A Cross-linguistic Developmental Study of Vowel Spectral Movement Patterns

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INTRODUCTION

• Traditionally, vowels have been characterized acoustically by formant frequencies measured at or near the vowel midpoint (e.g., Hillebrand, Getty, Clark, & Wheeler, 1995; Peterson & Barney, 1952).
• However, vowel perception studies (e.g., Neary & Assmann, 1986; Strange et al., 1976) have shown the important role of vowel spectral movement patterns in identifying and characterizing vowels.
• Chung, Kong, & Weismer (2010) showed systematic cross-linguistic movement patterns in identifying and characterizing vowels.

PURPOSE OF THE STUDY

• This study examines cross-linguistic spectral movement patterns of five shared vowels (/a, i, u, e, o/) produced by monolingual adults, 5-year-olds, and 2-year-olds of American English, Greek, and Korean.

Two questions were addressed:

• Do native-speaking adults from different languages produce shared vowels with similar or language-specific spectral movement patterns?
• If there is systematic cross-linguistic differences in vowel spectral movement patterns, to what extent are these differences in spectral movement patterns realized in children’s speech?

VOWEL SYSTEM OF EACH LANGUAGE

1) English
2) Greek
3) Korean

METHODS

The data used in this study is part of a larger study, ζωοκεραυνός project (Edwards & Beckman, 2008; Edwards & Beckman, 2009).

a. Participants

• Ten speakers in each of three age groups (2-, 5-year-olds, & adults) for each language;
• Native speakers of American English (Columbus, Ohio), Greek (Thessaloniki), and Korean (Seoul);
• All child participants passed a hearing screening and had age-appropriate oromotor skills;
• All adult participants had no history of speech, language, or hearing problems.

b. Stimuli

• /a/, /i/, /u/ and /u/ vowels in CVC contexts
• The word initial consonants were alveolar /s/ and post-alveolar /t/ for American English, alveolar /s/ for Greek, and dental-alveolar /s/ for Korean.
• Coda environment varied for each stimulus item.

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VOCAL TRACT MOTION ANALYSIS

• Cross-linguistic Differences (Adults' productions):
  - F1 and F2 trajectories of English and Greek vowels had more movement than Korean vowels, and had more consistent direction of movements, except for /u/.
  - Minimal movement in F1 and F2 trajectories was observed for /u/ of all languages.

RESULTS

a. Vowel space analysis

b. Developmental patterns

B. F1 & F2 trajectory analysis

c. Cross-linguistic differences in adults

DISCUSSION

• Cross-linguistic differences in vowel spectral movement patterns were found. English & Greek vowels showed more movement than Korean vowels.
• F1 and F2 trajectory patterns of children were very similar to those of adults, indicating children as young as 2 years of age are capable of producing vowels in a language-specific manner.
• Vowel spectral movements were vowel-specific. Minimal movement was observed for /i/, while greater movement was observed for /u/ (F2) across languages.
• Durational differences: minimal spectral movements in Korean vowels than English & Greek vowels might be due to significantly shorter duration of Korean vowels than Greek & English vowels.
• Similar F1 or F2 trajectory patterns of children and adults could also indicate children’s ability to produce adult-like degrees of coarticulation (e.g., Katz, Kripke, & Tallal, 1991)

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