

It has long been debated whether (or how much) fine phonetic details should be incorporated into phonology. One position is a unified model of phonetics and phonology on the assumption that phonological phenomena lie in a continuum with phonetics (Barry 1992; Zsiga 1993; Cho 1998; Flemming 2001), while the other is that those two consist of independent components (Keating 1996, Barnes 2002). So the revelation of examples of the interaction between the two can offer important clues to shed light on their closer relation, favoring a unified model. However, there have been very few investigations of the interaction between phonological rules and coarticulation across languages.

In this study, with the aim of revealing the interaction between phonological rules and coarticulation, we focused on the degree of anticipatory vowel to vowel coarticulation, centering around palatalization in Korean. In Korean palatalization, coronals /t,t^h/ become palatals /t͡ɕ,t͡ɕ/ before /i/ across a morpheme boundary. Articulatory data obtained through ultrasound imaging experiments was used to test three hypotheses. The first hypothesis is that the degree of V-to-V coarticulation is less prominent in words with palatalized consonants than in words with intervening alveolars. The basic reasoning behind this is that palatals show longer duration, and so work as stronger barriers to prevent coarticulation. The second hypothesis is that the degree of V-to-V coarticulation is more prominent in words with the triggering high front vowel /i/ than in words with a low vowel with regard to tongue frontness. The third is that the degree of V-to-V coarticulation is stronger in assimilated forms than in unassimilated forms as an influence of a phonological rule. On the basis of ultrasound images from 5 native Korean speakers, the distance from the palate to the tongue body were measured at two points (front and back), and the amount of distance between these two points was calculated with logarithm values to indirectly see how much the tongue body is articulated forward.

First, analyses of data set (1) revealed that back vowels preceding palatals are articulated farther front than those preceding alveolars, which does not support the first hypothesis as seen in (4a). This result indicates that back vowels preceding palatals undergo anticipatory coarticulation more than those before alveolars. This result is unexpected, considering that alveolars are farther fronter than palatals in the sense that the former is [coronal, +anterior], and the latter is [coronal, -anterior] in terms of a featural representation (Clements & Hume 1995). However, the lack of explanatory power of these phonological features in this case leads to a different interpretation in terms of tongue body gestures. That is, the reason why back vowels before palatals are articulated fronter may be due to the common gestural activity of /i/ and palatals. Both segments primarily involve tongue body movement, while alveolars employ tongue tip as a primary gesture. The successive employment of tongue body gestures from vowels to palatals play a major role in more prominent gestural overlap between the vowels.

Analyses of data set (2) were found to support the second hypothesis by showing that back vowels preceding the front vowel /i/ are produced farther front than those preceding a back vowel /a/ as is seen in (4b). It was found also that the back vowels preceding intervening palatals are articulated fronter than those before alveolars, confirming the role of tongue body gesture of palatals.

Lastly, and perhaps the most interesting analyses of data set (3) support the third hypothesis by showing that back vowels in the palatalized words were articulated significantly more front than those in words with underlying palatals (4c). This result suggests that intergestural timing relations between two vowels are fixed in the mono-morphemic words (3b), while those in palatalized words are looser because of the morpheme-boundary. However, the application of the palatalization rule plays a role in making the intergestural timing more overlapped between the vowels. Thus, this shows that high-level phonological rules directly enhance the degree of low-level coarticulation, indicating that gestural coordination can be included in phonological representation and that it is necessary to formally capture this type of phonological enhancement in the grammar. The difference in degree of coarticulation can be schematized with respect to the degree of gestural overlap as is illustrated in (5) (Cho 1998, Gafos 2002).

These ultrasound imaging data have several interesting implications. First, regarding the first hypothesis, it is shown that a gestural analysis works better than a strictly featural or acoustic analysis in order to explain the stronger V-to-V coarticulation effect. Second, our results about the second hypothesis confirm that /i/, which is the most resistant to coarticulation, influences the articulation of the preceding back vowels even with intervening coronals. Third, we report that phonological rules directly affect the degree of V-to-V coarticulation, implying that phonology can be intertwined with phonetic-fine details as in a unified model rather than separation model.

