The Acquisition of the Arabic Emphatic – Plain Consonant Contrasts by Arabic Speaking Children

Anwar Alkhudidi[1], Katherine Demuth[1], Ben Davies[1] and Titia Benders[1, 2]

[1] Macquarie University

[2] Amsterdam Center for Language and Communication, University of Amsterdam

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1. Introduction

This study aims to understand when and how typically developing Arabic-speaking children acquire Arabic emphatic consonants. This study is specifically concerned with the emphatics /tˤ/ and /sˤ/, which phonemically contrast with the plain /t/ and /s/ respectively.

Classified as phonologically marked and articulatory complex sounds, emphatics are produced with a primary alveolar and a secondary pharyngeal constriction [1]. Acoustically, vowels next to an emphatic consonant have a higher F1 and F3 and lower F2 than vowels next to a plain consonant counterpart, e.g., [2]. Moreover, the emphatic stop /tˤ/ has a shorter Voice Onset Time (VOT) compared to the plain stop /t/ [3]. Finally, emphatic consonants can spread emphasis bidirectionally to non-adjacent segments in the word, e.g., [4].

Previous literature, based on impressionistic data, claims that emphatic sounds are typically late acquired, namely around six years of age, e.g., [5][6]; however, auditory judgment does not always provide reliable assessments of children's speech, e.g., [7]. The current study, therefore, examined children's realisations of these emphatic sounds using acoustic measures over a range of ages. The goal is to provide a comprehensive understanding of the developmental trajectory of these complex speech segments.

The main hypothesis is that the acquisition process is gradual. Children are expected to first produce covert contrasts, contrasts that are imperceptible to listeners but can be detected using instrumental measures, e.g., acoustic measures [7]. It is expected that these may be followed by overt contrasts, perceptible contrasts with non-adult-like acoustic realisations, e.g., [8]). Finally, it is hypothesised that adult-like production might be observed in the speech of children around six years of age.

2. Methodology

A total of 40 typically developing Arabic-speaking children from Saudi Arabia are being recruited (30 children have already been tested) between the ages of 3 and 6 years. Ten adults (20 to 40 years) have already been recruited and tested to serve as controls. Target consonants examined in this study were the alveolar stop contrasts /tˤ/ vs. /t/ and the alveolar fricative contrasts /sˤ/ vs. /s/. The stimuli included 50 minimal/near minimal pairs (30 real words, 20 non-words) elicited in an imitative single word repetition task with a picture referent.

3. Data analysis

Speech will be analysed acoustically. This includes measuring the first three formants (F1, F2, F3) of vowels adjacent to emphatic and plain target consonants. In addition, VOT measurements will be obtained from the stop consonants /tˤ/ and /t/.

4. Preliminary results

Auditory perceptual judgments of the current data suggest that children as young as three years old can produce *overt* emphatic-plain contrasts that are perceptible to an adult native listener. Moreover, some children were observed to display strong emphasis spread, including anticipatory and carryover effects to other consonants in the word, as in (1) and (2),

(1) /tˤaːk/ → [tˤɑːq] (nonsense word)

(2) /gafasˤ/ → [qɑfɑsˤ] (*cage*)

These observations suggest that young children may use more coarticulation than adults, e.g., [8][9]. Future work will employ acoustic measures to answer the research questions and examine these observations.

5. References

[1] S. H. Al-Ani, *Arabic phonology: An acoustical and physiological investigation*, vol. 61. Walter de Gruyter, 1970.

[2] J. Al-Tamimi, "Revisiting acoustic correlates of pharyngealisation in Jordanian and Moroccan Arabic: Implications for formal representations," *Lab. Phonol. J. Assoc. Lab. Phonol.*, vol. 8, no. 1, p. 28, 2017, doi: 10.5334/labphon.19.

[3] G. Khattab, F. Al-Tamimi, and B. Heselwood, "Acoustic and auditory differences in the/t/-/T/opposition in male and female speakers of Jordanian Arabic," in *Perspectives on Arabic Linguistics XVI: Papers from the sixteenth annual symposium on Arabic linguistics*, 2006, pp. 131–160.

[4] B. A. Zawaydeh and K. de Jong, "The phonetics of localising uvularisation in Ammani-Jordanian Arabic," *Instrum. Stud. Arab. phonetics*, vol. 319, p. 257, 2011.

[5] M. M. Amayreh and A. T. Dyson, "The Acquisition of Arabic Consonants," *J. Speech, Lang. Hear. Res.*, vol. 41, no. 3, pp. 642–653, Jun. 1998, doi: 10.1044/jslhr.4103.642.

[6] H. S. Ayyad, B. M. Bernhardt, and J. P. Stemberger, "Kuwaiti Arabic: Acquisition of singleton consonants," *Int. J. Lang. Commun. Disord.*, vol. 51, no. 5, pp. 531–545, 2016, doi: 10.1111/1460-6984.12229.

[7] M. A. Macken and D. Barton, "The acquisition of the voicing contrast in English: a study of voice onset time in word-initial stop consonants," *J. Child Lang.*, vol. 7, no. 1, pp. 41–74, Feb. 1980, doi: 10.1017/S0305000900007029.

[8] E. Rubertus and A. Noiray, "On the development of gestural organisation: A cross-sectional study of vowel-to-vowel anticipatory coarticulation," *PLoS One*, vol. 13, no. 9, p. e0203562, 2018.

[9] A. Noiray, D. Abakarova, E. Rubertus, S. Krüger, and M. Tiede, "How do children organize their speech in the firstyears of life? Insight from ultrasound imaging," *J. Speech, Lang. Hear. Res.*, vol. 61, no. 6, pp. 1355–1368, 2018.