1. Cross-linguistic generalization
   • Stops with “unmarked” short-lag VOT values are usually mastered first in languages with a
     two-way laryngeal contrast. (e.g., /b, d, g/ vs. /p, t, k/ in English, /b, d, g/ vs. /p, t, k/ in
     French, Japanese, etc.)

2. Three-way laryngeal contrast in Korean stops
   - lax ([b, d, g] vs. tense ([p, t, k] vs. aspirated [ph, th, kh])
   - /b, d/ /m/ vs. /p, t/ /n/ vs. /ph, th/ /m/ mark tense stops are “marked” by multiple acoustic cues
   - Voice Onset Time (VOT): the stop is the short lag VOT category, but...
   - F0: the tense stop has higher F0, suggesting tension to actively prevent voicing
   - HI-H2: the tense stop has negative values, reflecting its pressed voicelessness

3. Mastery pattern of Korean stops
   - Acoustic measures (Kim, X, 1996; Kim & Paik, 2002; Kim, M, 2008) describe:
     a. All 3 types (lax, tense, and aspirated) mastered by three years.
     b. Tense stops appear first in youngest children’s productions (before 2½).

4. Research question
   - Does the VOT pattern explain the early mastery of tense stops? Given the
     multiplicity of acoustic cues, we need to show that native speakers weigh VOT more than
     other features in assimilating children’s stop productions to the adult norms.

5. Goals
   - Reproduce the results of earlier transcription studies in a large cross-sectional study.
   - Answer question in a, by exploring relationships between native speaker percept
     (trained transcriptions and naïve adults’ ratings) of children’s stop productions and the
     three acoustic characteristics (VOT, F0, HI-H2).

METHODS

1. Transcription Study
   - Materials: word-initial coronal and dorsal stops embedded in real words ([b, d, g] context)
     e.g., /ba, da, ga/ /correct, /ba/da/ /strawberry, /ba, da, ga/ /outside
   - Participants: 76 Korean-speaking children (24 mos. – 72 mos.) and 20 adults (10 males and 10 females;
     3½-39½ years) were tested in Seoul, Korea.
   - Task: A picture-prompted auditory word-repetition task.
   - Analysis:
     a. Accuracy judgment measures: native speaker transcriptions of ‘correct’ or ‘incorrect’
        in children’s stop productions. (Errors also transcribed phonetically.)
   - Acoustic analyses: mean, median, and mode for each of the 3 categories (lax, tense, aspirated)
   - Statistical analyses: Mixed effects logistic regression models

2. Perception Study
   - Materials: a subset of adults and children’s tokens of /b/, /d/, /g/ and /p/, /t/, /k/ in the
     transcription study: only CV portion.
   - Participants: 365 tokens from children’s productions and 30 from adults (productions)
     chosen based on the stop VOT values to reflect the whole range of the natural data from the production
     experiment.
   - Task: After each stimulus item was played, listeners were asked to select one stop category as
     their choice by clicking on the Hangul character on the screen.

RESULTS

1. Transcription Accuracy/Error Analysis

2. Acoustic characteristics

3. Mixed effects logistic regression models for transcriptions

4. Mixed effects logistic regression models for naïve categorizations

5. CHILDREN’S STOPS
   - VOT:
     - Short lag VOT range for 2½-year-olds.
     - VOT: relatively lower F0 in lax stops (p < 0.05)
       - HI-H2: lower HI-H2 for tense stops

6. ADULTS’ STOPS
   - VOT: short lag VOT only in tense stops
   - F0:
     - lower F0 in lax stops
     - HI-H2: lower HI-H2 for tense stops

DISCUSSION & CONCLUSION

• As in earlier transcription studies, tense stops were the first stop phonation category to be
  mastered by Korean children.

• A potential explanation is available from the distributions of acoustic cue values, namely ...
  Although the stop aspects are differentiated from lax and aspirated stops in adult
  productions by their high F0 values and negative HI-H2 values as well as by their uniquely
  short lag VOT values, younger children’s stops in all three categories are realized with short
  lag VOT values.

• Regression models relating perceived categories to acoustic parameters showed that ...
  - The naïve Korean adult listeners’ responses in the perception task showed the same
    patterns.
  - The early mastery of tense stops in Korean-speaking children’s productions was, in fact,
    related to two factors:
    a. Children’s earliest productions are high short lag VOT values
    b. Although the tense stops are differentiated from lax and aspirated stops in adult
      productions by their high F0 values and negative HI-H2 values as well as by their uniquely
      short lag VOT values, younger children’s stops in all three categories are realized with short
      lag VOT values.

• Regression models relating perceived categories to acoustic parameters showed that ...
  - The naïve Korean adult listeners’ responses in the perception task showed the same
    patterns.

• The early mastery of tense stops in Korean is not an exception cross-linguistically when we
  consider how children’s productions are understood by adult listeners of the native
  language.

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