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서울대학교
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Phonetic Development of Korean Fortis, Lenis, and Aspirated Stops in Young Toddlers

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16:25~16:50

Acquisition of the three-way contrasts of word-initial stops in Korean

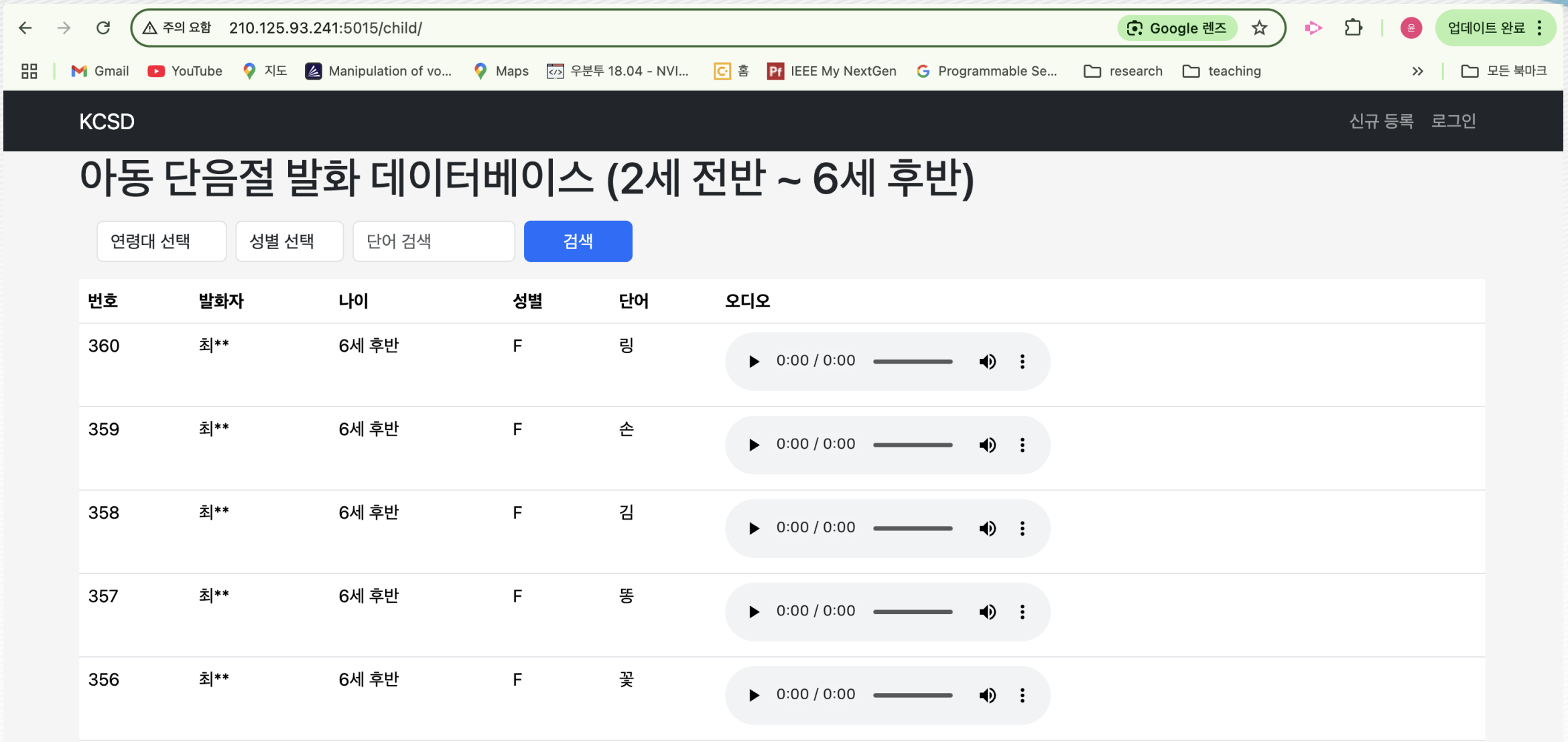
All three phonation types of stop were mastered by **75%** of Korean-speaking children in the age group **from 3;1 to 3;6.**

Fortis stops in the word-initial position were mastered **before lenis or aspirated stops**, produced correctly by 95% of children **before 2 years 6 months**

What about younger than 29months, e.g., 18 to 29 months?

Kim & Ha, 2022; Kim & Pae, 2005; Moon & Ha, 2012; Pae, 1995.

Monosyllabic words



http://210.125.93.241:5015/child/

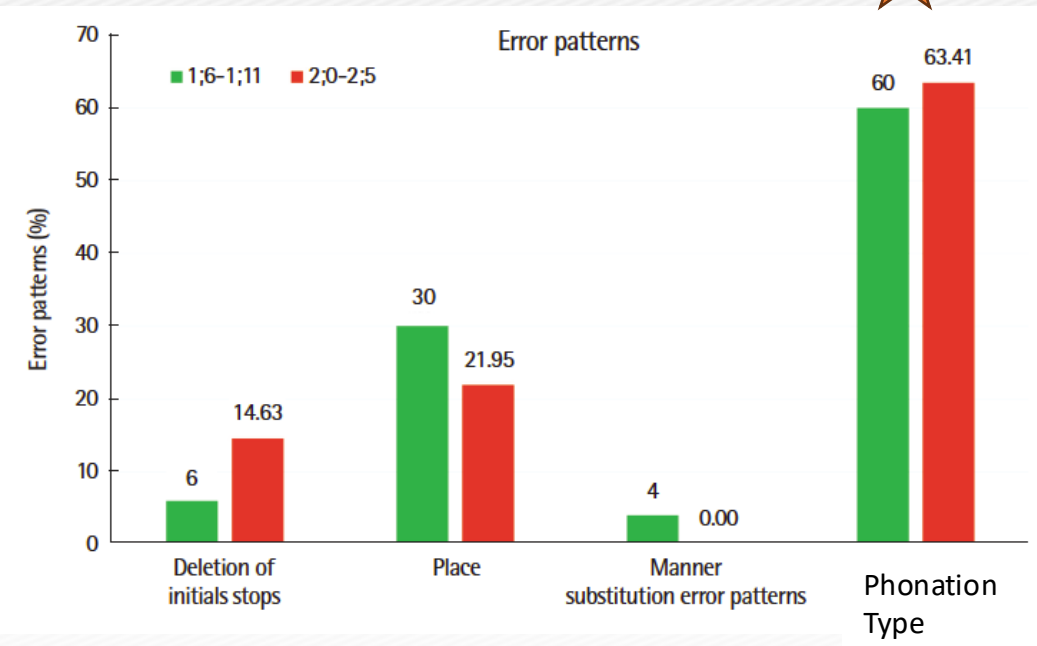
Age window of 18 to 29 months?

Kwon, Ha, & Yoon (2024) documenting the **accuracy and error patterns** of word-initial stops in children aged 18m to 29m.

Frequent phonation-type errors

suggesting that the phonatory aspect of Korean stops presents a particular challenge during this stage.

27m '팔'



Kwon, Ha, & Yoon (2024)

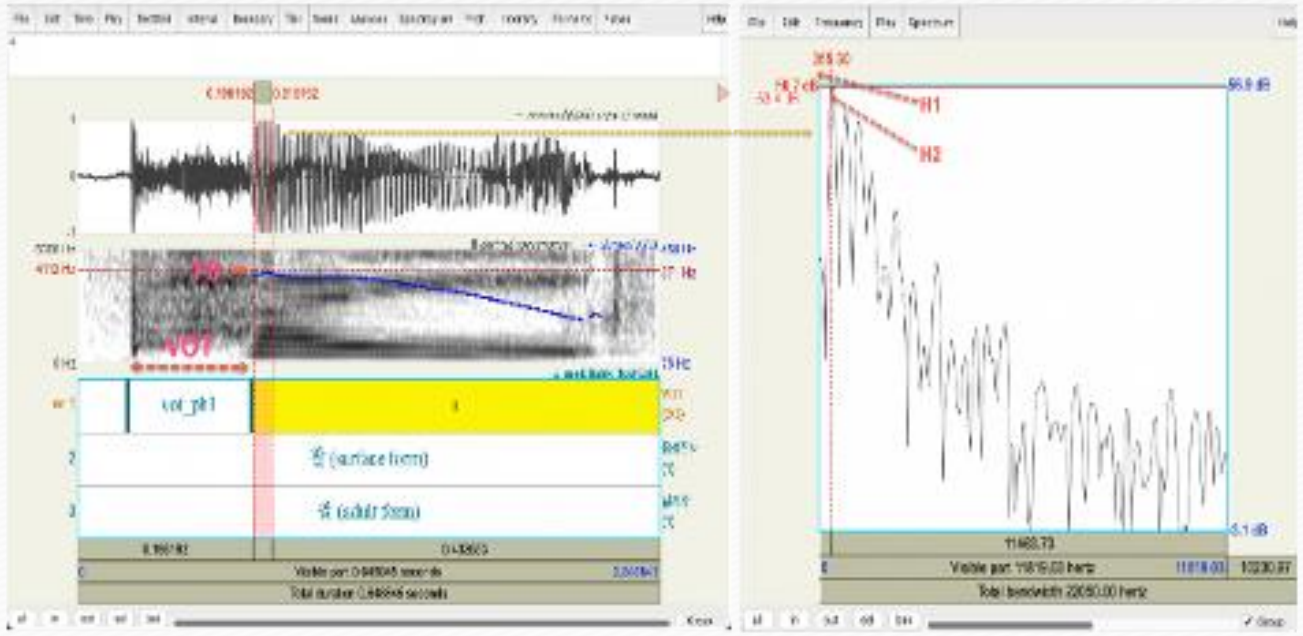
25_OJN_21mo_F_1

Acoustic properties of correctly produced stops

Children may produce **statistically significant acoustic differences** between phonemes that are **not yet perceptually salient**.

covert contrast

Such findings suggest that surface-level transcription may underestimate children's phonological competence during early development.



Forrest et al., 1990; Kim, 2013; Li et al., 2009; Macken & Barton, 1980

Target words with Korean stops in word-initial position

Lenis	Fortis	Aspirated
/pal/ “foot”	/p*aŋ/ “bread”	/pʰal/ “arm”
/tal/ “moon”	/t*al/ “daughter”	/tʰal/ “mask”
/koŋ/ “ball”	/k*ot/ “flower”	/kʰoŋ/ “bean”

Target words consisted of monosyllabic CVC triplets representing word-initial fortis, aspirated, and lenis stops at three places of articulation (bilabial, alveolar, velar).
These target words were primarily selected and adapted from CVC triplets utilized in the Kim and Stoel-Gammon (2009) study.

Participants

35 children

18 to 23 months

M = 21.8;
SD =1.37

15

5 boys
10 girls

24 to 29 months

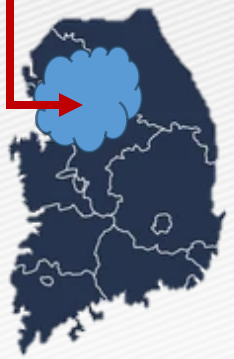
M = 26.65;
SD =1.93

20

4 boys
16 girls

All participants lived in the central region of Korea

No history of speech, language, hearing or sensory disorders and spoke the Seoul dialect



Adults

- 10 adults voluntarily participated in the study
- The age of the adult participants ranged from 20 to 35 years old

(M = 24.5, SD = 3.1)

Procedure

Data were collected in a quiet room at the child's home.

Before recording children's speech samples, she made efforts to establish a positive and supportive relationship with them, facilitating their cooperation and comfort for approximately 10-20 minutes.

To elicit production data, the children were prompted to produce the target words in response to questions such as "What is this?" or "Who is this?".

If the children did not respond spontaneously, the experimenter demonstrated the target word and then asked questions to elicit delayed imitation.

Coping with inherent challenges

In light of the inherent challenges posed by the limited attention and cooperation of young children aged 1-2 years in naming pictures and eliciting spontaneous speech, the research team implemented several strategies to address these limitations.

Initially, the team provided parents with picture materials representing target words before the scheduled visit, allowing them time to familiarize themselves and their children with the vocabulary through repeated exposure.

Furthermore, to enhance engagement, corresponding toys or objects were presented alongside the pictures.

If there was no response even after providing the toys, the recording was paused for about 10 minutes to allow for rest and familiarization with the target words.

The research assistants directly interacted with most of the children. However, for some of the youngest children who were not cooperative, the mother was also involved in the activities as instructed by the experimenter.

Token

Each participant was required to repeat each target word three times, resulting in a total of 27 tokens (9 target words x 3 times).

The order of presentation was randomized to control for order and learning effects.

The data collection process took approximately 10 to 15 minutes.

9 target words

X 3 X 35 = 945 tokens

repetition children

Linear Mixed-Effects Models

Separate linear mixed-effects models were fitted for each response variable—VOT, F0, and H1-H2—using the lme4 package in R.

Response ~ PHONATION + age group + PHONATION * age group + (1|speaker)

VOT
F0
H1-H2

two groups of children (18 to 23 months and 24 to 29 months)

the combined group of children with adults.

Lenis
Fortis
Aspirated

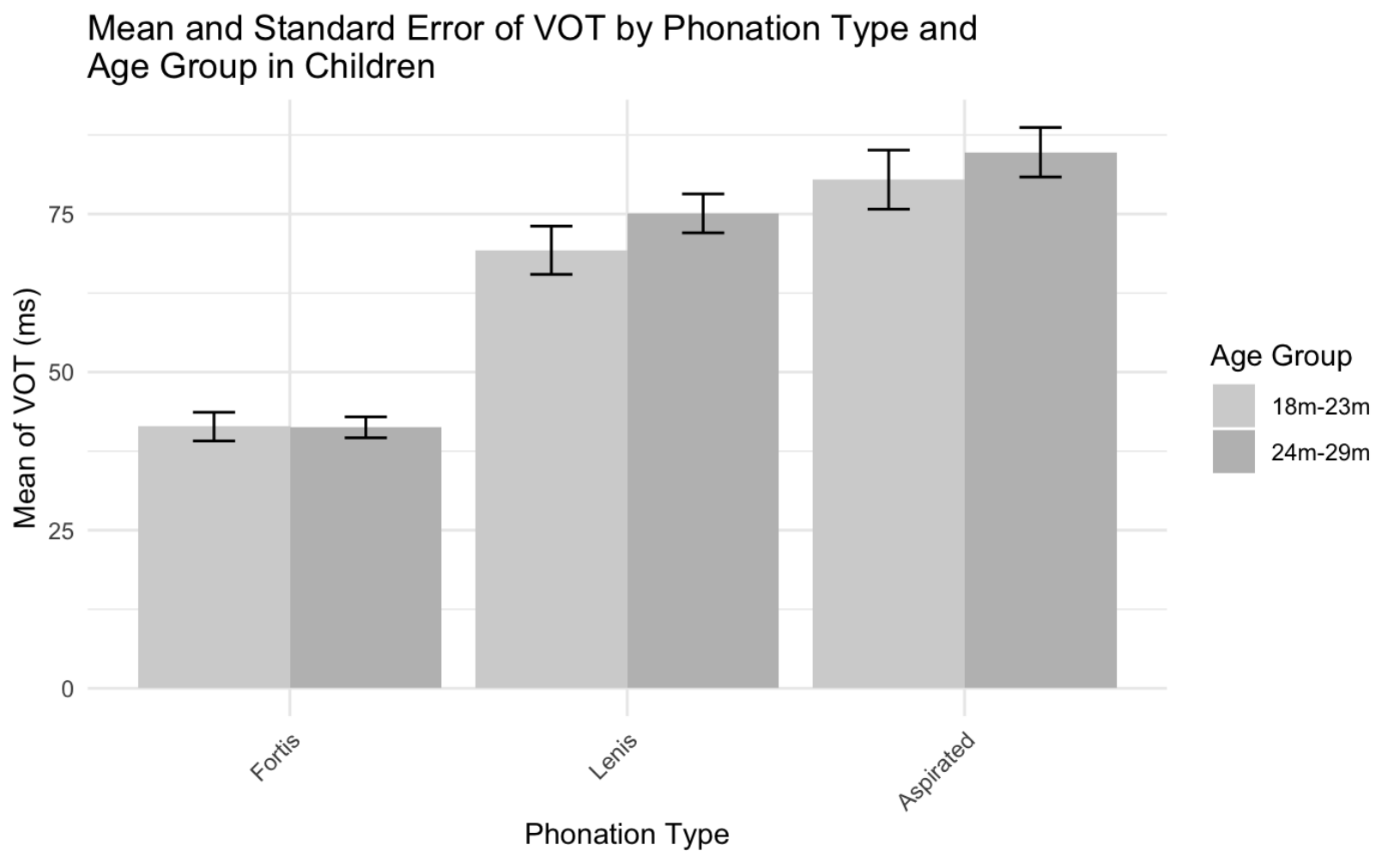
Random effects

Each model included **fixed effects** for age group and phonation type (lenis, fortis, and aspirated), as well as the interaction.

Random intercepts for individual speakers accounted for speaker variability.

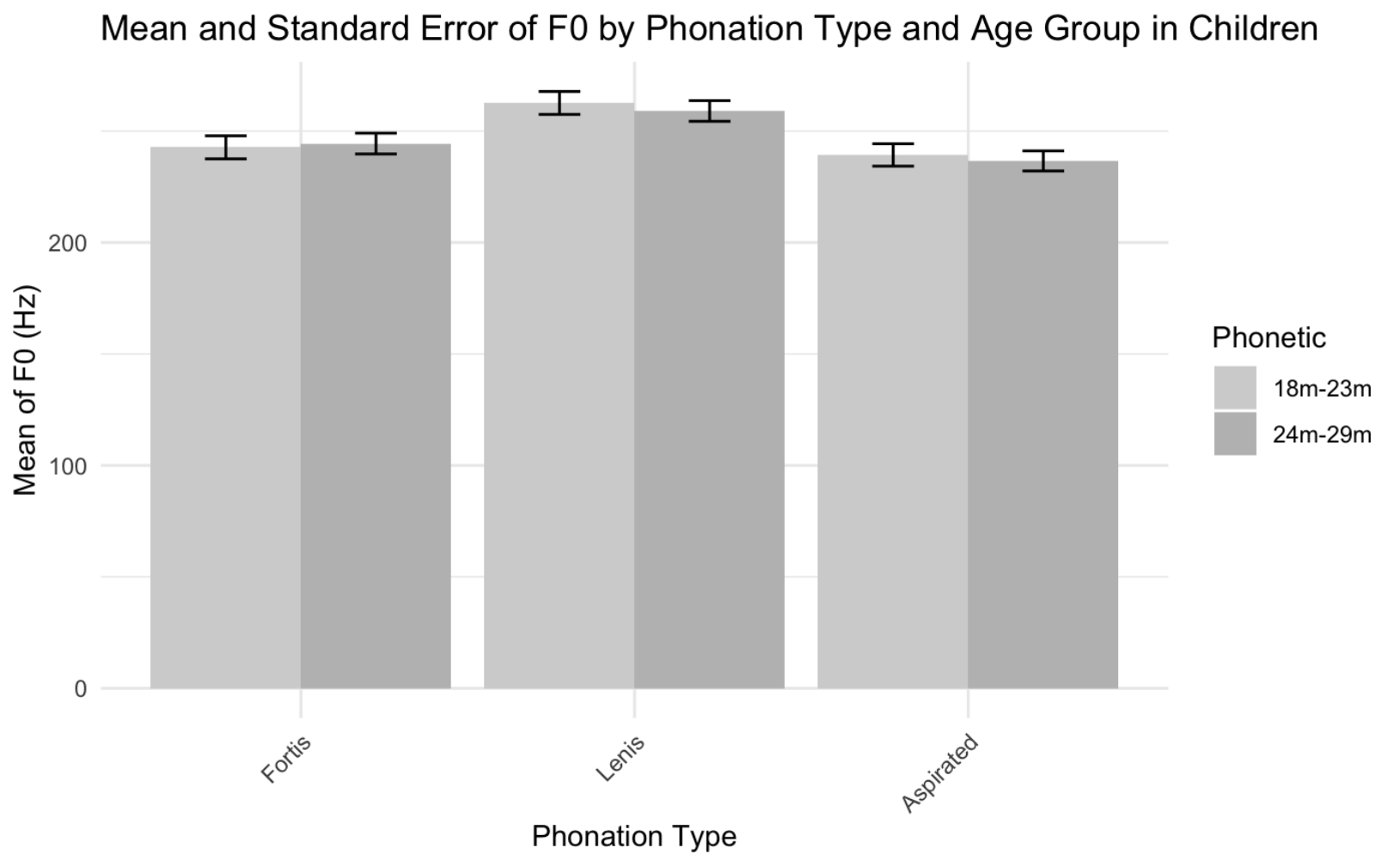
The age group variable was analyzed by comparing two groups of children (18 to 23 months and 24 to 29 months) and the combined group of children with adults.

VOT btw two child groups



- **No main effect** between age group
- **Main effects** between fortis vs. lenis and between lenis and aspirated
- **No interaction** between age group and Phonation Type

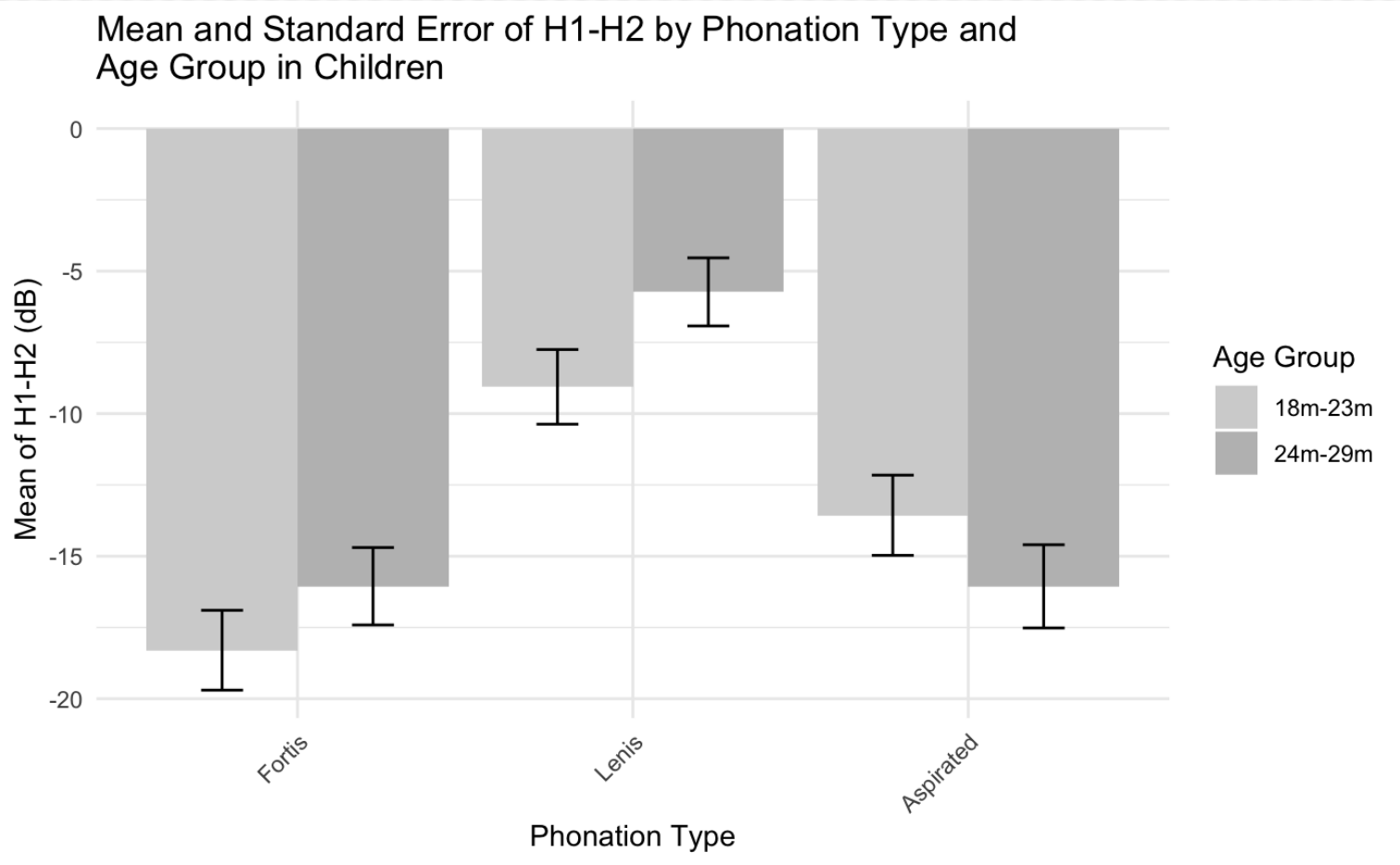
F0 btw two child groups



- **No main effect** between age group
- **Main effects** between fortis vs. lenis and between lenis and aspirated
- **No interaction** between age group and Phonation Type

H1-H2 btw two child groups

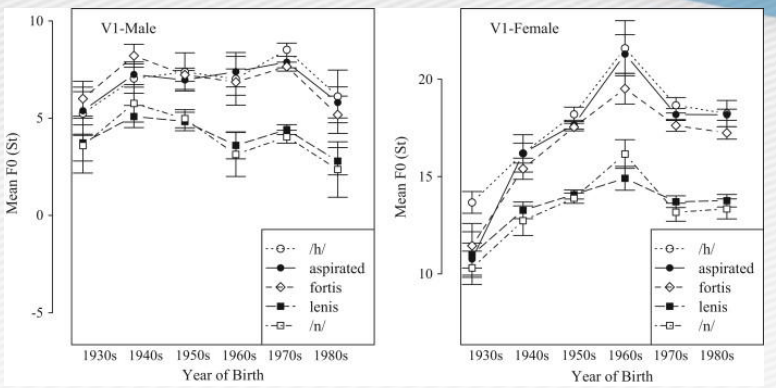
H1-H2, the amplitude of H1 – the amplitude of H2



- **No main effect** between age group
- **Main effects** between fortis vs. lenis and between lenis and aspirated
- **Interaction effect** between Age group and aspirated phonation

Discussion: F0

The established pattern observed **in adult Korean** (e.g., Cho, Jun, & Ladefoged, 2002) and **in child studies** such as Kim and Stoel-Gammon (2009) and Kong et al. (2011) - **rising F0 values across lenis, fortis, and aspirated stops**



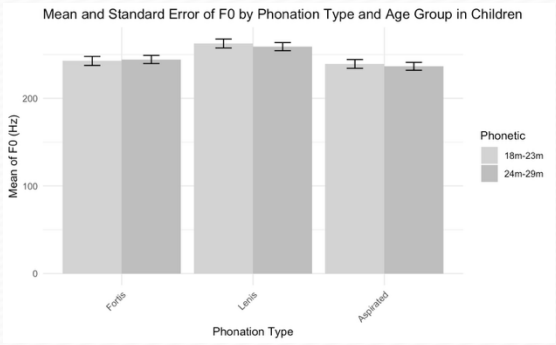
Kang (2014)

Expected

Fortis — Lenis — Aspirated

Observed

Fortis — Lenis — Aspirated



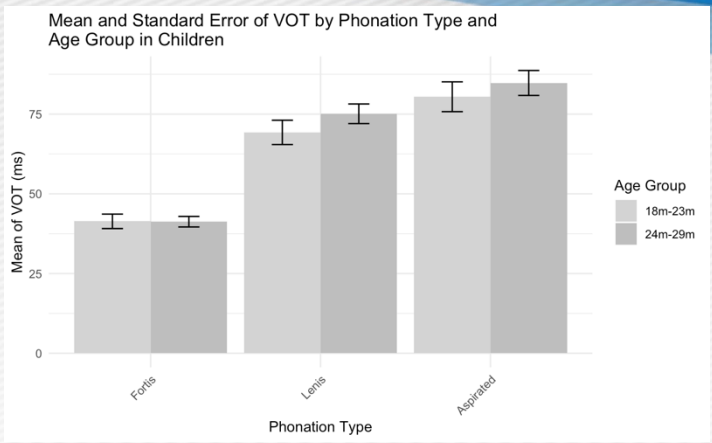
a reversed pattern in our study:
→ both fortis and aspirated stops exhibited significantly lower F0 values than lenis stops.

A genuine developmental characteristic rather than an artifact of measurement or analysis.

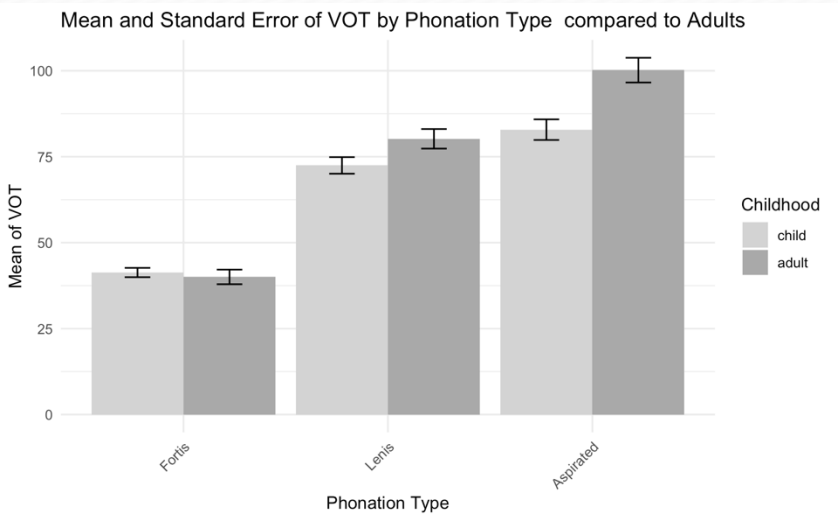
young children may not yet have fully developed **the laryngeal and respiratory coordination necessary for adult-like F0 control**.

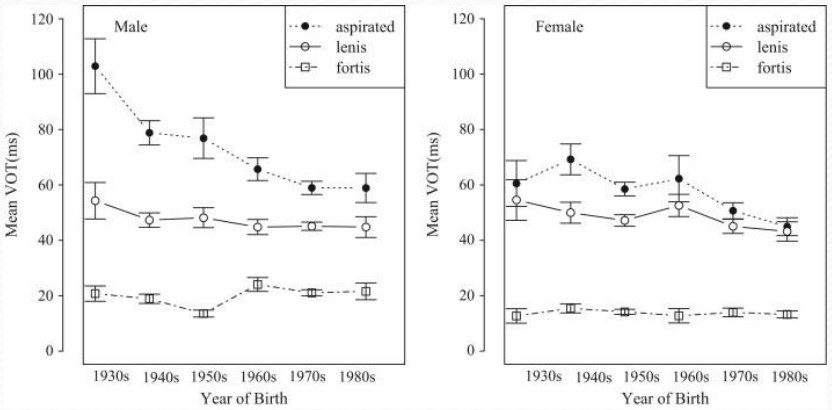
Discussion: VOT

While not all **lenis** and **aspirated** stops yielded clear VOT distinctions, the **fortis** category showed sufficient clarity



Children may begin to perceive and produce a three-way contrast similar to adult speakers **by 18 months.**





Kang (2014)

Frequency-based cues such as F0 mature later than **temporal-domain cues like VOT**

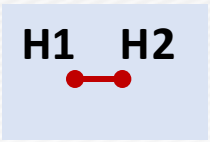
(e.g., Pollock et al., 1993; Nari et al., 2021)

Discussion: H1-H2

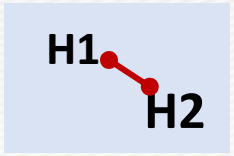
H1-H2, the amplitude of H1 – the amplitude of H2

Expected

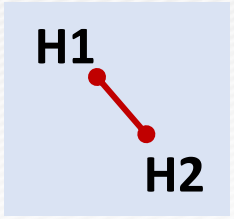
Fortis

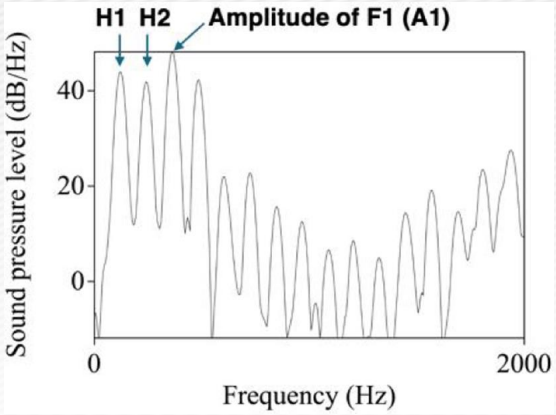


Lenis

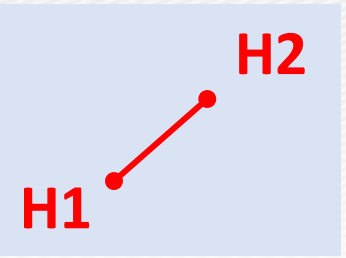


Aspirated





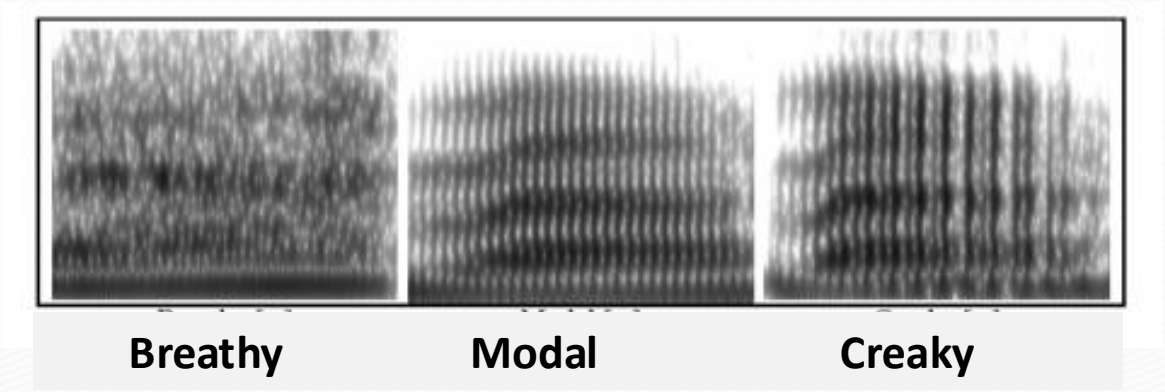
Observed

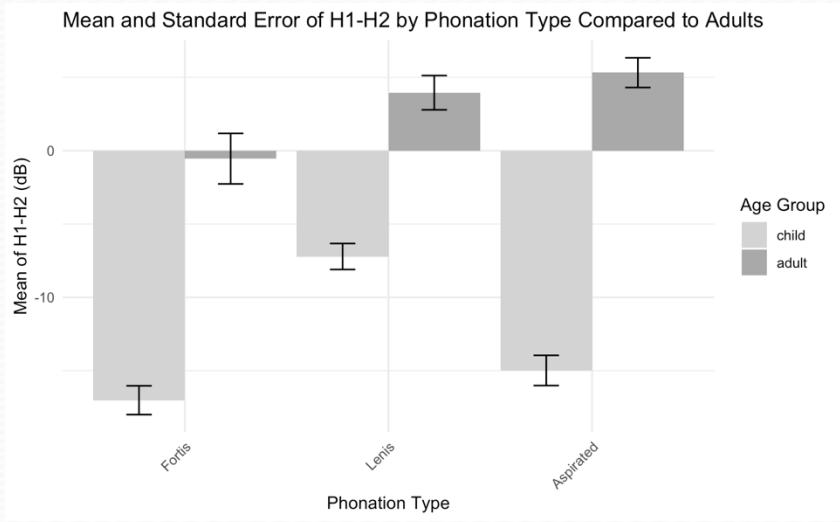


Irregularity

Fischer-Jørgensen (1967)

Positive ~0 Negative





https://journals.openedition.org/anglophonia/1952

Conclusion

This study examines how Korean-speaking children aged 18–29 months develop the acoustic properties of word-initial stops

1. **Aspirated stops** have the longest VOT, while **lenis stops** exhibit the highest F0.

2. **Fortis** stops lead to shorter VOT, lower F0, and a marked reduction in H1-H2, whereas **aspirated** stops yield longer VOT and moderate H1-H2 reduction.

3. **Minimal age btw 18m-23m and 24m-29m differences** were found.
   exception: H1-H2 for aspirated stops is more pronounced in the older group.

Phonation type significantly influences VOT, F0 and H1-H2

THANK YOU