ARTICULATION OF L2 FRENCH MID AND HIGH VOWELS

Madeleine Oakley

Georgetown University
mo643@georgetown.edu

ABSTRACT

This study uses Ultrasound Tongue Imaging and acoustic data to investigate the articulatory strategies used by L1 English L2 French learners to produce round vowels. It has been suggested that learners have more difficulty producing L2 phones that are 'similar' to L1 phones than L2 phones that are completely 'new' because learners use L1 categories to produce L2 phones [6], [10]. However, this claim is based solely on acoustic data. To this end, the present study records learners' articulatory strategies using Ultrasound during the production of French round vowels /y, u, ø, o/ compared English /u, o/. Results show that learners do not, in fact, use L1 articulatory strategies to produce L2 phones. Additionally, articulatory data show that learners still have difficulty producing target-like tongue positions for new phones, despite having target-like acoustic productions, which may suggest that non-native vowels have an acoustic rather than an articulatory target.

Keywords: Articulatory Phonetics, Speech Production, L2 Phonology

1. INTRODUCTION

This study uses Ultrasound Tongue Imaging and acoustic data to explore how L1 English L2 French learners produce phones that are phonetically and phonologically 'new' compared to phones that are phonetically 'new' but phonologically 'similar' to L1 phones. It is well documented, from both production and perception data, that L1 English learners of French have difficulty acquiring the difference between French front round and back round vowels [6], [4], [11]. Production data has largely been acoustic, and shows that L1 English learners have more difficulty producing target-like French /u/ than target-like /y/ [6]. These results have been argued to support Equivalence Classification, which predicts that learners classify L2 phones by L1 categories, and will therefore produce an L2 phone as if it were an L1 phone if the two are perceived as 'similar'. Because English /u/ has a higher F2 value than French /u/, learners may have difficulty producing target-like French /u/. However, production errors may be caused by several articulatory mechanisms: both tongue fronting and lip unrounding will raise F2 values and cause English learners to produce non-target like French /u/. This study uses articulatory and acoustic data from 6 L1 English L2 French learners and 1 L1 French speaker to show that tongue position is responsible for production errors. Articulatory data also reveals that learners are not using L1 articulatory strategies to produce L2 phones. Additionally, while new phones /y/ and /ø/ have target-like acoustic values, articulation remains non-target like, suggesting learners are trying to reach an acoustic rather than articulatory target for vowels.

1.1. Background

Models of L2 category formation have traditionally emphasized the role of the L1 phonological system in shaping perception and production of L2 phones [7], [2]. The Speech Learning Model (SLM) makes explicit predictions about how an L2 phone will be produced based on a learner's L1 system. SLM states that L1 and L2 phonological systems exist in the same phonetic space, and therefore production of an L2 phone will depend on how this phone compares to phones in the learner's L1 [7]. If an L2 phone is perceived as similar to an L1 category, SLM predicts that the L2 phone will be produced as if it were an L1 phone. If an L2 phone is perceived as completely different from an L1 category, then a new category is formed for the L2 phone. Under this assumption, the production of L2 phones will be based on how speakers produce L1 phones. This has been supported with acoustic data, showing that L1 English L2 French learners are more accurate producing the new French phone /y/ than the similar French phones /u/ and /t/, presumably because the speakers were producing /u/ and /t/ as if they were L1 phones [6]. Similarly, it has been found that L1 Japanese L2 French speakers were more accurate at producing French /y/ and /ø/ than /u/, which is phonologically similar but phonetically different from Japanese /u/ [10].

Importantly, the claims for SLM have been sup-

ported with acoustic data, and the articulatory strategies used in L2 production of new and similar phones is not yet clear. Learners appear to be acoustically more accurate producing new L2 categories than similar L2 phones, but it is not apparent that new phones are articulatorily target-like, or that learners are using L1 articulations to produce L2 phones. The present study will compare learner articulations of L2 phones to native-speaker productions in order to see how new and similar phones are articulated. Additionally, learners productions of L2 phones will be compared to L1 phone production to explore whether learners are using L1 articulatory strategies to produce L2 phones.

2. METHODOLOGY

6 L2 French speakers (EN02-EN07), who are currently enrolled in Intermediate 2 or Advanced Intermediate French courses and are native English speakers, completed a production task. One L1 French speaker (FR01) also completed the production task. All speakers are female between the ages of 18-27.

Each participant read a word list in French and in English. The present study analyses 5 tokens of each target vowel /i, y, u, e, ø, o/ in French, and /i, u, e, o/ in English, totaling in 30 French tokens and 20 English tokens per speaker. Each vowel was balanced for consonantal context across the two languages as much as possible.

Participants were prompted to read the word presented on a computer monitor using AAA [1]. Participants wore a stabilizing headset attached to a video camera to capture lip protrusion, and an ultrasound probe positioned below the speaker's jaw to record midsagittal tongue positions. Articulatory data were recorded in AAA [1]. Acoustic recordings were made using an AKG C544L headset microphone and a Marantz PMD661 recorder.

Acoustic data were analyzed in Praat, and F1 and F2 were calculated at the mid-point of each vowel [3]. It has been found that the contrast between the French front round and back round vowels is largely distinguished along the F2 dimension, so F2 values are compared for the present study [8]. Formant measurements were normalized using the Lobanov method.

Following [9], protrusion was measured by the horizontal distance between the corners of the mouth and the vertical distance between the upper and lower lips at the maximum point of constriction. Distances were measured in Inkscape and converted from pixels to millimeters. Finally, still frames of tongue contours were taken at the maximum point of constriction, and for each vowel, 100 points were extracted along the contour in Edgetrak [12]. Tongue contours were compared using SSANOVA. Smoothing Spline curves were generated for the tongue contours of each vowel for each speaker in order to compare within speaker tongue position. The smoothing splines represent the averages for 5 vowel tokens of each vowel, and distance is measured in pixels from coordinates in EdgeTrak [12]. Bayesian 95% confidence intervals are represented by dotted lines in the curves, and any point where the dotted lines do not overlap represent points where tongue positions are significantly different. For more on SSANOVA, see [5].

3. RESULTS

3.1. Acoustic results

Acoustic results partially confirm earlier findings that new phones tend to be target-like, while similar phones tend to be non-target like. A t-test was run to compare each learner's normalized F2 values of /y/, /ø/, /u/, and /o/ to the native speaker's. Results show that 5 out of 6 learners did not produce a significant difference in /y/ compared to the native speaker (the exception was EN06, p=.0495), and 5 out of 6 learners did not produce /ø/ differently from the native speaker (exception was EN04, p=.015). For the similar phones /u/ and /o/, results differ depending on vowel height. 4 out of 6 learners produced a difference in the F2 value for /u/ from the native speaker, while no speakers produced a difference in the F2 value of /o/ from the native speaker. The results of the t-test for the back vowels are presented in Table 1.

Table 1: Normalized back vowel F2 values: comparing learners to FR01 (n=5)

	/u/ Mean (p-value)	/o/ Mean (p-value)
FR01	-1.55	-1.33
EN02	-.795 (**.056***)	-1.183 (.4)
EN03	-.31 (**.014***)	-.907 (.069)
EN04	-.93 (.263)	-1.374 (.757)
EN05	-.67 (**.017***)	-1.154 (.659)
EN06	-.662 (**.0008***)	-.749 (.06)
EN07	-1.07 (.078)	-1.25 (.592)

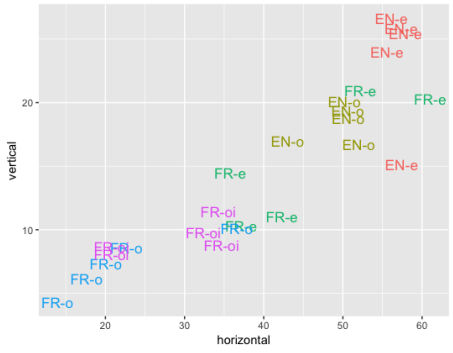
3.2. Articulatory results

Articulatory results indicate that tongue position is responsible for the non-target like production of

French /u/ vowels. Four one-way ANOVA tests were performed for each speaker to see if degree of lip opening is different for each vowel within each speaker; one ANOVA looked at the interaction between high vowels and horizontal distance of lip opening, one ANOVA looked at the interaction between high vowels and vertical distance of lip opening, one ANVOA looked at the interaction between mid vowels and horizontal distance, and one ANOVA looked at the interaction of mid vowels and vertical distance. All English and French mid vowels were included in two ANOVAs together, and all English and French vowels were included in the other two ANOVAS. The results of the ANOVAs for the high vowels show a significant difference in degree of opening for the vowel categories for all the learners and the native speaker ($p<.001$). The ANOVAs for the mid vowels also show a significant difference in degree of opening for the vowel categories for every speaker ($p<.001$). A post-hoc Tukey HSD test was run for each speaker to see which vowels had significantly different degrees of lip rounding. For the high vowels, the post-hoc test reveals that the native speaker (FR01) and all the learners round French /y/ and /u/ similarly. All speakers rounded /y/ and /u/ significantly more than /i/. Additionally, learners round French /u/ to the same degree as English /u/.

A post-hoc Tukey HSD for mid vowels shows that the native speaker rounds /ø/ and /o/ similarly, while /e/ is less round. For 4 out of 6 learners (EN03, EN04, EN05, EN06), French /o/ is more round than /ø/. These results can be seen for EN04 in Figure 1 (note that the symbol 'oi' stands for the IPA character /ø/). Turning to cross-language results, the Tukey

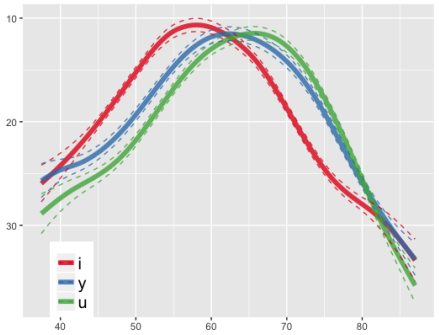
Figure 1: EN04 mid vowel degree of lip rounding opening (mm)



HSD test reveals that 3 out of 6 learners (EN02, EN03, EN04) are rounding the French round vowels /ø/ and /o/ more than the English mid round vowel /o/.

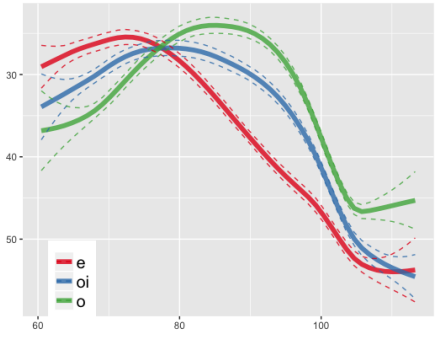
SSANOVA results show that for the high vowels, there are two patterns for the learners' tongue positions. The first group includes EN04 and EN07, who produced acoustically target-like French /y/ and /u/. These learners produce /y/ with a similar tongue position to /i/, as does the native speaker. /u/ does not overlap with /y/ or /u/ for these learners. The second group includes EN02, EN03, EN05, and EN06, who did not produce French /u/ acoustically target-like. SSANOVAs for this group reveal that French /u/ tends to have a fronted tongue position closer to /y/ (see Figure 2 for example). Additionally, /y/ does not overlap with /i/, showing that even though these learners produce target-like acoustic values for /y/, this new phone is still not articulatorily target-like.

Figure 2: EN05 French high vowel tongue contours (mm)



For the mid vowels, results from the SSANOVA also reveal that the new phone /ø/ is not produced with an articulatorily accurate position by 4 out of 6 learners. EN03, EN05, EN06, and EN07 tend produce /ø/ further back than /e/ (see Figure 3 for example).

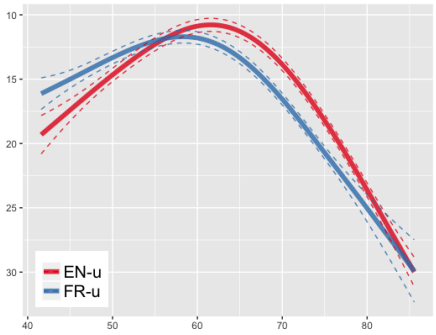
Figure 3: EN05 French mid vowel tongue contours (mm)



The cross-language results comparing learners' productions of the French round vowels to the English round vowels show that most learners do not

use L1 tongue positions to produce L2 phones. 2 out of 6 learners have overlap along the curve for French /u/ and English /u/ (EN03 and EN07). 3 out of 6 learners have overlapped tongue positions for French /o/ and English /o/ (EN02, EN05, and EN06). See Figure 4 for example of non-overlapped high vowels.

Figure 4: EN02 French and English /u/ tongue contours (mm)



4. DISCUSSION

This study investigates whether new phones are easier to acquire than similar phones by examining both acoustic and articulatory data. Previous research using acoustic measures has shown that new phones tend to be more target-like than similar phones [6], [10]. The acoustic results of the present study support these findings in that L1 English L2 French speakers are more target-like in productions of /y/ and /ø/ than French /u/. However, L1 English speakers are accurate producing French /o/. This may be because English /o/ is acoustically more similar to French /o/ in some dialects of American English, whereas English /u/ tends to have a higher F2 value than French /u/.

However, articulatory data suggests that many learners remain non-target like in their production of new phones. For the high front round vowel /y/, 4 out of 6 learners did not have a comparable amount of overlap with the front vowel /i/ to the native speaker. This shows that learners are not using the same articulatory strategies as native speakers in production of new phones. For the mid front round vowel /ø/ learners tend to have a non-target like lip rounding position and tongue position. 4 out of 6 learners did not round the new phone /ø/ as much as French /o/, and for tongue position, 4 out of 6 learners produced /ø/ further back than /e/. 5 out of 6 learners produced /ø/ with a target-like acoustic value, and the non-target like nature of these vowels is only revealed when considering the articulatory data. This result may suggest that learners are trying to reach an acoustic rather than articulatory target in their L2 vowel productions.

The second goal of this study was to determine if learners use L1 phoneme categories to produce L2 phones. It has been suggested that learners have difficulty producing L2 phones that are phonologically similar but phonetically different from L1 phones [6], [10]. Equivalence classification predicts that learners will use L1 categories to produce L2 phones that are similar, which can lead to production errors [7]. However, at least half of the learners in the present study do not use L1 articulatory strategies to produce L2 phones. For the high vowels, learners tend to produce French /u/ with a different tongue position than English /u/. For the mid vowels, both lip rounding and tongue position are different for French and English /o/. These results suggest that some learners do not reuse L1 articulatory categories in L2 production.

Other factors not considered in this study may have contributed to the non-target like production of the new phones, including age of acquisition and exposure to other languages, amongst other individual differences. Further study is recommended to investigate how these factors may have impacted learner productions. Additionally, the inclusion of more than one native speaker's data may bring to light variation in native speaker productions.

5. CONCLUSION

This study investigates the articulatory strategies used by L2 French learners to produce mid and high vowels in order to see how phonetically and phonologically new L2 phones are produced compared to phonetically new but phonologically similar L2 phones. Acoustic results show that learners are target-like in productions of the new L2 phones /y/ and /ø/, and are non-target like in productions of the phonetically new but phonologically similar L2 phone /u/. Despite the acoustic accuracy, learners tend to be non-target like in articulatory production of new French phones, which may provide evidence that vowels have an acoustic target for learners. The second goal of this study was to see if learners use L1 articulatory strategies to produce L2 phones. Half of the learners included in the present study did not use the same articulatory strategies to produce French and English /u/ and /o/. These results have implications for L2 category formation, and bring into question whether L1 and L2 phonetic systems exist in the same phonological space.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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