INDIVIDUAL VARIATIONS AND GRADIENCE IN ENGLISH PALATALIZATION

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1 Introduction

English palatalization is of two types : lexical palatalization being morphologically governed, in which it applies only in derived environments, before /j/-initial suffixes [1], and post-lexical palatalization resulted as a purely phonetic and coarticulatory process. It is also known that palatalization is optional at the post-lexical level [2]. Depending on individual speakers and speech rate, speakers of English may palatalize target consonants in post-lexical contexts to various degrees, or may not palatalize them at all. For this reason, post-lexical palatalization in English is also known to be gradient coarticulation, while lexical palatalization is a categorical phenomenon [2, 3].

The articulatory properties of lexical and post-lexical palatalization have been reported in numerous previous experimental studies [2, 4–6]. Previous EPG-based findings [2, 4] showed that palatalized /s/s from lexical palatalization in American English, e.g., *pressure*, exhibited categorical patterns, whereas palatalized /s/s from post-lexical palatalization, e.g., *press your*, yield gestural variations across speakers. Given that the findings were based on a small sample, it calls for further investigation whether this holds for other palatalized coronal consonants and other speakers of American English. This study investigates the articulatory aspect of palatalization using ultrasound imaging to verify the previously reported findings in relation to the phonological source of palatalization, i.e., lexical or post-lexical palatalization.

2 Method

2.1 Participants

Twelve native speakers of American English (6 females) from the University of Arizona participated in the production experiment. Age ranges from 20 to 23 with the exception of Speaker 12, who was 40 years old at the time of data collection.

2.2 Stimuli

Forty four English words and phrases were used in the experiment : 32 test items and 12 fillers. Table 1 shows the subset of items used in the experiment.

Table 1: Examples of the stimuli

segment	type	item
/t/	lexical	'spiritual'
	post-lexical	'last year'
/d/	lexical	'procedure'
	post-lexical	'would you'

2.3 Procedure

All the experiment sessions were conducted at the University of Arizona, using a SonoSite TITAN portable ultrasound unit and a C-11/7-4 11-mm broadband curved array transducer. The machine generates 30 frames per second, equivalent to approximately 15-20 ultrasound tongue images for a disyllabic word. The ultrasound images were concurrently recorded with audio, and the visual and audio data were synchronized. During the experiment session, with the ultrasound transducer held in position, speakers were allowed to move their heads freely without any head stabilization device. After the data was collected, raw tongue contours were adjusted based on the palate contour obtained at the beginning of each experiment session.

2.4 Analysis

Image frames corresponding to the palate contours and the test items were identified and extracted based on the corresponding acoustic signals using UltraPraat [7]. Once the image frames of interest were identified, the tongue curves shown in the frames were manually labelled. The data points were statistically analyzed using Smoothing Spline ANOVA (henceforth SSANOVA) [8]. As shown in Figure 1, the sets of tongue contours were considered to be significantly different when the confidence intervals do not overlap.

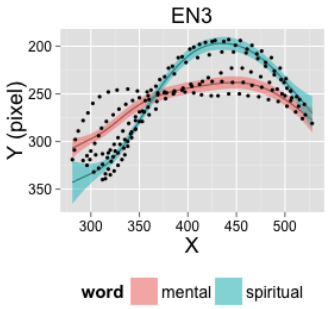

Figure 1: SSANOVA plot of *mental* (plain /t/) and *spiritual* (palatalized /t/) from Speaker 3 (EN3) : Tongue tip is to the right, and shades represent 95% confidence interval. Dots represent the data points.

3 Results

3.1 Plain vs. palatalized

The results are summarized in Table 2. The articulatory gestures from this study show that speakers do articulate the contrast between plain and palatalized coronal obstruents. While the majority of speakers made significantly distinct tongue curves for two conditions, however, no two speakers shared the same exact gestural pattern. For instance, as in Figure 2, Speaker 10 (EN10, female, age 22) only makes the articulatory distinction in the front region of the tongue, whereas Speaker 11 (EN11, male, age 20) makes the articulatory distinction in both tongue tip and back regions. The gestural patterns reported here provide articulatory evidence for inter-speaker variability in palatalization.

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Table 2: A summary of the results : numbers represent how many among 12 speakers showed significantly different tongue gestures.

segment	comparison	results
/t/	plain vs. palatalized	11/12
	lexical vs. post-lexical	9/12
/d/	plain vs. palatalized	12/12
	lexical vs. post-lexical	10/12
/s/	plain vs. palatalized	9/12
	lexical vs. post-lexical	8/12
/z/	plain vs. palatalized	10/12
	lexical vs. post-lexical	6/12

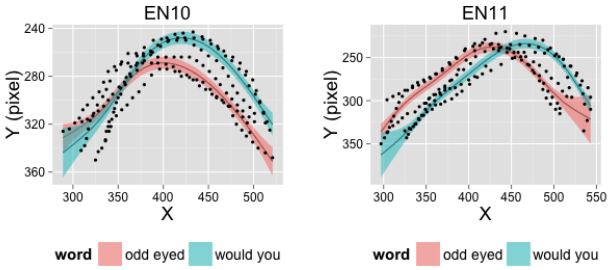

Figure 2: SSANOVA plots of /d/ from *odd eyed* (plain /d/) and *would you* (palatalized /d/) : Speaker 10 (EN10) and Speaker 11 (EN11)

3.2 Lexical vs. post-lexical palatalization

Compared to plain vs. palatalized consonants, the articulatory contrast between lexical and post-lexical palatalization was not always robust (see the results in Table 2). However, the gestural patterns for two different types of palatalization also showed a clear sign of inter-speaker variability, as shown in Figure 3. Speaker 8 (EN8, male, age 20) made a higher tongue dorsum in the post-lexical condition, whereas Speaker 9 (EN9, male, age 21) did so in the lexical condition.

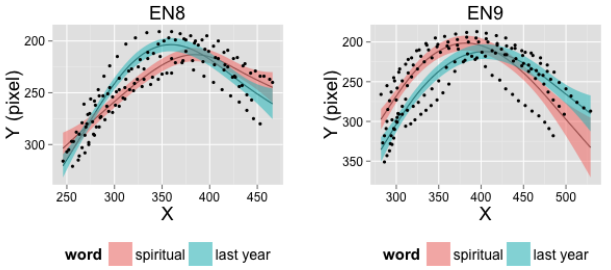

Figure 3: SSANOVA plots of /t/ from *spiritual* (lexical) and *last year* (post-lexical) : Speaker 8 (EN8) and Speaker 9 (EN9)

The articulatory data from 12 speakers confirms that the distinction between plain and palatalized coronal consonants manifests as different tongue gestures, and the way speakers distinguish them is not uniform across speakers. Furthermore, speakers may or may not differentiate palatalized consonants arising from two palatalization processes, also resulting in a substantial amount of individual variations.

4 Discussion

This study shows that speakers of English are aware of various palatalization-inducing contexts, and do articulate contrast among palatalized consonants from different phonological sources. The gestural patterns in this study offer further insight into lexical and post-lexical palatalization in English, in that both types of palatalization exhibit gradient behavior to some extent.

The individual variations in English palatalization suggest that speakers may not have a systematic means of producing palatalization or differing palatalized consonants from lexical and post-lexical processes. Another implication from the idiosyncratic patterns in this study is that speakers may internalize "individualized" palatalization grammar and articulate it. Given that similar individual variations have also been found in other languages [9] and among L2 speakers of English [10], the gestural variations for palatalization merit further cross-linguistic examination.

5 Conclusions

The gestural patterns from this study provide articulatory evidence for different types of palatalization in English and offer new insight into individual variations and gradience. The findings here also add weight to the growing literature on speaker-specific variability in speech production, and call for further cross-linguistic investigation of palatalization.

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