AN ARTICULATORY STUDY OF RHOTIC VOWELS IN CANADIAN FRENCH

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1. INTRODUCTION

Some speakers of Canadian French produce the vowels /ø/, /œ/, and /œ̃/ with an r-like quality, leading *pneu*, *docteur*, and *brun* to sound like [pnɻ], [dɔktʌɹʁ], and [bʁɻ]. These rhotic vowels are perceptually similar to English /ɹ/, which can be produced with a variety of tongue shapes, including bunched and retroflex variants shown in Figure 1 (Delattre and Freeman, 1968, etc.).

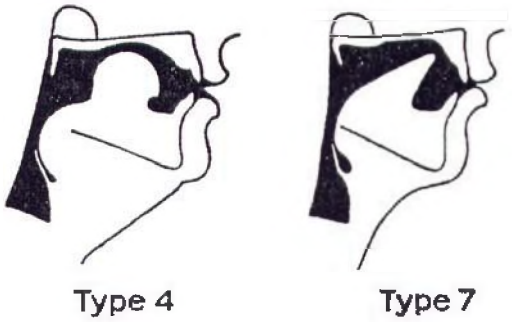

Figure 1. Two tongue shapes for English /ɹ/: type 4 bunched (left) and type 7 retroflex (right). Images adapted from Delattre and Freeman (1968).

Variability in English /ɹ/ raises the question of whether French rhotic vowels are also produced with more than one categorically different tongue posture. To investigate this, ultrasound was used to image the tongues of three Canadian French speakers during production of these vowels.

2. METHODS

Subjects produced words containing /ø/, /œʁ/, and /œ̃/ in a carrier phrase, as well as a comparable number of filler words. Each word was produced twice in the frame "Je dis X" and once in the frame "Je dis X encore." Mid-sagittal ultrasound video was recorded using a Terason T3000 portable ultrasound machine. The Palatron system (Mielke et al., 2005) was used to collect data for head movement correction, but no correction was necessary for the qualitative analysis on tongue shapes in this paper. Video of the subject's head in profile and ultrasound video were collected using Ultraspeech (Hueber et al., 2008) on the T3000, and audio was recorded using a condenser microphone, a USB preamplifier, and Audacity on a separate computer. The word list was randomized and presented on a monitor and the subjects advanced through the prompts at their own pace with a remote control. The subjects were three native speakers of Canadian French, aged 22-24, two female and one male. The female subjects (S1 and S2) were raised in Gatineau, QC, and report moderate English proficiency. The male subject (S3) was raised in Ottawa, ON and is fluent in English.

Target tokens were analyzed in three ways: (1) they were categorized impressionistically according to whether the target vowels sound rhotic to an English speaker, (2) F3 was measured for each target segment, and (3) the peak of each vowel gesture was visually categorized according to whether it matched an English /ɹ/ tongue shape such as those on Figure 1, or it looked more like a tongue shape expected for a front vowel.

3. RESULTS

Acoustic analysis of vowels categorized as rhotic- and non-rhotic-sounding reveals that sounding rhotic is associated with low F3, which is an important acoustic cue for English /ɹ/. Inspection of ultrasound images reveals that S1 and S2 produced rhotic vowels with a tip-down bunched tongue shape closely resembling Delattre and Freeman's type 4, and S3 produced rhotic vowels predominantly with a retroflex tongue shape, with the exception of *heureux* ([ɻʁɻ]), which he produced with two bunched rhotic vowels.

Table 1 shows the results of categorizing tokens by auditory impression. All tokens produced by S3 were categorized as sounding rhotic. S1 and S2 were variable for /ø/ and /œ̃#/ (e.g., *pneu* and *brun*), S2 was consistently rhotic for /œʁ#/ (e.g., *coeur*), and S1 was variable.

Table 1. Auditory impression of vowel tokens.

	S1	S2	S3
/ø/	variable	variable	rhotic
/œʁ#/	variable	rhotic	rhotic
/œ̃#/	variable	variable	rhotic

Figure 2 shows a representative spectrogram of S2's *majeure*, categorized auditorily and articulatorily as rhotic. Note the low F3 (~2000Hz) during the interval labeled as [ɹ], and that the expected uvular rhotic consonant [ʁ] is still present following the rhotic vowel.

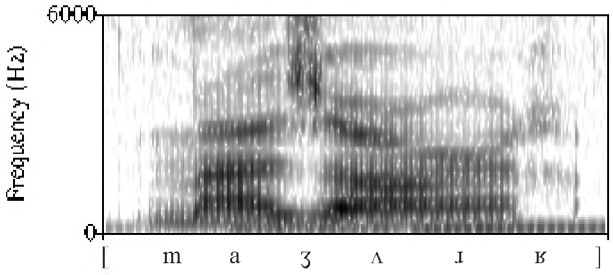

Figure 2. Representative spectrogram : *majeure* (S2)

Figure 3 shows representative ultrasound images. The top two images show bunched tongue shapes produced by S2 and S1, the bottom left image shows a retroflex tongue shape produced by S3, and the bottom right image shows a non-rhotic tongue shape produced by S2.

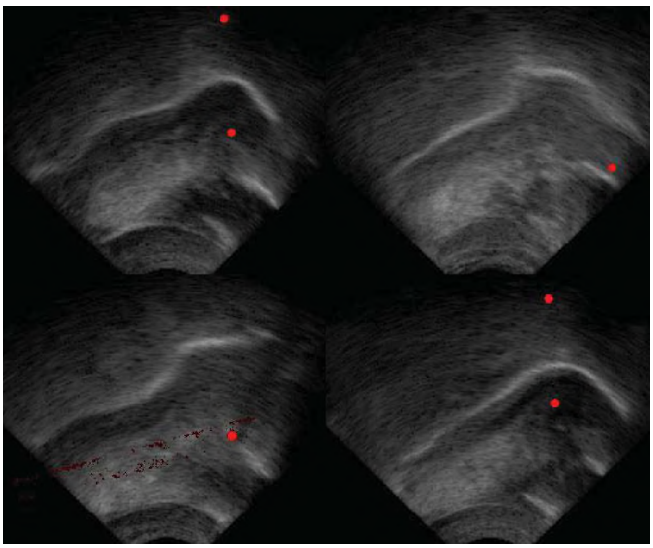

Figure 3. Representative tongue images: (clockwise from top left) bunched in *cœur* (S2); bunched in *pneu* (S1); non-rhotic *pneu* (S2); retroflex in *pneu* (S3).

Figure 4 shows F3 values for tokens produced by the two variable subjects (S1 and S2). The plot on the left shows tokens impressionistically coded as rhotic and non-rhotic. The plot on the right shows F3 for the same vowels, grouped by whether the tongue shapes appear [ɹ]-like. In both cases, vowels categorized as rhotic are lower in F3, which is consistent with F3 being an important cue for /ɹ/.

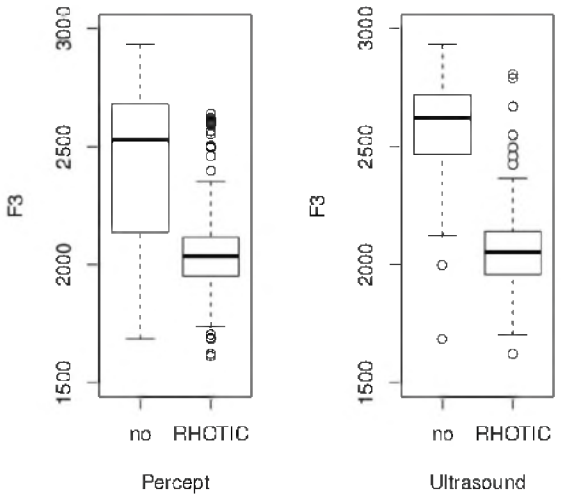

Figure 4. F3 for vowels categorized as rhotic or non-rhotic auditorily (left) and by tongue shape (right)

4. DISCUSSION AND CONCLUSIONS

The rhotic variants of Canadian French /ø/, /œ/, and /œ̃/ share phonetic properties with English /ɹ/. Like English /ɹ/, the vowels categorized as rhotic-sounding have low F3 compared to non-rhotic vowels. Further, the rhotic variants are produced with bunched and retroflex tongue postures closely resembling those observed in studies of English /ɹ/. Three speakers exhibit two categorically different tongue postures, much like English /ɹ/, with one exhibiting variation between bunched and retroflex. While the similarities with the English sound are striking, and while Canadian French is obviously in contact with English, it is not clear that the rhotic variant is borrowed from English

Previous descriptions of Montreal speech have associated variants of /ø/ and /ʁ/ described as retroflex with men and with English contact (Dumas, 1972; Sankoff and Blondeau, 2007). However, the present study has found rhotic vowels in the core French vocabulary of females with only moderate English proficiency. Rhotic vowels are also found in a wider range of segmental contexts than had previously been reported. While previous descriptions have used the term "retroflex" to describe related sounds, articulatory imaging indicates that a bunched tongue shape is used as well, and may be the most frequent tongue posture for the rhotic variants of these vowels. Some descriptions of retroflex /ʁ/ may reflect rhotic vowels in the presence of a uvular [ʁ], as seen above in Figure 2.

It remains to be seen how bilinguals' French rhotic vowels compare to their English /ɹ/. Allophonic variation between bunched and rhotic variants is common among English speakers (Mielke et al., 2010), and if the variation is articulatorily motivated, similar allophonic patterns are expected in both languages. These parallel cases of articulatory variability raise opportunities for investigating articulatory-acoustic mapping in bilinguals.

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