L2E). Instead we find that it is not the duration per se, but the long/short duration ratio that reflects the influence of Spanish on the three English speaking populations (Figure 6). The Anglo population exhibits the greatest difference in the two subsystems, while MHE falls between L2E and Anglo for this property as might be expected from a Spanish influence.

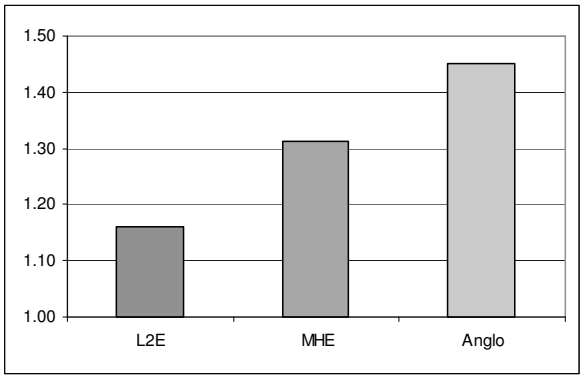

Figure 6: Long/short vowel duration ratio (+voice)

The VISC found in the MHE vowels (Table 4) is similar to that found in the Anglo population with the exception of /æ/. Although the static plot shows agreement between MHE and Anglo for this pivotal NCS vowel, the dynamic results show that the spectral movement is less than that of Anglo speakers ($p<.05$; 2-tailed t-test). Whether or not this is a Spanish influence, it indicates a difference from the regional norm.

Accent ratings obtained for the 14 MHE speakers are given in Appendix B. While any number of cues can affect perceived accentedness, the correlations of the vowel features that differed between MHE and Anglo populations indicate that it is the dynamic features of MHE vowel production that correlate with accent:

Static features:

- / ɪ / F2 r = -.01
- / i / F2 r = -.25 (less fronted, more accent!)

Dynamic features:

- +/- voice duration ratio r = -.31 (higher ratio, less accent)
- |æ| trajectories r = -.50 (more trajectory, less accent)
- Duration ratio (long/short) r = -.63 (higher ratio, less accent)

4. Discussion

Our L2E speakers can guide our expectations for Spanish influence on MHE since late learners' speech is generally more heavily accented. A conspicuous feature of the L2E vowel space is the apparent overlap of several English vowel pairs. For L2E speakers, the vowel pairs /i, ɪ/, /u, ʊ/ and /ɔ, ʌ/ show no significant differences between the vowels, indicating category collapse. In addition to the areas of vocalic merger, we see that the position of /æ/ for L2E speakers corresponds more closely to the Spanish /a/ than the /æ/ of American English. As might be expected for Spanish speakers whose language comprises a five vowel inventory, the

spectral locations of their English vowels have been heavily influenced by their experience with Spanish.

This is not the case for the MHE speakers. Their vowel categories are clearly differentiated, and are nearly identical to those of the Anglo vowel system in a static plot. This is of note since studies often rely on vowel plots as a means to efficiently differentiate dialectal groups. In the present case, MHE speakers are readily identified by naïve listeners as speaking a variant of the regional norm (as evidenced by accent ratings), yet exhibit little variation from the Anglo vowel structure in a static F1xF2 plot.

But vowels are not static entities. They unfold over time, and their dynamic properties act as important features in the characterization of English variants. In languages with larger vowel inventories we often find that vowels' inherent durations can be an important dimension of their language-appropriate production (Rosner & Pickering 1994). This is true for English where vowel length is not a phonologically distinctive contrast but is instead considered a secondary characteristic that nevertheless plays an important role in a native speaker's vowel production. Note that for MHE, vowel duration context effects and the relationships of durational subsystems are what distinguish it from the regional norm. Figure 8 breaks down the duration results and shows that Anglo English vowels differ from the Spanish influenced varieties when we consider the durational subsystem effects and phonetic context.

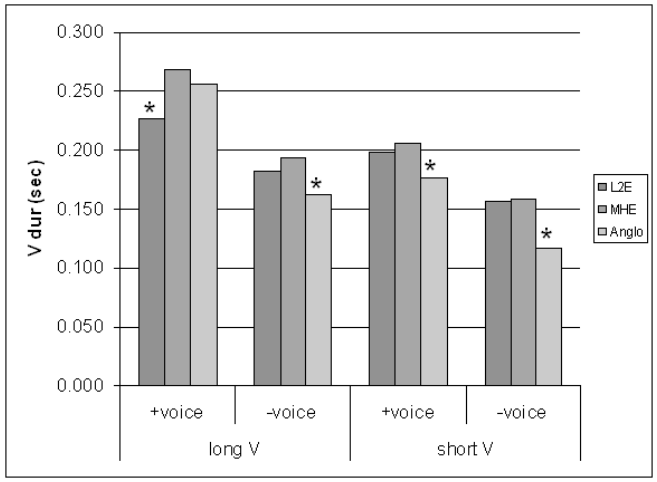

Figure 8: Vowel durations by subsystem and context
(asterisk indicates sig. diff. at $p<.05$; 2-tailed t-test)

Having determined that dynamic cues such as vowel durations and formant transitions are used and useful for vowel identification in a great variety of consonantal contexts (e.g. Joos, 1948; Hillenbrand, et al., 2001), sociophonetic studies are beginning to step beyond static vowel representations, and examine

more closely vowel dynamics independent of consonantal context. In the current study we find that /æ/ varies significantly in VISC between the Anglo and MHE populations. Given the lack of spectral change exhibited for this vowel by L2E speakers, we can infer that this may be due in some part to a Spanish influence, but the significance of this difference may lie in its status as an identity marker. The longer Anglo trajectory may be a social marker that is not used by these non-Anglo speakers. It is of note that /æ/ is a pivotal vowel in the NCS, believed to be one of the vowels initiating the shift, and for this reason may play a central role in defining an individual's regional identity.

Since MHE speakers by definition report English as their dominant language, foreign accent ratings are reasonably expected to be due to their community affiliations and experience with Spanish generally. Beyond their correlations with the dynamic features of vowel production, accent ratings act as an index of a speaker's social identity and community affiliations.

5. Conclusion

In his review of sociophonetic instruments, Thomas (2002) calls for cross-dialectal studies that use phonetic details beyond vowel shifting to yield insights into ethnic identity. The current study demonstrates how the details of vowel production tell us much about the effects of language contact that is not apparent from traditional vowel plots. In contrast to the vowels of L2E speakers, MHE displays a well-differentiated inventory of vowels whose formant centers are very similar to those of the Anglo speakers. However, consistent differences between the MHE and Anglo vocalic structure are found in vowel durations and formant trajectories. Vowel lengthening before voiced consonants varies significantly between the two groups, as do the duration ratios of long/short vowels. Measurements of vowel formant trajectories show that the vowel trajectory for /æ/ differs significantly between the groups, even though the duration does not. Overall, MHE shares the category structure of the Anglo variety while differing in secondary characteristics apparently preserved from Spanish.

The study corroborates recent research suggesting that /æ/ (an important vowel in characterizing the NCS) is a key component of MHE distinctiveness (Roeder, 2006), but it shows that it is a secondary characteristic of /æ/, its VISC, that differentiates it from the regional norm. Correlations with accent ratings show that vowel dynamics are the primary social-indexical markers, and not the subtle differences in the vowels of the static plot. The results contrast with the California MHE (Chicano) patterns in Godinez & Maddieson (1985), in that vowel duration is found to be a defining feature of the Chicago MHE variety. Additionally, the study provides a methodological basis for systematically evaluating evidence for a supraregional MHE.

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Appendix A Wordlists

English vowels analyzed

Vowel	# Tokens	Token from English CVC wordlist
i	11	be, keep, beast, she, these, each, deep, feed, street, heed, deed
ɪ	12	it, big, give, dish, lid, kiss, hid, wish, this, sick, dig, rip
e	10	space, make, paid, tape, jade, bait, late, fade, age, they
ɛ	8	death, fetch, head, sled, leg, less, text, wet
æ	9	cab, have, bad, glad, tax, gap, had, math, fact
a	7	hot, pod, lot, mob, job, dock, nod
ʌ	8	rust, thud, such, luck, love, smug, much, shrug
ɔ	6	walk, dog, thawed, gawk, cough, log
o	7	boat, poke, both, code, hope, most, toad
ʊ	6	should, hook, good, cook, book, hood
u	8	loop, who'd, loose, you, prude, hued, choose, tube

Spanish vowels analyzed

Vowel	# Tokens	Token from Spanish CVCV wordlist
a	4 x 5reps = 20	bata, pata, bada, pada
e	4 x 5reps = 20	beta, peta, beda, peda
i	4 x 5reps = 20	bita, pita, bida, pida
o	4 x 5reps = 20	bota, pota, boda, poda
u	4 x 5reps = 20	buta, puta, buda, puda

Appendix B Results of accent rating task

Ratings from 1-9; from "no foreign accent" to "very strong accent."

MHE participant	Average Likert score
mhe004	1.34
mhe032	2.02
mhe005	2.16
mhe036	2.37
mhe009	3.26
mhe013	3.86
mhe040	4.30
mhe012	4.40
mhe033	4.58
mhe011	5.16
mhe035	4.74
mhe010	5.91
mhe006	5.62
mhe007	6.67