

Investigating Vowel Hyperarticulation in Korean Infant-Directed Speech

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Previous research on the vowel production in Infant-Directed Speech (IDS; Kuhl et al., 1997; Burnham et al., 2002; Kalashnikova et al., 2018) presents conflicting findings (Benders, 2013; Englund & Behne, 2006; Cristia & Seidl, 2014), potentially influenced by factors such as word contexts, infant age, and the methods used for operationalizing hyperarticulation and formant extraction. Commonly applied formant and vowel space comparisons for hyperarticulation may lead to overestimations. To address this, the Vowel Hypo- and Hyper-articulation (VHH) index (Marklund & Gustavsson, 2020) emerges as an alternative metric, offering the degree of VHH for each individual vowel token. We investigate the vowel hyperarticulation hypothesis of IDS through a word-teaching task conducted with Korean mothers. We compare the degree of vowel hyperarticulation between Korean IDS and Adult-Directed Speech (ADS) using both the VHH index and traditional measures, while controlling for confounding factors in the statistical models.

Twenty-two Korean mother-infant dyads (7 girls) participated in the study, comprising 17 prelexical (M = 309, SD = 44 days) and 5 early-lexical infants (M = 502, SD = 1 day). The task involved teaching nonce words with vowels /a/, /i/, and /u/ in the initial syllable, serving as labels for novel objects in the picture books. Participants initially read books containing the stimuli and subsequently explained the words in spontaneous speech. Each participant taught the words to both their child and a confederate adult. We analyzed 2883 vowel tokens in total, coded for style (reading/spontaneous), target (target/non-target), and sentence position (initial/medial/final/isolated). For robust formant estimation, we individually optimized the formant ceiling for each speaker and vowel type by varying the maximum formant ceiling from 4500 Hz to 6500 Hz in 10 Hz increments and selecting the ceiling value with the lowest variance in the F1-F2 pairs (Escudero et al., 2009). Subsequently, outliers were identified and excluded using z-scores (> 2SD).

Euclidean distances between vowel pairs were calculated based on averaged F1 and F2 values and compared using paired t-tests, which yielded mixed results (/a/ - /i/: $t = -3.49$, $p = 0.002$; /i/ - /u/: $t = -4.70$, $p < 0.001$; /u/ - /a/: $t = -0.98$, $p = 0.341$). We found the dimension of vowel space to be greater in IDS compared to ADS ($t = -2.44$, $p = 0.024$). Differences in F1 and F2 values for a given vowel were examined through linear mixed-effects models (Table 1). These models incorporated speech register (IDS/ADS), style (reading/spontaneous), age, sex, target, and position as independent variables, with speakers included as random variables. Furthermore, the VHH index, computed for each vowel token per speaker, underwent comparison using parallel linear mixed-effects models (Table 1).

The VHH index consistently showed that Korean mothers hyperarticulated vowels in IDS. Moreover, we found that the proportion of vowel tokens that were highly hyperarticulated (e.g., VHH index > 75th percentile) in IDS was greater than in ADS. The vowel space area was noted to be larger in IDS than in ADS; however, the direction of formant shifts did not necessarily indicate hyperarticulation. Furthermore, relying solely on raw formant values did not consistently confirm enhanced vowel categories in IDS. Additionally, we observed the greatest degree of hyperarticulation in isolated words, followed by utterance-final words. This pattern is likely attributed to the lower articulation rate in these positions (Sjons, 2022), aligning with the recognized significance of these positions in infants' word learning (Brent & Siskind, 2001; Sundara, 2018). These results emphasize the importance of careful methodological considerations in uncovering aspects of IDS accommodation that might be overlooked with conventional approaches.

Table 1. Direction of Hyper/Hypo-articulation in IDS compared to ADS based on a comparison of formant values and the Vowel Hypo- and Hyper-articulation (VHH) index methods.

		Estimate	Std. Error	t value	Pr(> t)	Direction
/i/	F1	4.99	3.75	1.33	0.184	
	F2	72.04	14.23	5.06	<0.001	Hyper***
	VHH	0.04	0.01	5.21	<0.001	Hyper***
/u/	F1	35.07	8.39	4.18	<0.001	Hypo***
	F2	-57.08	21.03	-2.71	0.007	Hyper***
	VHH	0.04	0.02	2.63	0.009	Hyper***
/a/	F1	22.10	6.08	3.64	<0.001	Hyper***
	F2	21.80	9.68	2.25	0.025	Hypo*
	VHH	0.03	0.01	2.57	0.01	Hyper*

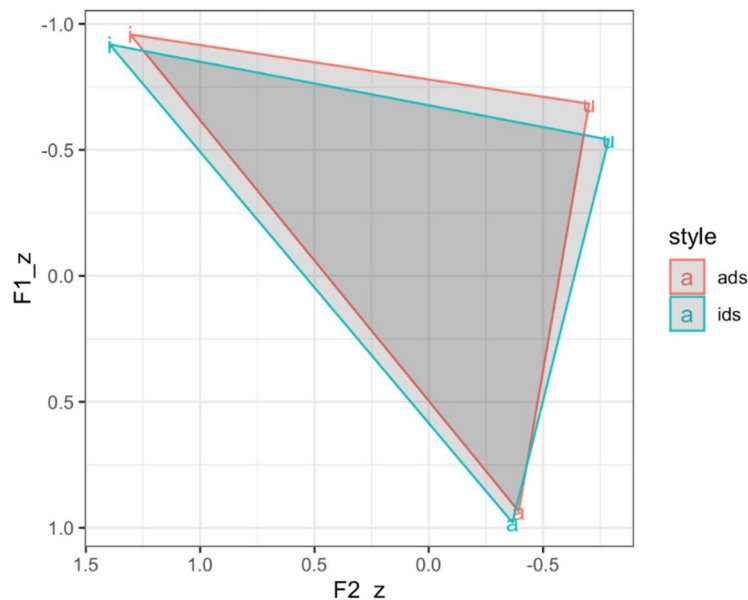


Fig. 1. Vowel space of Infant-Directed Speech (IDS) and Adult-Directed Speech (ADS) in Korean mothers

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