The effects of ultrasound image feedback on Korean L2 learners' production of English /ɹ/ in production training

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This study investigates the effects of production training with using ultrasound image feedback on Korean L2 learners' production accuracy of English retroflex. It has been widely known that Korean learners of English have a problem with production and perception of English /ɹ/ and /l/. It may arise from a one-to-two match relation between the Korean L1 phoneme /l/ and the English L2 phonemes /ɹ/ and /l/. Moreover, both Korean /l/ and English /ɹ/ and /l/ have two allophonic variants respectively depending on syllable position. When the variants are further considered, the learning mechanism of English /ɹ/ and /l/ may be more complicated. Numerous studies have examined L2 learners' production and perception of the sounds and extended to L2 perception training (Aoyama et al., 2004; Bird & Gick, 2018; Bradlow et al., 1999 among others), but there have been very few about production training, particularly using a high technology methodology, for instance, 'ultrasound images.' This sheds light on the current work of articulatory training of the English L2 retroflex with ultrasound imaging feedback and its effect on learning improvement.

In the experiment, nine Korean learners of English, who were rated as intermediate in English proficiency from a Foreign Accentedness (FA) task, participated in the production training sessions of English /ɹ/ with ultrasound imaging feedback. They went through 6 sessions of production training and took three production tests: a pretests, a posttest and a generalization test. In each test, they recorded 72 English words containing /ɹ/ (24 words * 3 repetitions) in onset and coda positions respectively and a half of them were minimal pairs with /l/. In the posttest and the generalization test, 12 novel words each were used. The posttest was carried out right after they finished the last training session, and the generalization test was given a month away from the last training. Participants were provided a 10-minute instruction about the speech organs and the tongue tip movement during /ɹ/ articulation only in the first training. Each training lasted one hour where a learner read a list of sentences 'Please say _____ for me' while they looked at the ultrasound videos of their production. When the tongue tip was not satisfactorily raised and curled back, the instructor showed a native speaker's ultrasound image of the same word for corrective feedback. The instructor did not present any oral explanation about how the trainees were incorrect. Ultrasound images were aligned with spectrograms and splined at the midpoint of the acoustic duration of /ɹ/. Spline coordinates (over 42 points) were extracted and submitted to SSANOVA in R for the tongue contour analysis.

Results showed that Korean learners of English with intermediate proficiency mostly produced the Korean tap [ɾ] in onset position before training as shown in Figure 1. However, they successfully raised up the tongue tip to make a retroflex in coda position though the tongue tip curling-back gesture was not sufficiently distinctive. In the posttest, the retroflexation articulation of /ɹ/ was successfully produced in both onset and coda similarly to native speakers' retroflex as in Figure 2. In the generalization test, individual differences were found; one of them failed to maintain the retroflexation gesture in onset position, and two of them showed that its degree decreased. For the production of coda /ɹ/, most of the participants maintained their learning of tongue tip curling gesture while tongue tip rising was unwaveringly observed. One of the participants showed a hyperarticulation; the tongue tip rising was toward further back of the hard palate.

The corrective feedback of ultrasound image seemed to be significantly effective on Korean learners' accuracy of English onset /ɹ/ production as most participants showed significant

improvement after training. The ultrasound imaging of a retroflexation gesture seemed to be satisfactorily applied to a participant' motor control over articulating the English retroflex.

Korean learners of English with intermediate proficiency were likely to be accurate at producing the coda retroflex before training though the location and the degree of tongue tip raising was various. Clear-[l], which is allophonically produced in coda position of Korean, is phonetically and in some languages phonologically very distant from [ɹ]. According to the L2 Speech Learning Model (Flege, 1995) that an L2 sound, which is more distant from its corresponding L1 sound, is perceptually more accessible and ultimately easier to learn to produce, the coda [ɹ] has been learned to a great extent. On the other hand, both tap and retroflex involve a concave tongue shape and a lower F3 in CV structure (Cathcart, 2012). This serves a substantial account for the inaccurate production of the onset /ɹ/ before training. Korean /l/ is allophonically realized as [ɾ] in onset position, and the English [ɹ] is phonetically closer to the Korean tap [ɾ], which may result in more perceptual confusion. It will therefore take more time to learn to perceive and produce, and even when it is learned, it will be hard to maintain the learning.
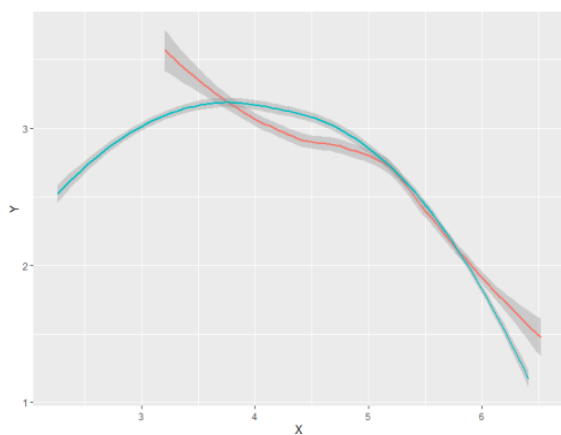

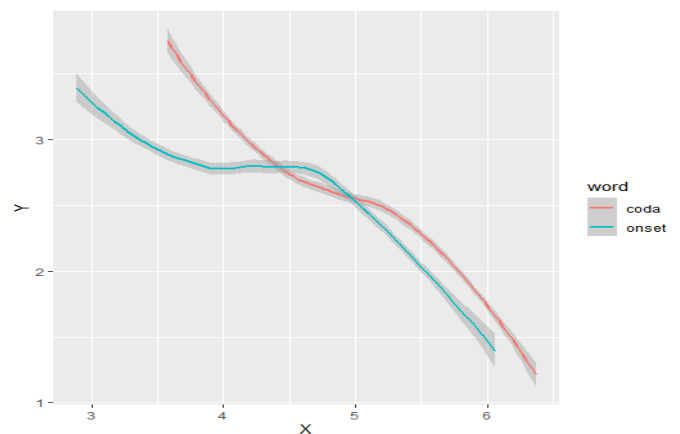Figure 1. Smooth splines of [ɹ] in pretest

Figure 2. Smooth splines of [ɹ] in posttest

References
[1] Aoyama, K., Flege, J. E., Guion, S. G., Akahane - Yamada, R., & Yamada, T. (2004). Perceived phonetic dissimilarity and L2 speech learning: The case of Japanese /r/ and English /l/ and /r/. *Journal of Phonetics* , 32 (2), 233 - 250.
[2] Bird, S. and Gick, B. (2018) Ultrasound biofeedback in pronunciation teaching and learning. *Proceedings of the 2nd International Symposium on Applied Phonetics*. (ISAPh 2018), 5 - 11.
[3] Bradlow, A. R., Akahane-Yamada, R., Pisoni, D. B., & Tohkura, Y. I. (1999). Training Japanese listeners to identify English/r/and/l: Long-term retention of learning in perception and production. Perception & psychophysics , 61 , 977-985.
[4] Cathcart, C. (2012) Articulatory variation of the alveolar tap and implications for sound change. UC Berkeley Phonology Lab Annual Report, 76-110.
[5] Flege, J. (1995) Second language speech learning: Theory, findings, and problems. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research*. Timonium, MD: York Press, 233-277.