# L2 PRODUCTION OF AMERICAN ENGLISH VOWELS IN FUNCTION WORDS BY SPANISH L1 SPEAKERS

**Scott J. Perry** [*1] and **Benjamin V. Tucker** [†1]

[1]Department of Linguistics, University of Alberta

## 1 Introduction

Studies investigating the pronunciation of second language (L2) speakers have focused on the production of individual segments in stable environments (e.g., vowels in the stressed syllables of lexical words). As such, there is a need for further investigation into the L2 pronunciation of segments which are more variable and subject to phonetic and phonological processes. The present study addresses this gap by investigating the production of vowels in function words in American English (hereafter English) by native (L1) speakers of Spanish.

Vowels contained in English function words are often reduced [1] (they move toward the center of the F1 × F2 space), while those in Spanish are less so [2]. Thus, the task faced by the Spanish speaker learning English is not only to acquire a new vowel inventory, but also to learn the process of reducing and/or centralizing these vowels in function words contrary to the orthographic input they receive.

## 2 Method

The data from this study was obtained from the Speech Accent Archive [3]. The methodology concerning the recording process is available online on the corpus website.

### 2.1 Participants

Participants in this study included L1 speakers of American English (n=30) and L1 Spanish speakers who are L2 speakers of English (n=62). All L2 speakers had resided in the United States for a minimum of 1 month. Dialect was not controlled for as the location of residence was not reported for L2 speakers. The L2 learners were split into two groups based on when they started learning English to examine the effect of age of onset of acquisition (AOA). The Early AOA group (n=30) was comprised of those who started learning before the age of 13 and the Late AOA group (n=32), contained participants who started learning English after the age of 13.

### 2.2 Analysis

The recordings were imported into Praat [4] where the vowels were segmented by hand using the spectrogram and waveform to determine vowel onset and offset. The formant values were then extracted from the vowel midpoint using the Burg algorithm. The maximum number of formants was always set to 5 and the formant ceiling was set to the value at which the formant tracker best aligned with visible formants,

between 4800-5100Hz for men and 5400-5800Hz for women. The formants were then normalized using the "Nearey Intrinsic" normalization method in PhonTools [5].

In order to measure the degree of neutralization of the vowels in function words and lexical items, pairwise comparisons were done between vowels within each group by use of MANOVA, which output a Pillai score that can be used as a measure of vowel overlap [6]. A Pillai score of 0 signifies that the two vowels are indistinguishable and a Pillai score of 1 indicates that the two vowels are completely distinct, showing no overlap.

## 3 Results

### 3.1 Vowel Spaces

The vowel plots for the three experimental groups are in Figure 1 below. Vowels produced in lexical items are on the left, vowels from function words are on the right. The English native speakers are on top, Low AOA L2 learners in the middle, and High AOA L2 learners on the bottom.
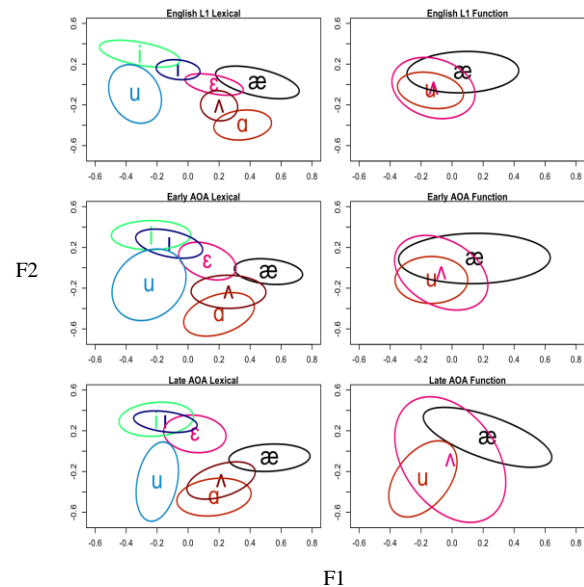


**Figure 1:** Vowel plots with normalized formant values for different word types and experimental groups. Mean values are plotted along with ellipses of 2 standard deviations.

### 3.2 Pillai Scores

The MANOVAs run for each pair of vowels present in both lexical and function words each output a Pillai score, used here as a measure of vowel overlap. The Pillai scores of the vowels produced in function words are listed by group in

[*] sperry1@ualberta.ca
[†] bvtucker@ualberta.ca

Table 1. The same vowels produced in lexical items appear in Table 2.

**Table 1:** Pillai scores: comparisons of vowels in function words.

| Vowel Pair | Eng L1 | Early AOA | Late AOA |
|---|---|---|---|
| ʌ - æ | 0.716 | 0.624 | 0.796 |
| ʌ - u | 0.045 | 0.220 | 0.483 |
| æ - u | 0.694 | 0.661 | 0.823 |

**Table 2:** Pillai scores: comparisons of vowels in lexical words.

| Vowel Pair | Eng L1 | Early AOA | Late AOA |
|---|---|---|---|
| ʌ - æ | 0.857 | 0.782 | 0.743 |
| ʌ - u | 0.933 | 0.834 | 0.850 |
| æ - u | 0.940 | 0.921 | 0.926 |

The Pillai scores confirm the general trends that can be seen in the vowel plots. We see that for L1 English speakers, /ʌ/ and /u/ produced in function words were practically indistinguishable, while /ʌ/ and /æ/ along with /æ/ and /u/ show less overlap. These same vowels do not overlap to the same extent when produced in lexical items by L1 English speakers.

The Early AOA group patterned closely with the L1 English group, with /ʌ/ and /u/ showing a great deal of overlap, though less than the L1 group. The other function word vowel pairs show less overlap, like the L1 group. All pairs of vowels show less overlap in lexical items.

The Late AOA group produced more centralized vowels in function words than they did in lexical items, but not to the extent that the L1 English or Early AOA L2 learners did. For the Late AOA group, /ʌ/ and /u/ also show the most overlap, like the other two groups. The other vowel pairs show only small differences across lexical items and function words.

## 4 Discussion

The goal of this study was to examine the L2 production of vowels in English function words by Spanish L1 speakers. Spanish vowels in unstressed syllables are only slightly centralized [2], and therefore Spanish speakers learning English must learn a centralization pattern of vowel reduction in their L2. This could be considered a difficult task considering these vowels show ample variability [7].

The L1 Spanish speakers who began learning English at a younger age patterned closely with the native English speakers. However, they showed more variability with their production of vowels in function words which led to less overlap between /ʌ/ and /u/ than the L1 English speakers and more overlap between those two vowels and /æ/, again mostly likely due to increased variation in their productions.

There are two possible explanations for why the High AOA L2 speakers were able to centralize vowels in function words. The first option is that this change in vowel quality is the same change that occurs in Spanish, and they are directly transferring the pattern from their L1 to their L2. The second option is that the learners have learned to reduce vowels in function words more than they do in their L1.

The first option cannot be evaluated properly, as there is a dearth of acoustic studies that have investigated Spanish vowel quality across stressed and unstressed syllables. The few studies that have been done have shown evidence of centralization, but not to the same degree that occurs in English or that was produced by the High AOA group.

The second option, that L1 Spanish speakers have learned a new pattern of reduction in their L2, is also possible. It would be possible for increased centralization to occur without Spanish L1 speakers accurately perceiving spectral differences. Based solely on the concept of undershoot [8], the L1 Spanish speakers would only have to perceive that the durational difference between stressed and unstressed syllables in English is larger than it is for Spanish, and produce relatively shorter syllables in unstressed positions. An advantage has been shown for learning durational differences in L2 Speech [9], making this the most plausible explanation for increased overlap by the late L2 learners.

## 5 Conclusion

The results of this study align with the large body of literature that reports an advantage for early L2 learners. It also suggests that spectral properties are also affected by the interaction between temporal and articulatory constraints in L2 speech production.

## Acknowledgments

## References

[1] D. Juraksky, A. Bell, E. Fosler-Lussier, C. Girand, & W. Raymond. Reduction of English function words in Switchboard. *5th International Conference on Spoken Language Processing*, 1998.

[2] M. Nadeu. Stress-and speech rate-induced vowel quality and variation in Catalan and Spanish. *Journal of Phonetics,* 46:1, 2014.

[3] S. H. Weinberger, S. A. Kunath. The Speech Accent Archive: towards a typology of English accents. *Corpus-based Studies in Language Use, Language Learning, and Language Documentation*, 265, 2011.

[4] P. Boersma, D. Weenink. Praat: Doing phonetics by computer (Version 6.0.14), 2016.

[5] S. Barreda. phonTools: Functions for phonetics in R. R package version 0.2-2.1. 2015.

[6] J. Hay, P. Warren, K. Drager. Factors influencing speech perception in the context of a merger-on-progress. *Journal of Phonetics*, 34(4):458, 2006.

[7] L. Colantoni, J. Steele. Native-like attainment in the L2 acquisition of Spanish stop-liquid clusters. *Selected proceedings of the 7th Conference on the Acquisition of Spanish and Portuguese as First and Second Languages*, 59-73, 2006

[8] B. Lindblom. Spectrographic study of vowel reduction. *The journal of the Acoustical society of America,* 35(11):1773, 1963.

[9] J. Steele, M. Patience. Relative Difficulty in the L2 Acquisition of the Phonetics of French Coda Obstruent Voicing. Talk presented at *International Symposium of Bilingualism*; 2019; Edmonton, Alberta, Canada.