Articulation of tense and lax vowels in Canadian French: Findings from ultrasound imaging
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A recurring assumption in phonological literature dealing with the classification of vowels is that, in languages with a tense/lax contrast, tense vowels are articulated with an advanced tongue root [+ATR], while lax vowels are produced with the tongue root either in a neutral or retracted position [-ATR] (although these gestures may co-occur with others, such as tongue body height). This assumption is motivated by analyses of certain Western African languages, such as Kinande (see e.g. Archangeli & Pulleyblank, 2002) which have two classes of vowels – produced with advanced and retracted tongue root – that engage in vowel harmony patterns. By analogy, this assumption has been carried over to other languages such as English (in which tense vowels are produced with an advanced tongue root in addition to a higher tongue body compared with lax vowels) and French.

French has three high vowel phonemes, /i y u/. Canadian French (CF) differs from its European counterpart in that it also has three lax high vowels, [ɪ ʏ ʊ], which exist as allophonic variants of the tense vowels. The distribution of tense and lax high vowel allophones in CF is regulated by several phonological processes (Walker, 1984), including closed-syllable laxing (in which tense vowels are realized as lax in word-final closed syllables) and vowel harmony (in which tense vowels in open syllables are laxed when followed by a laxed high vowel in a final, closed syllable; e.g. Philippe [fɪlɪp]). In his analysis of CF vowel harmony, Poliquin (2006) assumes that the advanced/non-advanced distinction is the articulatory correlate of the tense/lax contrast among vowels in CF. This articulatory assumption is unmotivated, due simply to a lack of experimental data.

The purpose of this experiment is to test the hypothesis that tense vowels in CF are produced with advanced tongue root, using ultrasound imaging to collect empirical data. The use of ultrasound imaging to study articulation is a relatively recent innovation, but has so far yielded promising results (e.g. Davidson, 2005a; Gick et al., 2005). Unlike methodologies used in the past to investigate articulation, such as x-ray imaging, ultrasound is non-invasive and relatively easy to employ. Also, unlike palatography or electropalatography, ultrasound can be used to track movements of the tongue during active production of vowels, during which the tongue does not make contact with the palate.

In this paper I report on data from three native speakers of CF recruited from the Ottawa region. Participants produced words containing tense and lax high vowels, yielding 30 tokens of each vowel from each participant. Ultrasound and video were recorded using Ultraspeech (Hueber et al., 2008) and digitally combined (see Fig. 1). The Palatron algorithm (Mielke et al., 2005) was used to correct for head movement. The resulting tongue images were traced and analyzed statistically using a smoothing spline ANOVA (Davidson, 2005b). The resulting data yielded the following results: (a) no significant tongue root advancement in tense high vowels, (b) no tongue root retraction in lax high vowels, (c) significant lowering of tongue body in lax high vowels, and (d) a
centralized articulation of lax high vowels, compared to a more peripheral tongue body position in tense vowels (see Fig. 1 for a representation comparison of tense [i] in *abri* and lax [i] in *vif*). These results bear important theoretical and methodological implications. Languages may implement a tense/lax contrast without movement of the tongue root, instead relying solely on the position of the tongue body. This is the case in CF. Consequently, vowel harmony in CF cannot be analyzed as an instance of ATR harmony analogous to harmony patterns seen in languages such as Kinande. The results of this experiment also provide further validation of the use of ultrasound imaging as a tool for investigating speech production. Articulatory data collected using ultrasound can be used to test assumptions which have thus far not been motivated due to a lack of empirical evidence.

References


Figure 1: Representative comparison of tense [i] (left) and lax [i] (right)