A Preliminary Study about Disappearing Laryngeal and Supralaryngeal Articulatory Distinction of the Three-way Contrast of Korean Velar Stops

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Classifying stops in many languages often involves two common phonetic features: voicing and aspiration [9]. However, Korean exhibits a typologically rare three-way contrast of word-initial voiceless stops, which are typically categorized as lenis, fortis, and aspirated stops based on their laryngeal characteristics. Previous phonetic studies have described that the lenis stops have a breathy quality and slightly aspirated; the fortis stops are tense, laryngealized, and unaspirated; and the aspirated stops are strongly aspirated [4]. While the three-way contrast was traditionally considered to be primarily reflected in VOT (longest for the aspirated, shortest for the fortis, and intermediate for the lenis stops), recent studies have shown that the VOT distinction between lenis and aspirated stops has been lost, leading to a VOT merger of the two categories, especially in the Seoul dialect of Korean [1,5,7,11]. Furthermore, it has been suggested that females are in the vanguard of this merger [6]. Given the VOT merger underway, a significant question arises regarding whether and to what extent the kinematic properties of the three-way stop contrast may have changed along with VOT, potentially reflecting the effects of the sound change on supralaryngeal articulation. The position of the tongue, for example, might be adjusted based on the articulatory closure duration, which tends to be inversely proportional to VOT when VOT is defined in terms of articulation [3], as pointed out by [10]. In the case of the lenis-aspirated distinction, if the VOT values for these sounds become similar, it might indicate that the differential hold duration-related impacts on articulation would also no longer exist between the two sounds. In other words, the three-way supralaryngeal distinction, which was previously present, would also be lost along with the VOT merger.

Twenty-two Korean speakers in their 20s from Seoul and Gyeonggi-do participated in the experiment as part of a large acoustic and articulatory database of Korean which is in construction at the Hanyang Institute for Phonetics and Cognitive Science of Language [12]. The articulatory data were collected by using the 3D electromagnetic articulography (EMA, AG501, Carstens Electronics). The participants were instructed to produce a randomly ordered sequence of eighteen syllables in the form of /Ca/. Only the velar stops in /ka/, /k^ha/, and /k*a/ were selected for examination in this study. The articulatory data from the tongue dorsum sensor have been examined to track the closing and opening movement of tongue dorsum for velar closure. A total of 132 tokens (3 velars x 22 speakers x 2 repetition) are included for the analysis.

In the acoustic data, the results of VOT in the present study showed that the lenis-aspirated contrast is lost in females (/k^h/=/k/>/k*/) while the three-way stop contrast still remains in males (/k^h/>/k/>/k*/). As for the results of articulatory gestures, there was no three-way distinction in closure duration for either females or males: females showed a binary distinction between the lenis and the other two stops (/k/=/k^h/</k*/), while males showed a difference between the lenis and fortis stops only (/k/</k*/). The results for peak velocity of the tongue dorsum opening movement (see Peak Velocity 2 in Fig.2) indicated that in males, there was a three-way contrast between the velar stops (/k^h/</k/</k*/), while in females, there was only a distinction between the aspirated and fortis sounds (/k^h/</k*/). In the case of deceleration duration of the tongue dorsum opening movement, females exhibited a binary contrast, with no differentiation between the aspirated and fortis stops (/k^h/=/k*/</k/), while males showed a binary distinction, with no distinction between the lenis and aspirated stops (/k/=/k^h/</k*/). The findings from opening movement duration showed that for female speakers, there was a difference only between the lenis and fortis stops (/k*/</k/). However, for male speakers, there was a difference between the fortis and lenis/aspirated stops but not between the lenis and aspirated stops (/k*/</k/=/k^h/).

As seen in Figure 1 and 2, the findings from males indicated an inverse association between VOT (laryngeal aspect) and Peak Velocity of the tongue dorsum opening movement (supralaryngeal aspect): the aspirated stop showed the longest VOT and slowest Peak Velocity whereas the fortis stop showed the shortest VOT and the fastest Peak Velocity during the opening movement. Bernoulli's principle, which is a fundamental concept in fluid dynamics, can be used to explain the relationship between VOT and Peak Velocity. According to Bernoulli's principle, when air flows through the wider end of the straw, the velocity of the air decreases, causing the pressure to increase. When air flows through a narrower end of the straw, the velocity of the air increases, causing the pressure to decrease. This pressure difference causes the air to

move faster through the narrower end of the straw, and slower through the wider end. Consequently, the fortis stop with the fastest peak velocity of the tongue dorsum during the opening movement can reach a wide opening at the contact area of the tongue dorsum and the palate most rapidly, causing slower air movement and the shortest VOT. On the other hand, the aspirated stop with the slowest peak velocity of the tongue dorsum opening movement can keep a narrow channel at the contact area for the longest duration, causing faster air movement and the longest VOT.

The findings of the current study provide some evidence of disappearing laryngeal and supralaryngeal articulatory distinction of the three-way stop contrast in velars along with the on-going sound change related to the VOT merger. Moreover, the findings also support that the lenis-aspirated distinction is disappearing and that the change is led by females.

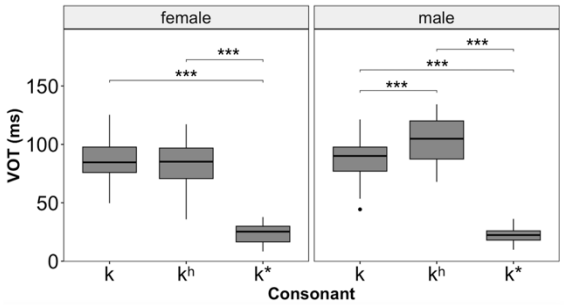

Fig.1 VOT for the three velar stops. Error bars indicate standard errors.

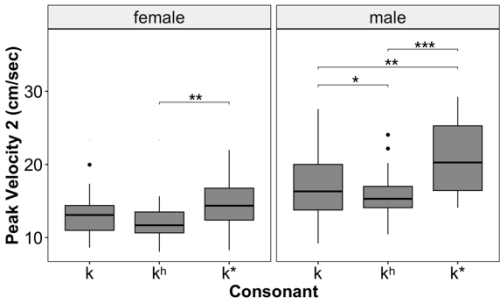

Fig.2 Peak velocity of the tongue dorsum opening movement for the three velar stops. Error bars indicate standard errors.

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