[ɹ], [w] or [ʁ]: Investigating French advanced learners' productions of English /r/

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Given its phonetic complexity, the English post-alveolar approximant [ɹ] is notoriously difficult to acquire in both native and non-native speakers. We present an exploratory acoustic analysis of /r/ produced by 165 French learners from a corpus designed to assess which accents English undergraduates typically use.

The French uvular fricative [ʁ] is phonetically dissimilar to [ɹ], which theoretically makes the two sounds easily distinguishable. Some studies have observed that [ɹ] is phonetically closer to [w] than [ʁ], resulting in the assimilation of English /r/ to /w/ in French learners. We therefore expect to find few [ʁ] productions for English /r/ with more cases of [w].

We aimed to use a combination of F2 and F3 to classify /r/ and /w/ productions. [ɹ] typically exhibits low F3 values, while [w] has a lower F2 and higher F3. [ʁ] presents F3 raising in the transition into the following vowel.

Acoustic data from five /r/-initial and four /w/-initial words in sentences produced by 165 learners and 2 native speakers of English were examined. The sentences were automatically segmented at the phoneme level. F2 and F3 values for /r/ and /w/ were extracted at 11 equally spaced points with formant parameters adjusted for sex.

Following Hagiwara (1995), to normalise interspeaker differences for [ɹ], a threshold was set to 80% below each speaker's average F3 value calculated from 29 "neutral" vowels. A combination of F3, F2 and F3 minus F2 were used to classify the productions as [ɹ], [w], [ʁ], or unidentified. The most conservative classification was developed which allowed all tokens produced by native speakers to be correctly classified, and which ensured that no /w/ tokens were erroneously classified as [ɹ] in learners. After classifying [ɹ], the remaining tokens were classified as [w], [ʁ] or unclassified using the same approach.

The results showed that 54.48% of the /r/ tokens were [ɹ], 15.48% were [w], 3.35% were [ʁ] and the remaining 27.10% were unclassified. For /w/, 86.06% of the tokens were [w], 1.76% were [ɹ] and 12.16% were unclassified. Nearly 70% of the speakers predominantly produced [ɹ] for /r/, 18% preferred [w], 27% had mostly unclassified pronunciations, and just 2% tended to produce [ʁ].

The findings support our prediction that very few learners replace the English rhotic with its French counterpart. They also confirm that some learners produce [w] for /r/, while the majority seem to have acquired a native-like pronunciation. While the unclassified pronunciations could be caused by formant extraction errors, they may actually represent productions that fall between the [ɹ] and [w] categories. We intend to further analyse unclassified tokens using a machine learning approach by training the model to learn the acoustic difference between [ɹ] and [w] to classify the remaining tokens. Articulatory data could also provide insights as we expect intermediary tokens to stem from [ɹ] productions with heavy lip rounding.
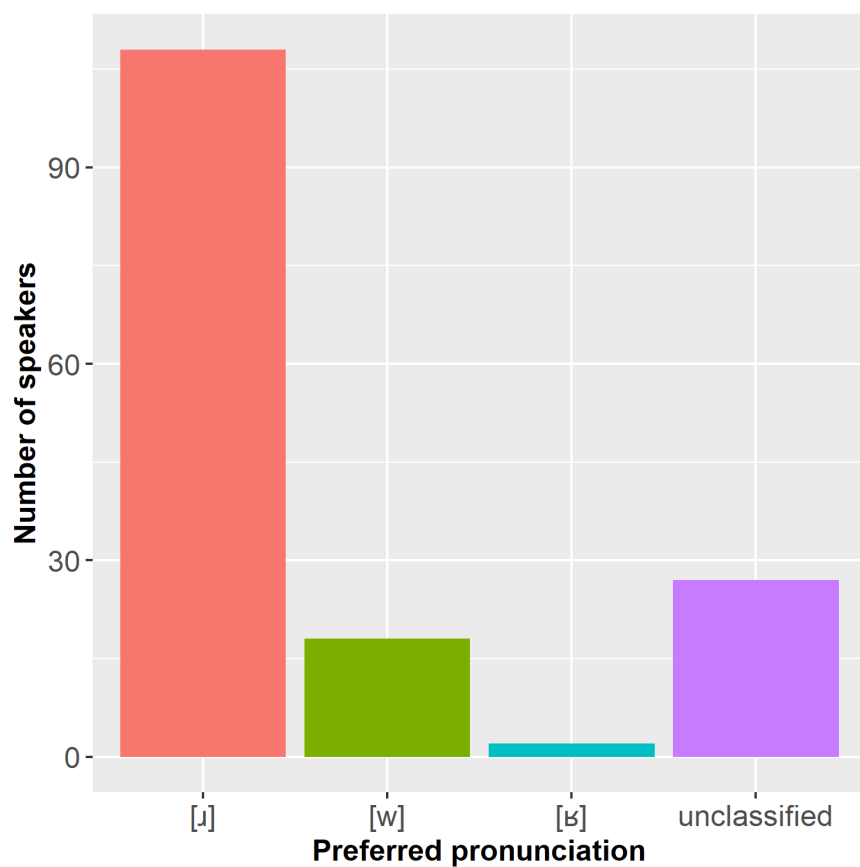
Figure 1: Preferred pronunciations of English pre-vocalic /r/ in French advanced learners

Reference:

Hagiwara, R. E. (1995). Acoustic realization of American /r/ as produced by women and men (Doctoral dissertation, University of California, Los Angeles). *UCLA Working Papers in Phonetics*, 90.