Comparing simulations and experimental data in order to explain looping patterns

Jana Brunner
Zentrum für Allgemeine Sprachwissenschaft, Berlin
Email: brunner@zas.gwz-berlin.de

Models in speech production and perception are built on theoretical concepts. The advantage of running simulations by means of speech production models and comparing the respective results with experimental data consists in the fact that on the one hand models can provide possible explanations of the underlying mechanisms which are difficult to assume on the basis of articulatory kinematic data. On the other hand experimental data can help to verify models or improve their current state. Such an approach is used here in order to describe looping patterns for intervocalic velar stops in Korean by comparing experimental data with simulations with a 2D biomechanical tongue model.

Korean was chosen for gaining experimental data because it is a language characterised by a three way voicing contrast, it distinguishes between a voiced, a voiceless aspirated and forced velar stop. Looping pattern can be found in all the stops, the size of the loops which means the movement amplitude of the sliding movement along the palate during closure, however, differs. Two possible explanations for this will be dealt with in this study. The first one investigates the relationship between the angle of incidence at the palate and the movement amplitude of the movement during closure. Following kinematics, if an object moves into another object with a certain force the force should be redirected depending on the angle of incidence. For example, if the tongue moves against the palate in an obtuse angle coming from the back it should be redirected towards the front. If the angle is around 90° the tongue should have the greatest impact on the palate since the force cannot be redirected. If the tongue moves against the palate in an acute angle the tongue should be redirected towards the back, however, since there are other mechanisms pushing the tongue towards the front, we expect it to move towards the front as well, however, with a smaller movement amplitude. Consequently, there should be a positive correlation between angle of incidence and movement amplitude. The second possible explanation for differences in the size of loops lies in tongue biomechanics. Following Perrier et al. (2003) loops are at least in part a result of tongue biomechanics. This means that the movement amplitude of the sliding movement along the palate should be independent of the impact of the tongue at the palate and should also be found even if there was no palate.

Experimental data were won by recording two speakers of Korean via electromagnetic articulography. The word material consisted of VCV-sequences where V is either /a,i/ or /u/ and C one of the three Korean velar stops. The angle of incidence was estimated by using the coordinates of velocity peak during the closing gesture, articulatorily measured closure onset and closure offset to form a triangle and then calculating the angle at closure onset. The movement amplitude from closure onset to closure offset was measured. Correlations between size of angle and movement amplitude could be found: The greater the angle the longer the movement amplitude.

In order to find out in how far both, the angle of incidence and the movement amplitude are influenced by tongue biomechanics simulations with the 2D-biomechanical tongue model by Payan & Perrier (1997) and Perrier (2003) will be carried out. There will be two series of simulations. In the first series it will be tested whether the model reacts in the same way in that the movement amplitude is greater if the angle is larger. In the second series of simulations we will use the model without a palate in order to see whether the influence on the movement amplitude comes from biomechanics or from the angle of incidence or maybe from both.