ICA 2013 Montreal
Montreal, Canada
2 - 7 June 2013

Speech Communication
Session 5aSCb: Production and Perception II: The Speech Segment (Poster Session)

5aSCb6. Perception of Canadian French rhotic vowels
Jeffrey Lamontagne and Jeff Mielke*

*Corresponding author’s address: English, North Carolina State University, Raleigh, North Carolina 27695, jimielke@ncsu.edu

Some speakers of Canadian French produce words such as pneu, un, and coeur with rhotic-sounding vowels similar to English /r/ (Dumas 1972). Articulatory imaging (Mielke 2011) shows that they are produced with bunched and retroflex tongue postures and low F3, much like English /r/. Nevertheless, native speakers typically are completely unaware of the difference, even when it is pointed out to them. We report a preliminary perception study of rhotic vowels. 7735 words with mid front round vowels were coded as "rhotic", "non-rhotic", or "ambiguous" by two listeners: a French-English bilingual from eastern Ontario and an American English speaker. The bilingual coded 0.3% as rhotic (vs. 10.0% for the anglophone) and 7.3% as ambiguous (vs. 8.9%). Logistic regressions show that the anglophone relied on F3 to distinguish rhotic+ambiguous tokens from non-rhotic tokens, while the bilingual weighted several cues about equally, including F1 cues to diphthongization, which can co-occur with rhoticity. Results will be presented from an ongoing AX discrimination task experiment involving rhotic, non-rhotic, and ambiguous vowel tokens, with francophone, bilingual, and anglophone listeners from the Ottawa-Gatineau region, Paris, France, and Raleigh, North Carolina.

Published by the Acoustical Society of America through the American Institute of Physics
INTRODUCTION

This is an acoustic and perceptual investigation of Canadian French rhotic vowels. The term rhotic vowel refers to a production of mid front rounded vowels /ø/, /œ/, and /˜œ/ with a rhotic perceptual quality, much like English [ɻ], leading the words heureux, docteur, and commun to sound like [ɥɥ], [dɔktMil], and [kɔmɪ]. Previous reports of retroflex-sounding variants of Canadian French vowels date back to the early 1970s in Montreal (Dumas 1972, 100, Sankoff, p.c.), and a retroflex-sounding variant of /u/ has also been observed (Sankoff and Blondeau, 2007).

When asked, native speakers typically are completely unaware of the difference between rhotic and non-rhotic pronunciations, suggesting that rhoticity is a change from below. While phonetically-motivated change from below is a fundamental concept in contemporary approaches to phonology and variation, empirical data is sparse (Cedergren, 1973; Trudgill, 1974; Labov, 1994), partly because changes usually go unnoticed until long after their inception. Perceptual data on changes from below is sparse in general, and typically involves chain shifts and neutralization (Labov, 1994, 2011), but rhoticization of mid-front rounded vowels is non-neutralizing and not a chain shift. Thus, it presents an important opportunity to investigate the perception of a change from below in progress.

We are in the process of running a perception experiment involving rhotic and non-rhotic vowel tokens, with francophone, bilingual, and anglophone listeners from the Ottawa-Gatineau region, as well as francophones in Paris, France and anglophones in Raleigh, North Carolina. This report summarizes what is known about the acoustic and articulatory properties of rhotic vowels and presents preliminary data on their perception by two listeners: a French-English bilingual and an English monolingual.

PHONETIC DESCRIPTION OF RHOTIC VOWELS

Acoustically, American English /u/ is characterized by low F1, low F2, and especially low F3 (Delattre and Freeman, 1968; Alwan et al., 1997; Boyce and Espy-Wilson, 1997; Westbury et al., 1998). Rhotic vowels are produced with lower F3 than their non-rhotic counterparts, as seen in the representative spectrograms in Figure 1, where arrows identify F3 during the target vowel. The rhotic speaker’s vowels (on the left) show a lowering of F3 and very little difference between F3 and F2, whereas the non-rhotic speaker’s vowels show comparatively even spacing between the formants. The spectrogram for rhotic beurre shows a typical situation for /œ/, which in French occurs almost exclusively before /u/: the uvular /u/ is still present following the rhotic vowel, which is diphthongized, meaning a phonetic transcription of this word as spoken by a rhotic speaker would be [b2u] (with two consecutive rhotic sounds at different places of articulation). Further evidence that the rhoticity of the vowel is not due to the following uvular fricative is that the F3 minimum is typically achieved prior to the end of the vowel, and F3 rises again going into the uvular fricative.

Recent corpus work (Mielke, accepted) indicates that rhotic vowels first appeared in Gatineau, Quebec among speakers born after 1965. The corpus study involved the transcription and measurement of recordings from two corpora housed in the Sociolinguistics Laboratory at the University of Ottawa: Corpus du français parlé à Ottawa-Hull (Poplack, 1989), recordings of adults from Ottawa and the area of Quebec that is now called Gatineau, recorded in 1982; and Corpus du français de l’Outaouais au nouveau millénaire (Poplack and Bourdages, 2010), recordings of high school students and teachers from the last decade. This study revealed that F2 of /ø/ has fallen steadily since the early 20th century, preceding the fall of F3 that starts with speakers born after 1965. This is seen in the LOESS curves shown in Figure 2, based on formant means for 75 speakers.
Articulatory imaging (Mielke, 2011, accepted) revealed that bunched tongue shapes are used to produce all moderately rhotic vowels and most extremely rhotic vowels. Figure 3 shows examples of tongue shapes for two extremely rhotic speakers. One young speaker who produced extremely rhotic vowels produced them with retroflex tongue shapes, suggesting that the use of retroflexion emerged only after the change progressed to the point where the perceptual target was extreme enough to motivate a learner to use a non-vowel-like tongue posture.

This pilot study investigates the role of language background in the perception of rhotic and non-rhotic productions of Gatineau French mid front rounded vowels. We are concerned not with listeners’ ability to discriminate between retroflex and bunched variants, but with listeners’ ability to distinguish rhotic vowels from their non-rhotic counterparts.
Words with mid front vowels ($n = 7735$) were extracted from the two University of Ottawa Sociolinguistics Laboratory corpora used for the corpus study (Corpus du français parlé à Ottawa-Hull, Poplack 1989; and Corpus du français de l’Outaouais au nouveau millénaire Poplack and Bourdages 2010). These words were impressionistically coded as “rhotic”, “non-rhotic”, or “ambiguous” by a French-English bilingual from Orleans, Ontario who uses rhotic vowels in his own speech and anglophone from the United States. The coding was performed as a Multiple Forced Choice perception experiment implemented in Praat (Boersma and Weenink, 2007).
RESULTS

The anglophone coded 10.0% of tokens as rhotic and 8.9% as ambiguous, and the bilingual coded only 0.3% as rhotic and 7.3% as ambiguous. Table 1 shows the distribution of tokens as coded by the two listeners (excluding English loanwords). A large number of tokens (313) were coded as rhotic only by the anglophone listener, and only three were coded as rhotic only by the bilingual listener.

<table>
<thead>
<tr>
<th></th>
<th>non-rhotic</th>
<th>ambiguous</th>
<th>rhotic</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>anglophone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4176</td>
<td>172</td>
<td>3</td>
<td>39</td>
</tr>
<tr>
<td>bilingual</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>465</td>
<td>68</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>313</td>
<td>149</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 1:** Coding of /øœœ/ tokens by two listeners

As with English /ʌ/, the most salient cue for rhoticity is expected to be low F3. Logistic regressions were performed with each listener’s coding (combined rhotic+ambiguous vs. non-rhotic) as the dependent variables and F1, F2, and F3 measurements taken at 20%, 50%, and 80% points during the vowel as independent variables. /œœ/ was separated from the other vowels because it is typically diphthongized, especially when rhotic. Figures 4 and 5 show the coefficients for each of the nine cues for the two listeners for the vowels in question. The magnitude of the coefficients indicates their importance, and the sign indicates whether higher or lower values were associated with rhoticity. Thus, a coefficient close to −1 indicates that the listener associated rhoticity with low values of the formant in question.

![Figure 4: Logistic regression coefficients for acoustic cues to the rhoticity of /øœœ/, bilingual and anglophone listeners. Symbols indicate formant and time, e.g., F3.5 = F3 at the vowel midpoint.](image-url)
FIGURE 5: Logistic regression coefficients for acoustic cues to the rhoticity of /ɔ/, bilingual and anglophone listeners

The regressions found that the anglophone relied most on low F3 at 50% for /ɔ̃ɔ̃/ (as in pneu and commun), and low F3 at 80% for /ɔ/ (as in docteur), which is often diphthongized such that the rhotic portion is near the end of the vowel interval. The bilingual listener relied about equally on several cues, including low F1 at 20% for /ɔ̃ɔ̃/ and low F2 at 20% and 50%, high F2 at 80%, and high F1 at 20% more heavily than F3 at 80%.

DISCUSSION

The two listeners differ in the number of tokens they categorize as rhotic, and in the acoustic cues used to make the categorization. Both listeners are native speakers of English, which has /ɔ/ as a phoneme, and both listeners are familiar with the phenomenon of rhotic vowels in Canadian French. The results of this pilot experiment suggest that a larger perception study of naive francophone and anglophone Canadian listeners will find differences in how these vowels are perceived, and that Canadian French vowel rhoticity is a change from below still at a stage where speakers are unaware of the change in progress.

ACKNOWLEDGMENTS

This project was funded by SSHRC grant #410-2010-0552, “Data Mining Sound Patterns”. The corpus data was made available by the University of Ottawa Sociolinguistics Laboratory, directed by Shana Poplack. Kimberley Miller and Natalie Dion provided help working with the corpora, Peter Milne developed the aligner (Milne, 2011) used to transcribe French recordings, and Brendan Henry and Laura Kastronic contributed to the transcription process.
REFERENCES


