Lingual coarticulation and articulatory constraints in 3-year-olds: an ultrasound study

Growing evidence from studies of coarticulation in children suggests that age-related segment-specific differences in coarticulatory patterns may be due to developmental immaturities in speech motor control (e.g., Sussman et al. 1999; Katz & Bharadwaj 2001; Zharkova et al., 2014, 2015; Reidy 2015). For example, in an ultrasound study by Zharkova et al. (2015), 5-year-old children did not have some of the vowel-related differences in tongue shape that were demonstrated by 13-year-olds, when coarticulating stop consonants with upcoming contrasting vowels. In the present study, ultrasound tongue movement data were used to quantify lingual coarticulation in 3-year-old children. Also, the data for these children were compared with the data from Zharkova et al. (2015), in order to describe developmental patterns of coarticulation.

The speakers were seven typically developing children acquiring Scottish Standard English (three girls), aged between 3;4 [years;months] and 4;1, with the mean age of 3;9. The children repeated a short carrier sentence after their carers, as part of a game. The target consonants were /p/ and /t/, produced in CV syllables with the vowels /i/ and /a/. The ultrasound transducer was hand-held under the speaker's chin by the experimenter. Each target was repeated between three and six times. The ultrasound data were recorded at the frame rate of 100 Hz, synchronised with the acoustic signal. Simultaneous video recordings were qualitatively examined, to ensure that each token selected for tongue shape analyses showed a midsagittal tongue image surrounded by the shadows of the chin and of the hyoid bone. For each token, the tongue curve outline was traced at mid-closure. The data for /t/ from one child and for /p/ from another child had to be excluded from inferential statistical analyses, due to insufficient numbers of repetitions satisfying the criteria above.

The same measures were used as those from previous studies of coarticulation in children (e.g. Zharkova et al., 2015). One measure, $LOC_{a\text{-}i}$, quantifies the location of bunching along the tongue curve, and the other measure, Dorsum Excursion Index (DEI), assesses the extent of tongue bunching. There were significant effects on $LOC_{a\text{-}i}$ for /p/ and on DEI for /t/, with values for both indices being larger in the context of /i/, as would be expected for adults. For /t/, the effect of vowel on $LOC_{a\text{-}i}$ was not significant. When the sizes of the observed coarticulatory effects were compared with those reported for 5-year-olds and 13-year-olds by Zharkova et al. (2015), there were no significant across-group differences. The findings demonstrate that 3-year-old children are able to adjust the tongue shape to that of the following vowel not only for the bilabial stop, but also, to an extent, for an alveolar stop, despite certain constraints on the tongue imposed by the /t/ production requirements. At the same time, 3-year-olds have similar developmental immaturities to 5-year-olds, in that they do not use relative location of tongue bunching for coarticulating the alveolar consonant. This pattern may suggest the lack of coordination between the front and the back of the tongue.

References

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