

The Three-way Contrast of Conversational Korean Stops

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ABSTRACT

The Journal of Studies in Language 34.4, 649-660. Conversational speech has received considerable attention in recent years, but many instrumental studies have focused on heavily resourced languages and the phonetic reduction in conversation. In order to diversify and expand on conversational speech research, this study examines the unique system of stop contrast in Korean and the acoustic cues in spontaneous phone conversations. The study investigates some key acoustic properties of intervocalic Korean stops in casual speech, adding to the growing body of research on conversational speech. Korean stops from careful reading and casual conversation show greater acoustic variability in conversation, as previously noted. Despite the phonetic variability in acoustic signals, conversational Korean stops contrast with one another in three acoustic dimensions: intensity difference, VOT, and closure duration, allowing some cues to enhance the stop contrast in conversation. The findings point to manner-specific adjustments in spontaneous Korean stops and suggest that variability in conversational speech yields both phonetic reduction and enhancement. (Yonsei University · Korea University of Technology and Education)

Keywords: speech styles, conversation, spontaneous speech, read speech, Korean stops



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본인이 투고한 논문은 다른 학술지에 게재된 적이 없으며 타인의 논문을 표절하지 않았음을 서약합니다. 추후 중복게재 혹은 표절된 것으로 밝혀질 시에는 논문게재 취소와 일정 기간 논문 제출의 제한 조치를 받게 됨을 인지하고 있습니다.

1. Introduction

Speech sounds in casual conversation differ dramatically from those found in citation forms, owing to various phonetic reduction processes, differing prosodic constraints, and so forth. For example, a common English word *yesterday* /jɛstə-deɪ/ is phonetically realized as [jɛʃɛ] in casual conversation by a young American adult (Warner and Tucker, 2010, 2011). This conversational “reduction” (Warner, 2011) is prevalent across languages and varieties (Barry and Andreeva, 2001; Ernestus and Warner, 2011), and it has been acoustically represented by shorter duration or deletion of segments or syllables, shorter distance between sound

categories, and fewer acoustic cues in speech signals. Conversational speech in Korean is not an exception to this. Figure 1 illustrates two instances of a common Korean word /opun/, ‘5 minutes’, produced by one of the speakers in this study. The conversational token in Figure 1 exhibits a clear sign of phonetic reduction in conversational speech, in which the phonetic representation of the word considerably deviates from its canonical/phonological representation. Some of the segments and syllables in the phonological representation are “smeared” or deleted completely. As a result, the underlying two-syllable word is phonetically realized as one, [ǽn], which is markedly different from the canonical form.

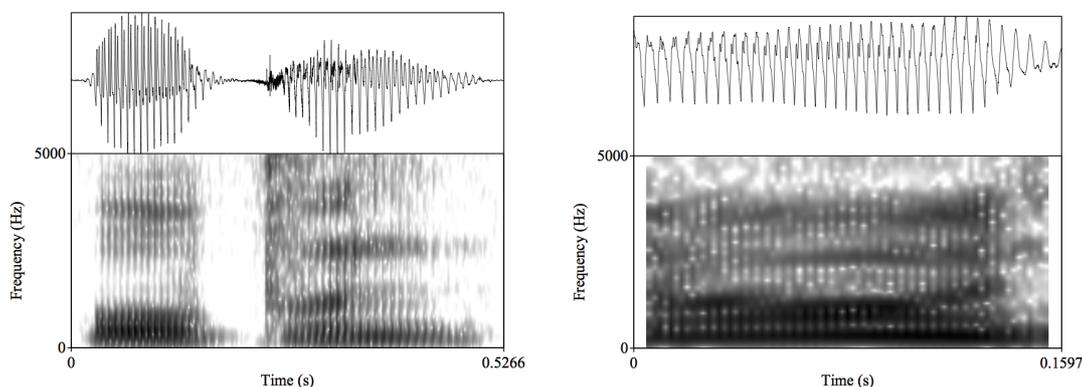


Fig. 1. Read (left) and conversational (right) tokens of /opun/ ‘5 minutes’ by speaker 8

As phonetic research on conversational speech has gained much attention in recent years, phoneticians and speech scientists innovated various research methods to collect spontaneous speech, and acoustic measures to examine the phonetic differences between careful and casual speech. Phonetically annotated spontaneous speech corpora, such as the Switchboard corpus (Godfrey and Holliman, 1993), the Buckeye corpus (Pitt et al., 2007), and the Seoul Korean corpus (Yun et al., 2015), have served as a source of conversational speech. Map Task (Anderson et al., 1991) has also been known as a way of obtaining casual speech, in which speakers engage in a conversation to give each other a direction to a certain place or point on a map, resulting in speakers’ producing multiple instances of the place name. One of the most innovative methods in conversational speech research is to record a speaker’s phone conversation (Warner and Tucker, 2010, 2011). Instead of recording *through* a phone, speakers are instructed to sit in a sound booth under good acoustic conditions, and phone their friend or family member while wearing a good head-mounted microphone. The conversation recorded through this method tends to be extremely casual and spontaneous, compared to the conversational speech collected using other methods such as Map Task or interviews, as indicated by the content of the recorded speech described in this paper. The merit of this method makes it a natural candidate for the purpose of this study, and thus the method was adopted in the study.

Considerable bodies of work have explored conversational speech, as reported in Ernestus and Warner (2011). Nevertheless, instrumental acoustic studies are still few for casual/spontaneous speech in non-European languages. Recent phonetic studies, however, have started to examine the production of spontaneous speech in less resourced languages such as Japanese (Arai, 1999; Arai et al., 2007) and Chinese (Berry, 2009; Cheng, 2012; Cheng and Xu, 2009, 2013, 2014; Brenner, 2015). They reported that casual speech in these languages does exhibit substantial phonetic

variability just like in English and show similar cue reduction processes. In order to further extend the scholarship on less spoken languages, this study examines acoustic cues in use in Korean conversation, focusing on word-medial, intervocalic Korean stops. The three-way contrast of Korean stops is illustrated in Table 1.

Table 1. Word-initial and -medial stop contrast in Korean

manner	word-initial		word-medial	
lenis	/pul/	‘fire’	/kuapa/	‘guava’
fortis	/p*ul/	‘horn’	/ap*a/	‘father’
aspirated	/p ^h ul/	‘grass’	/ap ^h a/	‘It hurts’

Traditionally, Korean stops were known to exhibit a three-way contrast in VOT, in which VOT is longest for aspirated stops, intermediate for lenis, and shortest for fortis (Lisker and Abramson, 1964; Cho et al., 2002). However, the sound change in progress in Korean (Kang and Guion, 2008; Lee and Jongman, 2012; Lee et al., 2013; Kang, 2014; Bang et al., 2018 among many) has made the stop contrast more dynamic, in which both VOT and f_0 of the immediately following vowel serve as important cues to distinguish three stop series. For younger speakers of Korean, f_0 is highest for aspirated stops, intermediate for fortis, and lowest for lenis (Kang and Guion, 2008). This multi-dimensional stop contrast is not very common cross-linguistically, and thus raises an interesting question how the dynamic nature of stop contrast in Korean is phonetically realized in a casual speech setting. For this reason, it is worth investigating how those cues function in casual speech in comparison to careful speech. In addition, while domain-initial (e.g., word-initial, phrase-initial, etc.) stops have been extensively studied in the previous literature, a study of word-medial, intervocalic stops can offer new insights into Korean stop contrast, and will provide complementary documentation of the Korean language using an innovative method of data collection in laboratory phonology. The overall goal of this study is to document the acoustic cues at play in conversational intervocalic Korean stops, and to add to the growing literature on conversational speech and cue interactions in read vs. spontaneous speech.

2. Methods

2.1 Participants

Ten native speakers of Korean (three males and seven females, aged 18-24, $SD=1.7$) were recruited and recorded at the Alberta Phonetics Laboratory in the University of Alberta. Two of the speakers moved to Canada at the age of nine and eleven respectively, but reported that they speak Korean at home and are involved in Korean speaking communities (e.g., Korean churches, Korean student associations, etc.) on a regular basis. Further, the two speakers did not behave differently from other eight speakers in terms of their production of intervocalic stops in two speech registers, and thus were included and analyzed for this study. All other speakers are late learners of English and have not lived in English-speaking countries until their late teens or early twenties.

2.2 Stimuli

This study examined nine Korean stop phonemes /p, p*, p^h, t, t*, t^h, k, k*, k^h/ in various intervocalic (i.e., VCV) environments, some of which are illustrated in Table 2. Roughly 100 to 300 instances of intervocalic stops were extracted from each speaker's phone conversation, and 81 words that contain intervocalic stop phonemes and 19 filler words were chosen for the wordlist. Common loanwords such as /k^hʌp^hi/ 'coffee' or /p^hat^hi/ 'party', as well as native Korean words, were also considered for this study.

Table 2. Conversational and read intervocalic stops

manner	segment	example (conversational and read)	
lenis	/p/	/opun/ '5 minutes'	/kipun/ 'feeling'
	/t/	/ɛtil/ 'kids'	/putam/ 'burden'
	/k/	/ʃaki/ 'self'	/saki/ 'fraud'
fortis	/p*/	/op*a/ 'brother'	/ap*a/ 'father'
	/t*/	/ʌt*ɛ/ 'How is it?'	/ʌt*ʌn/ 'some'
	/k*/	/pak*at/ 'outside'	/kak*im/ 'sometimes'
aspirated	/p ^h /	/ʌʃ ^h ap ^h i/ 'anyway'	/k ^h ʌp ^h i/ 'coffee'
	/t ^h /	/p ^h at ^h i/ 'party'	/kjo ^h on/ 'traffic'
	/k ^h /	/p ^h ak ^h in/ 'parking'	/ʃok ^h ʌ/ 'joker'

2.3 Procedure

Each speaker was instructed to sit comfortably in a sound-attenuated booth, phone their family member or close friend (who is also a native speaker of Korean) using their phone and carry out a brief conversation with them in Korean for fifteen minutes. Only one speaker held a conversation with the investigator (first author) as she could not find an interlocutor who was available at the time of her experiment. Only the speaker in the sound booth was consented and recorded (44.1kHz/16-bit WAV) through the high-quality head-mounted microphone (E6 Countryman) which the speaker was wearing. Every conversation was free conversation; no topics were offered. Topics of conversation ranged from moderately serious ones (e.g., car accident, selecting a major, party planning for their friend's parent) to extremely casual ones (e.g., boyfriends/girlfriends, hangover, roommates, cohorts, homework, exams, classes, part-time jobs). During the conversation, the investigator was not in the same room so that the speaker can hold their conversation without feeling observed. Around at the fifteen minutes' mark for the conversation, the investigator came back to the sound booth to inform the speaker of closing their conversation. Following the phone conversation, speakers read a prepared list of Korean words in which each word appears three times in a random order. All the instructions, spoken and written, were given in Korean throughout the experiment session. After their experiment sessions were completed, speakers were debriefed on the purpose of the study and monetarily compensated for their participation.

2.4 Measurements

Four acoustic cues of intervocalic stops were measured using Praat (Boersma and Weenink, 2018): intensity drops

from the amplitude peaks of neighboring vowels (henceforth intensity differences, illustrated in Figure 2, VOT, f_0 of the immediately following vowel, and closure duration. The first measure is not a cue to Korean stop contrast, but was chosen for this study as it has been identified as a sign of acoustic reduction of intervocalic stops, in a way that intensity differences are smaller in casual speech than in reading or storytelling (Warner and Tucker, 2010, 2011). Intensity difference was defined as the difference between the intensity peaks of neighboring vowels and the trough in the region of the target stop, i.e., mean distance among three red dots (along with green arrows) in Figure 2. The rest of the measures - VOT, f_0 , and closure duration - are known as primary and secondary acoustic cues in Korean stop contrast (Lee and Jongman, 2012; Lee et al., 2013; Schertz et al., 2015), and thus were considered for this study.

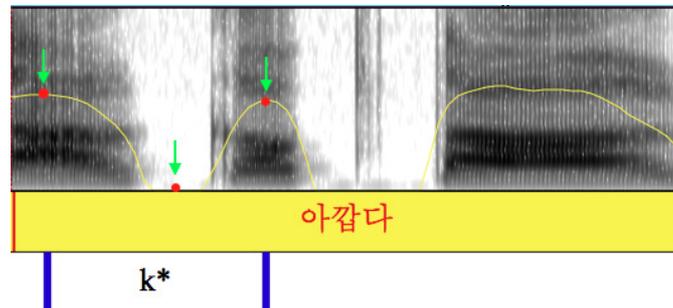


Fig. 2. A sample measurement of intensity difference

2.5 Analysis

This study employed Linear Mixed Effects modeling (Bates et al., 2015) using R (R Core Team, 2018) to determine whether the acoustic signals of Korean stops are statistically significant across two speech registers. Results are reported in the following section for the fixed effects of speech style, manner of articulation, and the two-way interactions of style with manner and with place (expressed as style \times manner and style \times place respectively in the following section), as well as the three-way interaction of style, manner and place (expressed as style \times manner \times place). Two random intercepts, speaker and item (word), were controlled in the statistical analysis.

3. Results

3.1 Intensity Difference

Intensity difference was previously introduced as a cue that defines acoustic reduction of stops when produced in a casual setting. In rapid and casual speech, articulatory targets are very often “undershot”, and in the case of stops, the physical contact between two articulators, or the complete obstruction in the vocal tract often does not occur in a casual speech setting. This undershot articulatory gesture is expressed as an approximant-like spectrogram, resulting in smaller deviation in intensity from neighboring vowels, i.e., smaller intensity difference. Figure 3 compares the intensity contours from two previously introduced tokens of /opun/ ‘5 minutes’, and indicates that the intensity difference is much smaller when produced in conversation.

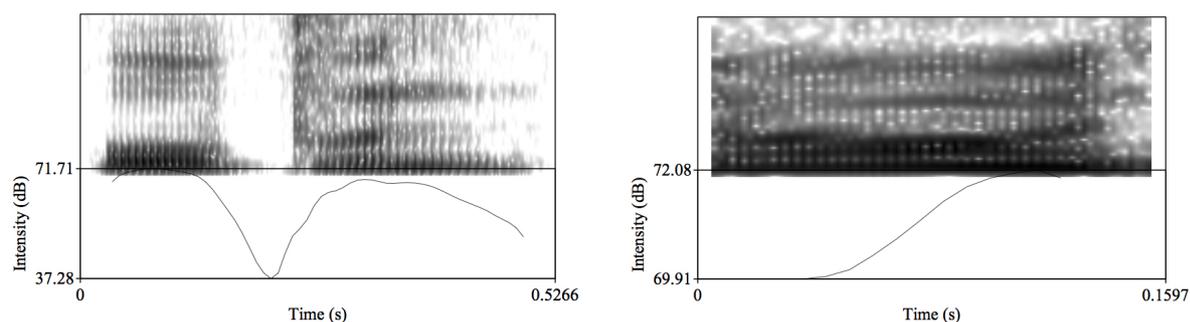


Fig. 3. Wordlist (left) and conversational (right) tokens of /opun/ '5 minutes' by Speaker 8, with intensity contours added

Figure 4 presents the intensity differences from all stop series produced in two speech styles. The effects of all factors - style, manner, and place - and all the possible interactions among them were statistically significant on the intensity difference measurement: $\chi^2=13.5$, $df=1$, $p<.001$ (style); $\chi^2=80.8$, $df=2$, $p<.001$ (style \times manner); $\chi^2=39.9$, $df=2$, $p<.001$ (style \times place); $\chi^2=32.4$, $df=8$, $p<.001$ (style \times manner \times place).

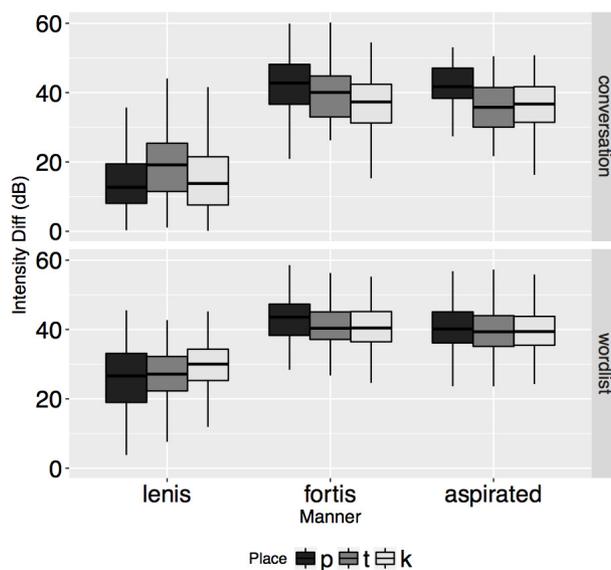


Fig. 4. Intensity differences of conversational vs. read stops

Intervocalic lenis stops in Korean are susceptible to partial voicing and approximation, which decreases the amount of deviation in intensity from neighboring vowels. As a result, lenis stops of all three places exhibit significantly smaller intensity differences in conversation (/p/: $\beta=11.2$, $SE=2.2$, $t=5.2$, $p<.001$; /t/: $\beta=8.6$, $SE=1.9$, $t=4.6$, $p<.001$; /k/: $\beta=14.0$, $SE=1.5$, $t=9.5$, $p<.001$). These results are in line with findings on intervocalic voiceless stops in American English reported in Warner and Tucker (2010, 2011), and indicate that intervocalic lenis stops in Korean undergo acoustic reduction when produced in conversation. Style interacts with place, such that the effect of style is significantly larger for /k/ than for the other two stops. In the collected conversation recordings, intervocalic velar lenis stops occurred in frequently used function words such as /neka/ 'I + nominative marker' or /kikʌ/ 'that'. Given that function words are

more susceptible to phonetic reduction than content words (Johnson 2004), this might have resulted in a significantly greater effect of the velar place on intensity difference compared to other two places.

On the other hand, the intensity differences from fortis and aspirated stops in conversation are not statistically different from those in read speech, which means that fortis and aspirated stops are not affected by speech styles. The results on fortis and aspirated stops indicate that acoustic reduction in intensity is specific to manner of articulation, and stops of different manners are resistant to conversational reduction. As a result, the intensity differences from conversational stops yield a greater contrast between lenis and non-lenis stops, represented by a greater distance between lenis and non-lenis stops in conversational speech than in read speech. The patterns of acoustic reduction in intensity differences show that manner-specific acoustic reduction might enhance phonetic contrast in conversational speech.

3.2 VOT

VOT has been introduced as one of the two primary cues to stop contrast in Korean. Figure 5 shows the VOT values from all stops in two speech styles. The effects of all factors and their interactions were statistically significant: $\chi^2=11.4$, $df=1$, $p<.001$ (style); $\chi^2=35.8$, $df=2$, $p<.001$ (style \times manner); $\chi^2=31.2$, $df=2$, $p<.001$ (style \times place); $\chi^2=42.4$, $df=8$, $p<.001$ (style \times manner \times place).

Note that in Figure 5, VOT creates a three-way contrast in conversation, whereas it distinguishes aspirated from non-aspirated stops in (wordlist) reading. Along with the results on intensity difference, the patterns of VOT in Figure 5 support the previously mentioned hypothesis that conversational reduction contributes to phonetic enhancement. Intervocalic voicing of lenis stops in conversation, represented by negative VOT values, resulted in a more robust distinction among three stop series in conversation. For lenis stops, VOT for /t/ and /k/ is significantly smaller in conversation than in reading (/t/: $\beta=0.004$, $SE=0.002$, $t=2.3$, $p<.05$; /k/: $\beta=0.008$, $SE=0.002$, $t=3.9$, $p<.01$),

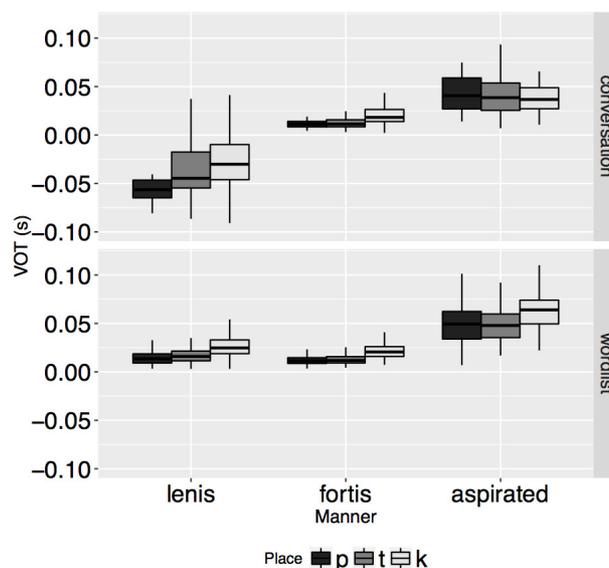


Fig. 5. VOT of conversational vs. read stops

demonstrating two lenis stops' conversational reduction in VOT. The effect of style is different across stop places, in which VOT of velar lenis stops is most affected by style. This can be interpreted by the fact that intervocalic /k/ was found in many high-frequency function words, as discussed earlier in the previous section. As shown by the intensity difference measure, fortis and aspirated stops were not statistically different across two speech styles, which supports manner-specific acoustic reduction again.

3.3 F0

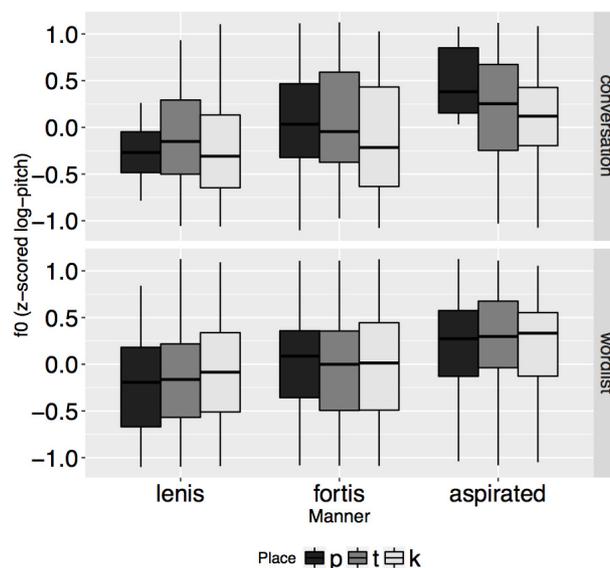


Fig. 6. f0 (of the immediately following vowels) of conversational vs. read stops

F0 has been previously introduced as one of the primary cues to stop contrast in Korean for younger speakers of Korean. Figure 6 illustrates the normalized (z-scored) f0 values from all stops in two speech styles, showing that f0 does not serve as a reliable cue in either conversational or read speech, at least word-medially. F0 tends to be higher in conversation than in reading for fortis and aspirated stops, but there were no significant effects of place or manner. Of interest here is that there was a significant interaction of style with place for aspirated stops ($\chi^2=15.7$, $df=3$, $p<.01$), in which /p^h/ and /t^h/, but not /k^h/, showed significantly higher f0 values in conversation than in reading. Unlike the patterns on intensity difference and VOT, there were no clear signs of acoustic reduction or phonetic enhancement in f0.

3.4 Closure Duration

Figure 7 presents closure duration values from all stops in two speech styles. Except for the two-way interaction between style and place, all the factors and their interactions were found significant: $\chi^2=27.6$, $df=1$, $p<.001$ (style); $\chi^2=174.2$, $df=2$, $p<.001$ (style \times manner); $\chi^2=0.9$, $df=2$, $p>.1$ (style \times place); $\chi^2=68.8$, $df=8$, $p<.001$ (style \times manner \times place).

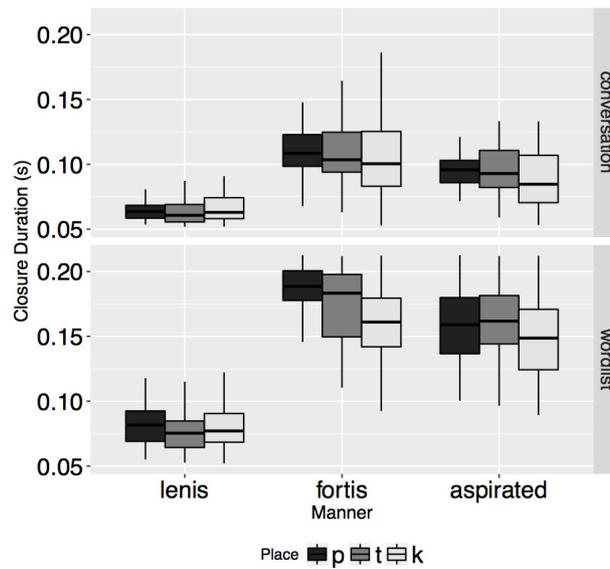


Fig. 7. Closure duration of conversational vs. read stops

Closure duration, known as a secondary cue in Korean stop contrast, successfully distinguishes three stop series in both speech styles, as illustrated in Figure 7. Further, closure duration is the only acoustic measure in this study that demonstrated the significant effect of style for all nine stop phonemes ($/p/$: $\beta=0.02$, $SE=0.004$, $t=4.8$, $p<.001$; $/t/$: $\beta=0.02$, $SE=0.004$, $t=5.7$, $p<.001$; $/k/$: $\beta=0.03$, $SE=0.004$, $t=6.7$, $p<.001$; $/p^*/$: $\beta=0.1$, $SE=0.01$, $t=11.1$, $p<.001$; $/t^*/$: $\beta=0.1$, $SE=0.01$, $t=7.6$, $p<.001$; $/k^*/$: $\beta=0.9$, $SE=0.01$, $t=9.6$, $p<.001$; $/p^h/$: $\beta=0.1$, $SE=0.01$, $t=6.6$, $p<.001$; $/t^h/$: $\beta=0.1$, $SE=0.01$, $t=9.0$, $p<.001$; $/k^h/$: $\beta=0.1$, $SE=0.01$, $t=6.3$, $p<.001$). All three stop series resulted in significantly shorter closure duration in conversation than in reading. This indicates that closure duration is as important a cue as VOT at least for word-medial stops, in both speech styles.

Note that despite the significant decrease in closure duration for all manners of stops, three stop series are contrastive in conversation. This can be understood in line with H&H theory (Lindblom 1990). According to the H&H theory, speakers make articulatory modifications in response to the expected perceptual needs, and reduce their efforts in producing phonemic sound categories in a less careful setting as long as the sound categories remain contrastive. In other words, some acoustic cues may undergo acoustic reduction, but only to the extent that phonological contrast remains intact, and conversational Korean stops exemplify this.

Overall, word-medial Korean stops are significantly different across two speech styles in three acoustic dimensions: intensity difference, VOT, and closure duration. Despite the phonetic variability in spontaneous conversation, three stop series in Korean – lenis, fortis, and aspirated stops – are contrastive in the aforementioned acoustic dimensions. Further, comparisons of Korean stops in read and conversational speech show the interplay of manner-specific acoustic reduction and phonetic enhancement.

4. Discussion and Conclusions

Taken together, intervocalic Korean stops are contrastive in both careful reading and casual conversation, despite acoustic reduction in some cues. Intensity difference comes into play for both read and conversational stops, but it serves as a more robust cue in conversation than in reading in that the acoustic reduction of intervocalic lenis stop enhances the contrast between lenis and non-lenis stops. Two previously known cues in Korean stop contrast, VOT and closure duration, also contribute to the contrast in both speech styles. VOT enhances the three-way contrast in conversation, whereas closure duration makes the contrast less robust. Finally, while it may serve as one of the primary cues for word-initial stop contrast, f_0 does not seem to play a role in word-medial stop contrast. Numerous previous studies on word-initial stops in Korean show that f_0 functions as a more reliable cue than VOT in differentiating three stop series (e.g., Kang, 2014; Bang et al., 2018; among many). The results on word-medial stops in Korean from this study, however, do not support the role of f_0 in Korean stop contrast. This study points to the dynamic nature of acoustic cues in stop contrast, and the way Korean stop phonemes are phonetically realized calls for further investigation.

The findings from this study suggest that conversational speech is not always about acoustic reduction, and the term “reduced speech”, which is often used interchangeably with conversational speech, needs to be reconsidered. Conversational reduction is not necessarily associated with reduction in contrast as it may sound, and not every aspect of conversational speech exerts reduction. As shown in this study, represented by intensity difference and VOT, some acoustic cues enhance phonetic contrast across sound categories in a more casual speech setting. Thus, acoustic reduction may not be the only aspect of conversational speech research, and one should look into conversational speech in various perspectives.

The focus of this study is to investigate manner-specific adjustments in conversational stops, but the same dataset can lead to several additional analyses in regard to the influence of other phonological and morphological information on conversational stops. Johnson (2004) and other phonetic studies on conversational speech reported that in the case of short (one- or two-syllable long) words, functional words are more susceptible to massive acoustic reduction than content words. In addition, future studies can examine whether phonetic reduction and enhancement are affected by various boundary types exemplified in Korean inflection and derivation, such as / $n\epsilon\#k^*a$ / ‘mine (I + thing)’ and / $n\epsilon+k^*a$ / ‘streamside’. It merits further exploration whether different morphosyntactic conditions affect Korean stop contrasts, and if so, how they are phonetically realized.

On the whole, this paper adds weight to noteworthy differences between careful reading and casual speech, and offers further insight into conversational reduction and phonetic enhancement in conversation. Three stops series in Korean are contrastive in both speech styles, but in a slightly different way in the same acoustic dimensions. Lastly, the findings from this paper highlight the importance of diversifying language data beyond the heavily resourced languages such as English or Dutch.

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