The magnitude of articulatory gestures for the glide /w/ in Korean: Implications for the phonological representation of /w/

Soohyun Kwon
(Seoul National University)

Kwon, Soohyun. 2020. The magnitude of articulatory gestures for the glide /w/ in Korean: Implications for the phonological representation of /w/. *Studies in Phonetics, Phonology and Morphology* 26.3. 395-409. This study examines the articulatory properties of the glide /w/ in Korean, using ultrasound. While some claim that there is no dorsal glide, others argue that glides have two designated articulators, and that /w/ is both [Dorsal] and [Labial]. The results of this study reveal that /w/ in Korean consists of both lip and tongue gestures, and that the primary articulatory correlate of /w/ is lip protrusion while tongue dorsum raising serves as a secondary but important articulatory feature. The findings are discussed in terms of phonological representations and articulatory implementation of glides. **(Seoul National University, Lecturer)**

Keywords: glide, /w/, articulatory correlates, Korean, phonological representation, Optical Flow Analysis (OFA)

1. Introduction

While a relatively large number of studies have documented the articulation of vowels and consonants, only a handful of studies have studied the articulatory properties of glides (but see Gick 2003). Since we have a limited understanding of the articulatory features of glides due to the paucity of instrumental studies, articulatory characteristics of glides have been usually inferred from acoustic or auditory data.

It is generally accepted in the phonetics literature that the glide /w/ involves labial constriction and tongue dorsum raising and backing (Stevens 2000, Gick 2003, *inter alia*). In the articulator theory put forward by Halle et al. (2000) and Halle (2005), however, it is argued that glides are not allowed to have multiple articulators. It has been claimed that all vowels have [Dorsal] as their designated articulator, while no glides have [Dorsal] as their designated articulator: in this model, /j/ and /w/ contain [Coronal] and [Labial] as their designated articulator, respectively. According this theory, glides are allowed to have one single designated articulator.

There is a representational approach opposed to this view that argues that glides may have multiple articulators (e.g. Keating 1988, Nevins and Chitoran 2008). Under this approach, it is regarded that glides are mentally represented as neither vowels nor consonants, but have their own constriction degree. In order to capture the phonetic and phonological distinction among vowels, glides and consonants, Nevins and Chitoran (2008) proposes a new featural representation as in (1).

(1) Featural representation of natural classes of segments proposed in Nevins and Chitoran 2008[1]

obstruents = [+cons, –voc, –sonorant]
liquids, nasals = [+cons, –voc, +sonorant]
vowels = [–cons, +voc, +sonorant]
glides = [–cons, –voc, +sonorant]
illicit combination: *[+cons, +voc]

According to this featural model, vowels and glides are differentiated in a feature [+–vocalic]. While a number of featural models (e.g. Hyman's (1985)) have argued for [consonantal] as the feature that distinguishes vowels and glides, [consonantal] is used to differentiate glides from consonants under this model. In addition to the major class features [cons, voc, son], the manner features [lateral, nasal], and the laryngeal features of voicing and aspiration, it is assumed that all segments may include one or more unary-valued Articulator feature(s) (sometimes called the Designated Articulator(s)), which include [Labial], [Coronal], [Dorsal], and [Glottal].

Therefore, /j/ has both [Coronal] and [Dorsal] as designated articulators and /w/ is [Labial] as well as [Dorsal]. Nevins and Chitoran (2008) further predict that, when glides involve two gestures, the cross-linguistic distinction between vocalic and consonantal behavior of glides would be reflected phonetically in the relative magnitude of one or the other of the two gestures. That is, the glides with a relatively

---

[1] Under this approach, the features are defined as follows:
[+consonantal] = presence of an occlusion of the free passage of air in the supralaryngeal vocal tract
[+vocalic] = absence of a narrow constriction among the articulators

larger dorsal gesture would alternate with dorsal consonants, while the glides with a relatively larger non-dorsal gesture would alternate with non-dorsal consonants.

In this context, this study aims to shed light on this issue regarding the representation of glides by conducting an articulatory experiment on the phonological representations and phonetic implementation of the glide in Korean. Korean provides an interesting testing ground for exploration of the issue in that /w/ sometimes alternates with a labial [p] in Korean as shown in (2).[2]

(2)
/nup+ə/ → [nu.wə] ‘lie down’
/nup+ko/ → [nup.ko] ‘lie down and’
/kup+ə/→ [ku.wə] ‘bake’
/kup+ko/→ [kup.ko] ‘to bake and’

Based on the representational theory arguing that multiple articulators are involved in the production of glides and that the phonological behaviors of glides are reflected in the gestural magnitude, the immediate prediction made is that Korean /w/ would have a larger labial gesture than dorsal gesture. In the meantime, it has been noted that the labial gestures for the Korean glide /w/ is quite subtle. Since the gestural magnitude of lip protrusion for /w/ appears very small, it appears questionable whether the labial gesture can serve as a primary articulation.

In this light, the present study aims to answer the following specific questions. First, which articulators are involved in the production of /w/ in Korean? Do lips form the only articulator or does the tongue also participate in the articulation of /w/? Second, if both articulators are used, which articulator makes more radical constriction in terms of gestural magnitude? Third, what are the effects of the preceding consonants and following vowels on the magnitude of lip and tongue movements involved in the production of /w/ in Korean? To answer these questions, ultrasound was used to image tongue movements and a side-view face video to capture lip protrusion from Korean speakers producing the glide /w/ in different segmental contexts.

---

[2] This alternation takes place at the end of a verb stem when the stem is immediately followed by a suffix which begins with ə. This alternation, however, has been characterized as irregular in that it has many exceptions (e.g. ip+ ə/→ [i.pə] ‘wear’).

2. Methods

2.1 Participants

Three female speakers in their late 20s or early 30s who were born and raised in Seoul, Korea, participated in the study.[3] None reported any history of speech or hearing impairments. All participants were phonetically untrained and were unaware of the nature of the study at the time of data collection. They were compensated for their time.

2.2 Stimuli

For test items, 72 monosyllabic words of the syllable type CwV and CV (e.g. *pwa* and *pa*, *twa* and *ta, kwe* and *ke*) were employed. In all items, /w/ is preceded by a bilabial, alveolar or velar stop and followed by one of the four different vowels (/i, e, ə, a/) that co-occur with /w/ in Korean. Twelve additional filler words were added to the stimuli set and the order of items was randomized. The stimuli were repeated three times.

2.3 Procedures

Recordings were made inside a sound-attenuated booth at the Phonetics Lab of the University of Pennsylvania. Midsagittal images of the tongues from the participants were recorded using the EchoB portable ultrasound machine. A 5-8 MHz convex-curved transducer that produced up to 87 scans per second across a 70 degrees field of view was used. Focal depth was 70mm. The probe stabilization headset, designed by Articulate Instruments, was used to stabilize the speakers' heads. This lightweight and portable headset fixes the transducer midsagitally under the speaker's chin (see Figure 1). This ensures that there is little lateral movement of the probe and no probe rotation.

[3] They were all graduate students at the University of Pennsylvania who had lived in the United States for less than four years at the time of recording. While the participants' substantial exposure to English can be considered a limitation, their production of Korean did not sound different from that of native speakers of Korean.

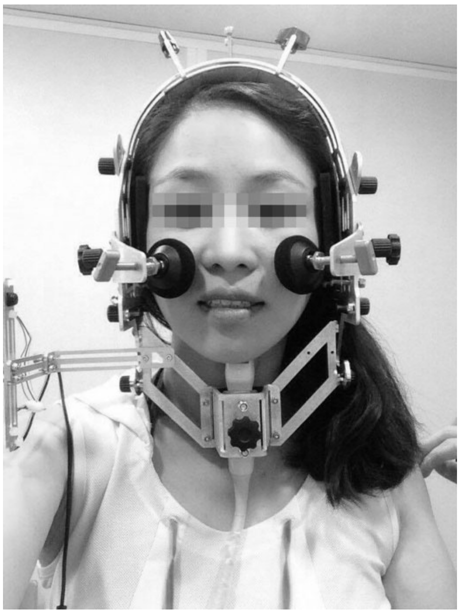

Figure 1. Probe stabilization headset to hold the probe steady but allow natural head movement during speech.

Once the participants were seated in the chair, a SONY Shure SM58 microphone was attached to the participants, which enabled the simultaneous audio recordings. Also, the side-view of the participant's face was videotaped to record the lip protrusion. An audio signal from a microphone and the incoming video signal from the ultrasound machine were synchronized, using a SyncBrightUp unit (Articulate Instruments Ltd. 2010).

The stimuli were presented to the speaker using Articulate Assistant Advanced (AAA) software, which records participants' ultrasound images in addition to acoustic data. The speakers read aloud the items corresponding to the stimuli number from written lists at a comfortable pace. They were prompted to read the items written on a sheet of paper very carefully to elicit clearly articulated CwV and CV tokens.[4]

[4] In Korean, /w/ can be variably deleted before a vowel. Because the participants were asked to read the items very carefully, however, no CwV token in this study was produced with /w/ deleted.

2.4 Data analysis

2.4.1 Segmentation and synchronization

All sound files were first exported from Articulate Assistant Advanced (AAA). Acoustic segmentation was made mainly through the Korean Forced Aligner (Yoon and Kang 2013), but *textgrid* files were manually inspected and, if necessary, corrected in Praat. These sound files were imported back into AAA along with their *textgrid* files. The ultrasound and side-view videos of CV and CwV sequences were exported as *avi* files. Sample ultrasound image of tongue and camera image of lips are provided in Figure 2.

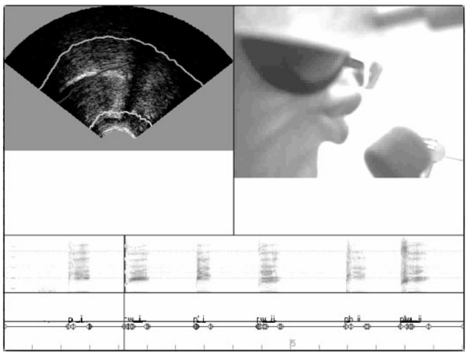

Figure 2. Sample image of a tongue surface (ultrasound) and lip shape. The right side is the tongue tip and the left side is the tongue root. The green line in the ultrasound image is the palate trace, the highest possible point of the tongue, and the red line indicates the average tongue position.

2.4.2 Optical Flow Analysis (OFA)

The quantitative analysis technique called Optical Flow Analysis (OFA; Horn and Schunck 1981, Fleet and Weiss 2006) was employed in this study to measure the amount of articulatory gesture involved in the production of /w/. Optical Flow Analysis (OFA) is a video-based motion analysis tool that measures the apparent magnitude of movement (MM) of objects in a video (Barbosa et al. 2008). The method's utility has been demonstrated for the data from a number of languages including Plains Cree, English, and Shona. Recent linguistic studies using ultrasound have introduced OFA as a relatively easy but powerful tool for extracting articulatory information from ultrasound video (e.g. Hall et al. 2015). For the current study, OFA enabled us to calculate the total amount of lip and tongue gestures for each of the CV and CwV tokens.

OFA is a particularly appropriate analytical method for the current study for the following reasons. First, preliminary analyses have proven that analyzing tongue shapes using a widely used statistical technique for ultrasound data such as the smoothing spline analysis of variance (SSANOVA) was not very fruitful. Because the tongue gesture for /w/ in Korean was quite small, SSANOVA did not capture the subtle differences well. Second, OFA is capable of extracting reliable kinematics from any type of video. For the current articulatory study of the production of /w/ involving two articulators, lips and tongue, OFA can capture both the movement of tongue in the ultrasound videos and that of lips in the side-view videos. This enables the unified measurement of the motions of tongue and lips, which allows a direct comparison between two articulators in terms of the magnitude of gesture to be made. Lastly, OFA extracts the data from all frames, rather than single frames as is common with static postural analyses widely used in the ultrasound analysis (Barbosa and Vatikiotis-Bateson 2014, Moisik et al. 2014, Hall et al. 2015). Since /w/ is heavily coarticulated with surrounding segments, extracting the movement of articulators from a series of time sequences can be more advantageous in seizing the global movements of articulators before and after the production of /w/.

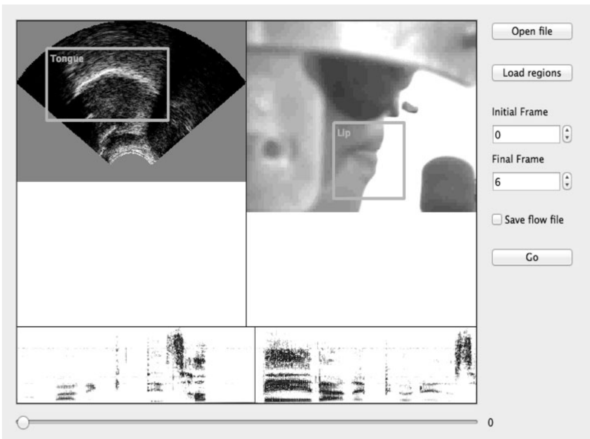

Figure 3. Defining regions of interest in the optical flow domain

Once the regions of interest (lips and tongue in this case) were selected as in Figure 3, the optical flow algorithm compares the difference in brightness of individual pixels from frame to frame, and then calculates how much and in which direction each pixel in the defined regions of interest in the image moved from one frame to the next. The summed optical flow for the n-th region of interest at the discrete time k is computed as in Eq. (1) in which ‖.‖ denotes the vector magnitude, and xi, xf, yi, yf are the initial and final boundary positions of the region of interest in the horizontal and vertical directions, respectively. This results in frame-by-frame measures of Magnitudes of Movements (MMs) and the sum of the magnitudes of all pixels inside each region of interest could be calculated (Barbosa et al. 2008).

$$Vn(k) = \sum_{x=xi}^{xf} \sum_{y=yi}^{yf} \| \underset{v}{\rightarrow} (x, y, k) \| \qquad \text{Eq. (1)}$$

Magnitudes of Movements (MMs) were normalized to eliminate gestural variation due to physiological differences among speakers and to adjust the magnitude of lip and tongue gestures to a common scale.

3. Results

All of the ultrasound and side-view videos were closely inspected to confirm that the major articulatory correlates of /w/ in Korean are lip protrusion and dorsum raising and backing as suggested in the literature and to determine which articulatory gesture demonstrates a more salient manifestation. A close examination revealed that there was a substantially larger increase in the magnitude of lip gestures for CwV in comparison to CV, whereas the increase for the magnitude of tongue gesture was relatively small.

The OFA was used to test whether this impressionistic observation in which the lip gesture contribution for /w/ was significantly greater than that of the tongue gesture could be confirmed. Figure 4 shows the distribution of the magnitudes of lip and tongue gesture, respectively, of CV and CwV sequences. Lip gesture distribution showed evidence of bimodality, showing two totally different distributions for CwV and CV. However, no evidence of bimodality is found in the distribution of the tongue gesture. This indicates that lips certainly make a substantial contribution to the production of /w/, whereas it is not clear whether tongue makes significantly different gestures for CwV and CV.

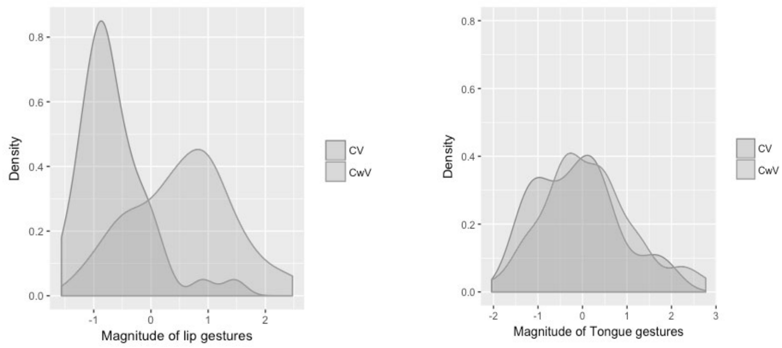

Figure 4. Density plot for the amount of lip and tongue gestures for CV and CwV

Let us assess the magnitude of articulatory gestures for /w/ then. For all remaining quantitative analyses, the difference between the magnitude of movement (MM) for CwV and mean MM of CV (MM of each CwV tokens minus mean MM of all CV tokens of the same phonological contexts) was used instead of the magnitude of /w/ itself, for the following two reasons. First, determining the boundary between /w/ and the following vowel was not always straightforward because the transition from /w/ to the following vowel is quite smooth. Another reason for using the delta value is that since /w/ heavily coarticulates with surrounding gestures, considering the whole sequence is more advantageous for seizing the global movements of articulators. The magnitude of /w/ in *kwa*, for example, was measured by subtracting the mean magnitude of all tokens of *ka* from the magnitude of each token of *kwa*. Quantitative analysis was performed on these delta values as a proxy for the amount of gesture left purely for /w/ after any possible gestural reduction or overlap with neighboring segments. It is assumed that the larger this difference is, the more robust and salient the acoustic and perceptual cues for /w/ are.

A closer examination of the data reinforces the finding that the magnitude of lip gesture is larger than that of tongue gesture. As shown in Figure 5, the magnitude of lip gesture is larger than that of tongue gesture in all phonological environments except for when /w/ is preceded by a bilabial. A smaller magnitude of lip gesture for /w/ in this context is not surprising because there must be a fairly large amount of gestural overlap between a preceding bilabial consonant and /w/. Moreover, the lip rounding gesture for /w/ conflicts with the lip spreading gesture for the front vowel /i, e/. When we rule out the pattern found in this phonological environment, it appears that the magnitude of lip gesture is larger than that of tongue gesture across the board.

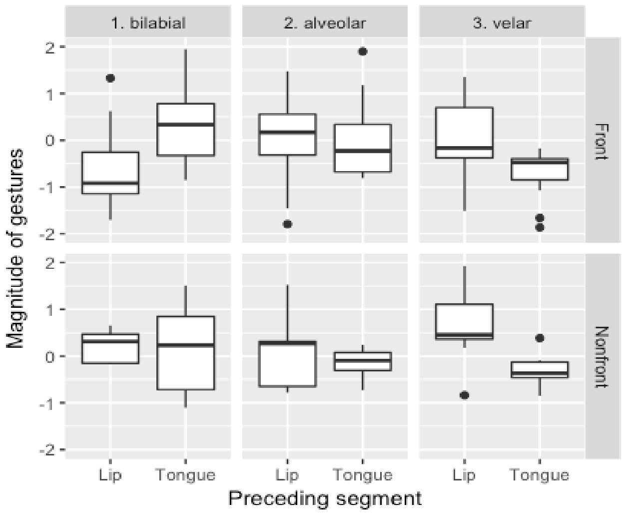

Figure 5. Magnitude of lip and tongue gesture for (CwV-CV)

These observations were upheld in a mixed-effects linear regression model. Since there were complex interactions between ARTICULATOR (lips vs. tongue) and PRECEDING CONSONANT (bilabial, alveolar, velar) and FOLLOWING VOWEL (front, non-front), six separate linear mixed effects regression models (MODEL 1-6) were run on magnitude of gesture for /w/ using *lmerTest* in R (Kuznetsova et al. 2013, Bates et al. 2014) with ARTICULATOR (lips vs. tongue) as a contrast-coded fixed factor (Lip as a baseline) and intercepts for participants as random factors in six different phonological environments, respectively: bilabial consonant-w-front vowel, alveolar consonant-w-front vowel, velar consonant-w-front vowel, bilabial consonant-w-non-front vowel, alveolar consonant-w- non-front vowel, velar and consonant-w-non-front vowel. [5]

[5] Models were stepped down from full models and model selection was guided by log likelihood tests in addition to both the Akaike Information Criterion and Bayesian Information Criterion values. Significance levels or p-values were calculated based on Satterthwaite's approximations for the degrees of freedom using the lmerTest package.

Results from MODEL1-6 show that the main effect of ARTICULATOR was highly significant, with TONGUE having much lower magnitude of gesture compared to LIPS in all environments except when /w/ is preceded by a bilabial consonant; there is no significant difference between the lip and tongue gesture magnitudes when /w/ is preceded by a bilabial and followed by a non-front vowel [$\chi^2(1)=2.79$, $p=0.09$] and the magnitude of tongue gesture was even greater than that of lip gesture when /w/ is preceded by a bilabial consonant and followed by a front vowel ($\beta=0.56$, standard error (SE)=0.12, $t=4.53$, $p<0.001$). The magnitude of tongue gesture for /w/ is significantly smaller than that of lip gesture when /w/ is preceded by an alveolar consonant and followed by a front vowel ($\beta=-0.39$, SE=0.15, $t=-2.52$, $p<0.05$), when /w/ is preceded by a velar consonant and followed by a front vowel ($\beta=-0.79$, SE=0.21, $t=-3.78$, $p<0.001$), when /w/ is preceded by an alveolar consonant and followed by a non-front vowel ($\beta=-0.75$, SE=0.12, $t=-6.31$, $p<0.001$), and when /w/ is preceded by a velar consonant and followed by a non-front vowel ($\beta=-1.38$, SE=0.22, $t=-6.31$, $p<0.001$).

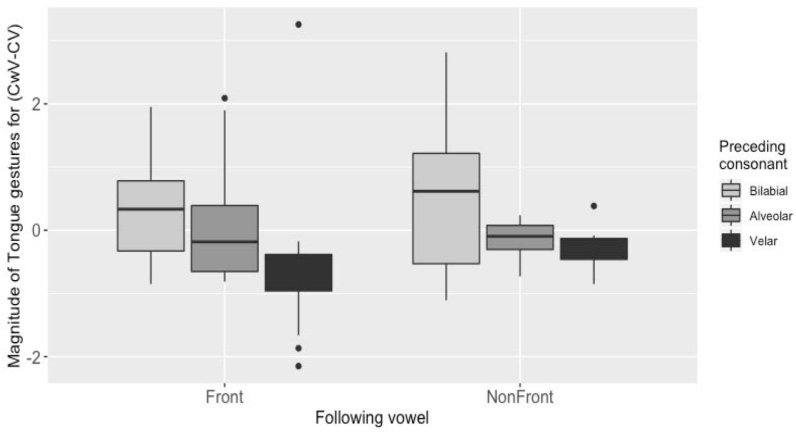

Figure 6. Magnitude of tongue gesture by place of preceding consonant

A question that arises at this point is that does the tongue contribute to the articulation of /w/ in Korean at all? The examination of the magnitude of tongue gesture for /w/ by different preceding consonants allowed us to confirm that tongue dorsum movement contributes to the articulation of /w/ in Korean. As shown in Figure 6, the magnitude of tongue gesture substantially differs according to place of preceding consonant. The magnitude of tongue gesture is much smaller when /w/ is preceded by a velar compared to when it is preceded by a bilabial or an alveolar. This can be attributable to gestural overlap between /w/ and a preceding velar consonant sharing the same articulator, the tongue dorsum. We argue that this can be taken as evidence showing that tongue still makes a significant contribution to the production of /w/. If the glide /w/ in Korean did not involve any tongue gesture at all, the amount of tongue gesture should be more or less similar across different preceding segments.

This was also backed up by the results from a linear mixed effects regression model (MODEL 7) which was fitted on the magnitude of tongue gesture for /w/ with PRECEDING CONSONANT (bilabial, alveolar, velar) and FOLLOWING VOWEL (front, non-front) as fixed effects and PARTICIPANT as a random intercept. Results from this model show that, while following vowel did not reach significance, the magnitude of tongue gesture is conditioned by place of preceding consonant: the magnitude of tongue gesture is significantly smaller when /w/ is preceded by a velar compared to when /w/ is preceded by a bilabial or an alveolar (β=-0.7, SE=0.25, t=-2.75, $p<0.01$). Therefore, we conclude that tongue dorsum movement can be considered a secondary, but important, articulatory correlate for the production of /w/ in Korean.

4. Discussion and conclusion

In this study, we investigated the articulatory properties of /w/ in Korean, using ultrasound. We confirmed that both labial and dorsal gestures are involved in the articulation of /w/ in Korean. It was further shown that the magnitude of lip gesture contributing to the production of /w/ is greater than that of tongue gesture across different segmental contexts, from which we conclude that labial gesture is the primary articulatory correlate for /w/ in Korean and the tongue dorsum gesture makes a secondary contribution. The different magnitudes of tongue gesture for /w/ by place of preceding consonant, however, strongly suggests that the tongue dorsum movements still play an important role.

The results of this study lend support to the representational theory that allows glides to have multiple designated articulators (e.g. Keating 1988, Nevins and Chitoran 2008). This study confirms that the glide /w/ in Korean consists of vocalic (the tongue dorsum raising and backing gesture) and consonantal (the lip constriction gesture) gestures. Thus, under this theory, the glide /w/ in Korean would have the featural representation [–cons, –voc, +sonorant, Labial, Dorsal], exhibiting two designated articulators involved in its production. This finding here is consistent with Gick's (2003) findings that /w/ in American English consists of both the tongue dorsum and lip constriction gestures, which he termed V- and C-gestures, respectively.

The findings of this study also provide the first empirical evidence for Nevins and Chitoran's (2008) prediction that the cross-linguistic distinction between vocalic and consonantal behavior of glides would be reflected phonetically in the relative magnitude of articulators' gestures. Consonant with their predictions, it was shown Korean /w/ that alternates with a labial consonant, as exemplified earlier in (2), indeed have larger lip gesture than tongue gesture. This suggests that the glide /w/ in Korean is more consonant-like. This finding brings into question Anderson's (1976) argument that the decision between primary and secondary articulation is purely based on phonological patterning rather than phonetic consideration. A more prominent role of the articulator, lips, is phonetically manifested in the form of the larger magnitude of labial gestures in the case of Korean.

Further research with different phonological environments, tasks, and population will shed more light on the featural representation of the glide /w/ in Korean.[6] Also, more extensive research on this topic will address the long-running controversy on the positional status of the glide /w/ in syllables in Korean as to whether /w/ occurs under onset (Ahn 1985, *inter alia*) or nucleus (Kim-Renaud 1978, *inter alia*). Additional comparative research with different languages in which /w/ alternates with dorsal consonants rather than labials, would reveal whether the relative magnitude of lip and tongue gestures are truly reflective of the vocalic behavior of glides.

REFERENCES

AHN, SANG-CHEOL. 1985. *The Interplay of Phonology and Morphology in Korean*. PhD Dissertation. University of Illinois, Urbana-Champaign.

[6] Different registers of the speech (e.g. careful vs. casual speech) and speaking rate may make a significant impact on the results of the study.

ANDERSON, STEPHEN R. 1976. On the description of multiply-articulated consonants. *Journal of Phonetics* 4, 17-27.

ARTICULATE INSTRUMENTS LTD. 2010. *SyncBrightup Users Manual: Revision* 1.10. Edinburgh, UK.

BARBOSA, ADRIANO V. and ERIC VATIKIOTIS-BATESON. 2014. Optical flow analysis for measuring tongue-motion. *The Journal of the Acoustical Society of America* 136.4, 2105-2105.

BARBOSA, ADRIANO V., HANI C. YEHIA and ERIC VATIKIOTIS-BATESON. 2008. Linguistically valid movement behavior measured non-invasively. In Roland Göcke, Patrick Lucey and Simon Lucey (eds.). *Auditory and Visual Speech Processing - AVSP08*, 173-77. Moreton Island, Australia: Caual Productions.

BATES, DOUGLAS, MARTIN MAECHLER, BEN BOLKER and STEVEN WALKER. 2014. lme4: Linear mixed-effects models using Eigen and S4. R package version 1.0-6. http://CRAN.R-project.org/package=lme4.

FLEET, DAVID and YAIR WEISS. 2006. Optical Flow Estimation. In Nikos Paragios, Yunmei Chen and Olivier D. Faugeras (eds.). *Handbook of Mathematical Models in Computer Vision*, 239-57. NJ: Springer.

GICK, BRYAN. 2003. Articulatory correlates of ambisyllabicity in English glides and liquids. In John Local, Richard Ogden and Rosalind Temple (eds.). *Phonetic Interpretation: Papers in Laboratory Phonology VI*, 222-236. Cambridge: Cambridge University Press.

HALL, KATHLEEN CURRIE, CLAIRE ALLEN, KEVIN MCMULLIN, VERONICA LETAWSKY, and ALANNAH TURNER. 2015. Measuring magnitude of tongue movement for vowel height and backness. *Proceedings of the 18th International Congress of Phonetic Sciences*.

HALLE, MORRIS. 2005. Palatalization/Velar softening: what it is and what it tells us about the nature of language. *Linguistic Inquiry* 36.1, 23-41.

HALLE, MORRIS, BERT VAUX and ANDREW WOLFE. 2000. On feature spreading and the representation of place of articulation. *Linguistic Inquiry* 31.3, 387-444.

HORN, BERTHOLD and BRIAN G. SCHUNCK. 1981. Determining optical flow. *Artificial Intelligence* 17, 185-203.

KEATING, PATRICIA. 1988. Palatals as complex segments: X-ray evidence. *UCLA Working Papers in Phonetics* 69, 77-91.

KIM-RENAUD, YOUNG-KEY. 1978. The syllable in Korean phonology. In Chin-Wu Kim (ed.). *Papers in Korean linguistics*. Columbia, SC: Hornbeam Press.

KUZNETSOVA, ALEXANDRA, PER B. BROCKHOFF and RUNE H. CHRISTENSEN. 2013. lmerTest: Tests for random and fixed effects for linear mixed effect models, R package version 3.0-1. https://cran.r-project.org/package=lmerTest.

MOISIK, SCOTT R., HUA LIN and JOHN H. ESLING. 2014. A study of laryngeal gestures in Mandarin tones using simultaneous laryngoscopy and laryngeal ultrasound (SLLUS). *Journal of the International Phonetic Association* 44.1, 21-58. DOI:10.1017/S0025100313000327

NEVINS, ANDREW and IOANA CHITORAN. 2008. Phonological representations and the variable patterning of glides. *Lingua* 118, 1979-97.

STEVENS, KENNETH N. 2000. *Acoustic phonetics (Vol. 30)*. MIT press.

YOON, TAE-JIN and YOONJUNG KANG. 2013. The Korean Phonetic Aligner Program Suite. https://korean.utsc.utoronto.ca/kpa/

Soohyun Kwon (Lecturer)
Department of English Language and Literature
Seoul National University
1 Gwanak-ro, Gwanak-gu
Seoul 08826, Republic of Korea
e-mail: soohyunkwon@snu.ac.kr

Received: November 23, 2020
Revised: December 27, 2020
Accepted: December 28, 2020