Development of Speech Perception in Korean Infants: Discriminating Unusual Sound Contrasts with Diachronic Change

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Compared to other languages, phonetic categories that are utilized in Korean are relatively unusual: (1) stops and affricates contrast in three ways as fortis, lenis, and aspirated and they are all voiceless (e.g., for bilabial stops: /p*/, /p/, /p^h/, and for affricate: /c*/, /c/, /c^h/). Fricative contrast in Korean is also all voiceless unlike other languages although they do not contrast in three ways. (2) two of the three categories, lenis and aspirated, have also undergone a tonogenetic sound change in the past few decades such that voice onset time (VOT) is no longer the primary cue for distinction and instead, fundamental frequency (F0) has become the primary cue for their distinction [1]. These unique phonetic characteristics and diachronic change that has occurred in Korean present a unique opportunity to study the emergence of phonetic categories in young infants and the specific roles that infants' initial perceptual capacities and the phonetic input play in speech perception development. In the past several decades, much has been uncovered about the development of speech perception and yet, it still is crucial to investigate cases such as Korean to better understand how diverse phonetic categories emerge and what factors contribute to these development.

We have been investigating Korean infants' development of the ability to discriminate these sound categories, including three-way bilabial stop contrasts [2], two-way fricative sound contrast [3, 4], and three-way affricate contrasts (currently on-going). Using a modified visual habituation paradigm [5, 6], we have tested 4 through 12 months olds to examine the developmental patterns of these sound categories.

For fricative contrast, presented in /a/ vowel context, spoken by a female speaker using Infant-directed speech register such as fortis /s*a/ (mean aspiration duration = 3.6 (SD=1), mean noise duration = 170.07 (SD=30)) versus lenis /sa/ (mean aspiration duration = 70.4 (SD=19), mean noise duration = 123.27 (SD=10)), we observed that 7-9-month-olds (N = 23, 9 girls, mean age = 255 days, age range: 215~301 days) reliably discriminated the fricative pair, displaying significantly increased looks to the changed sound category trial (F(1, 21) = 3.807, p = .016) as compared with the unchanged sound trial. By comparison, the younger infants (N = 21, 7 girls, mean age = 165 days, age range: 138~209 days) did not show a clear sign of distinction (F(1, 19) = 0.728, p = .404). These results suggested that Korean infants begin to discriminate fortis-lenis fricative pair around 7 months of age and not before [3]. Interestingly, when the fricative contrast was presented in /i/ vowel context [4], 7-8-month-olds (N = 20, 8 girls) could not distinguish the contrast (t(19) = .004, p = .997). It was 8 1/2 to 9 months of age (N = 20, 10 girls) that could reliably discriminate the fricative pair (t(19) = 2.236, p = .038). This finding additionally showed that infants' abilities to discriminate the phonetic contrast may be somewhat limited and initially context-bound and slowly generalize to various phonetic contexts.

For bilabial stop contrasts, even 7-9-month-olds (N = 24, 11 girls, mean age = 255 days, age range: 212~296 days) did not show signs of clear discrimination for lenis-aspirated contrast (i.e., /pu/ versus /p^{h}u/) because their looking times did not differ by the change in the sound category (F(1, 23) = 0.248, p = .623). 10-12-month-olds (N = 27, 16 girls, mean age = 340 days, age range: 307~377 days), however, showed significant difference in their looking time in response to the sound category change (F(1, 26) = 7.030, p = .013), suggesting that it is after about 10 months of age that Korean infants begin to discriminate this pair [2]. By comparison, we observed that infants as young as 5-6 months (N = 24, 11 girls, mean age = 182 days, age range: 160~209 days) could discriminate the fortis-aspirated contrast (t(23)= 2.592, p = .016). For fortis-lenis contrast, it appeared taking time until Korean infants begin reliably distinguishing them. In

our study, it was 8-9 months of age that infants (N = 20, 9 girls, mean age = 278 days) could clearly discriminate this pair but 7-8-month-olds (N = 20, 9 girls, mean age = 238 days) were not able to discriminate this contrast. Furthermore, mothers of 7-9-month-old infants showed individual differences in producing VOT differences across the three pairs and the individual differences in VOT particularly for fortis-lenis pairs showed a positive correlation ($r(20) = .507$, $p = .023$) with their infants' looking time differences between the same and change category trials. The effect of maternal phonetic differences accounted for about 17.6% of 7-9-month-olds' discrimination behavior even after controlling for infant's age, which showed a positive correlation with infants' discrimination ability [7]. These suggested that the larger the related acoustic cue was provided by the mothers, the better their infants were to distinguish the two sound categories.

Currently, we are testing infants between 4 and 6 months with fortis-aspirated affricate pair (i.e., /c*a/ versus /c^{h}a/). Although the results are preliminary (with 13 babies participated thus far), so far it appears that Korean infants begin to discriminate this pair around 5-6 months, similar to our observation on fortis-aspirated bilabial stop contrast.

Taken together, our findings demonstrate that Korean infants' learning of three-way contrasts may take longer than those whose language utilizes two way contrast. More importantly, the sound contrasts that have undergone a tonogenetic sound change were the latest for Korean infants to become able to discriminate. Our finding on the relationship between maternal phonetic input and infants' individual differences in their discrimination abilities suggest that this delay may have something to do with this on-going change. In another investigation, we observed that maternal input varied more widely than expected: some mothers reflect the tonogenetic change in their input when they speak to their infants but not to other adults. But other mothers do not fully reflect the diachronic change in their input to their babies. The mixed nature of the input due to this on-going diachronic change might delay young infants as they discover the relevant sound categories in their language. This, in turn, suggests that the acoustic properties of the input provided for infants play an important role in the development of speech perception.

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