The effects of clear speaking style and lexical competitors on acoustic detail in native and non-native speech

Ye-Jee Jung[1,2], and Olga Dmitrieva[3]

[1]Hunter College, City University of New York (USA), [2]The Graduate Center, City University of New York (USA), [3]Purdue University (USA)

Both the clear speaking style and the presence of a lexical competitor for a certain phonological feature are known to impact acoustics of speech, as studied primarily in native speakers of English. Clear speech is characterized by hyperarticulation of acoustic properties signaling phonological distinctions. For example, tense vowels were lengthened more than lax ones in clear speech, making the phonological contrast more acoustically pronounced in [6]. Likewise, such hyper-articulation is also found in the presence of lexical competitors: in competitor pairs (e.g., *sheep-ship*) lax vowels were more centralized, while tense ones were peripheralized, resulting in an enhanced spectral distance between the two categories [7].

Enhancement of clear speech is believed to be listener-oriented and aimed at increasing speech intelligibility [1]. While the mechanism behind the competitor-based enhancement is debated, one possible explanation is, likewise, listener-oriented hyperarticulation [2]. In our study, we investigate whether explicitly elicited clear speech interacts with implicitly induced local hyperarticulation due to the minimal competitors, such that the results are additive. Moreover, we tested a group of native and non-native speakers of English in order to explore the role of lexical knowledge and the resulting implicit knowledge of potential difficulties listeners may experience with minimal lexical competitors.

Twenty native speakers of Midwestern American English (mean age = 25.0) and thirty advanced speakers of English with L1 Korean background (mean age = 29.4) residing in the United States as undergraduate or graduate students at the time of participation took part in the study. Participants read a list of 16 common English words in casual and clear speaking style: eight of the words were minimal pairs in terms of the vowel tenseness contrast (*heat* vs. *hit*, *sheep* vs. *ship*, *seat* vs. *sit*, *beat* vs. *bit*), four were tense-vowel words without lax competitors (*speak*, *need*, *feed*, *beef*), and four were lax-vowel words without tense competitors (*pig*, *big*, *give*, *tip*). Clear speech was elicited by instructing the participants to read each word as if they were talking to elderly or hearing-impaired interlocutors [4]. First and second formant frequencies and vowel duration were analyzed.

The results of the linear mixed-effect analysis showed that the F1 and durational differences between tense /i/ and lax /ɪ/ were enhanced in clear speech (Figure 1), while the F2 contrast was, in contrast, reduced in clear speech. Further, a significant three-way interaction between Speaking Style, Vowel Type, and Speaker Group indicated that this F2 contrast reduction was more pronounced in native clear speech. The effect of lexical competitor was found only in native speech and only for F1, with the F1 contrast enhanced for words with competitors (Figure 2). There were no interactions between Speaking Style and Lexical Competitor for any of the examined acoustic properties.

These findings suggest (1) that vowel height (F1) and duration, but not backness (F2), were targeted when English vowel tenseness distinction was to be enhanced for clarity, possibly because increasing F2 differences may require further centralization of lax vowels and vowel centralization/reduction is typically counteracted in hyperarticulated speech. (2) While we observed the effect of competitor on enhancement of the F1 differences, it was not further increased in clear speech, arguing against the prediction that the hyperarticulation effects would be additive, possibly because a certain hyperarticulation limit was reached. (3) Finally, non-native speakers enhanced the tenseness in clear speech, similarly to native speakers, indicating their ability to manipulate the relevant acoustic properties with the goal of increasing intelligibility of speech. However, hyperarticulation of vowels in words with competitors was not found in non-native speech, suggesting that a deeper knowledge of the lexicon is necessary in order to anticipate listeners' hypothetical difficulties and accommodate them with local acoustic modifications aimed at increasing speech clarity.

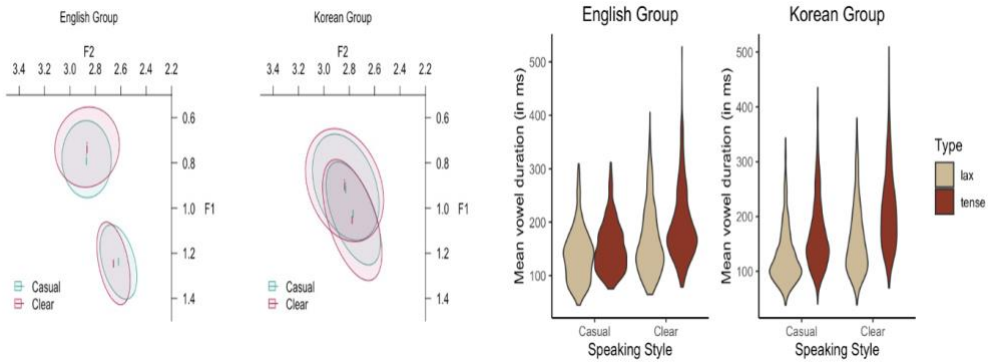

Fig. 1. Tense and lax spectral contrasts (left panel) and durational contrast (right panel) by the effect of speaking style for each speaker group

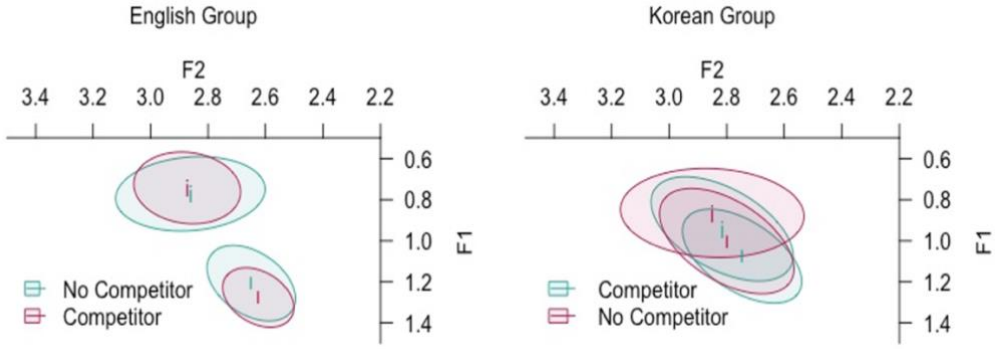

Fig. 2. Tense and lax spectral contrasts (left panel) and durational contrast (right panel) by the effect of lexical competitor for each speaker group

Table 1. Vowel duration and normalized F1 and F2 values for each level of the factors.

			Duration (in ms)	**Normalized F1**	**Normalized F2**
Speaking style	Casual	[i]	161.39	0.86	2.84
		[ɪ]	131.63	1.11	2.71
	Clear	[i]	205.37	0.83	2.85
		[ɪ]	159.69	1.13	2.73
Lexical competitor	Present	[i]	155.63	0.86	2.84
		[ɪ]	119.08	1.16	2.70
	Absent	[i]	211.14	0.83	2.85
		[ɪ]	172.20	1.08	2.74

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