

CHILDREN'S PERCEPTION OF THE ALBANIAN DARK-CLEAR LATERAL CONTRAST

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ABSTRACT

Purpose. The aim is to assess the development of phonemic categorization in the typologically rare dark /l/-clear /l/ contrast in Albanian, a largely understudied language. Specifically, this study investigates the use of two cues (formant values, vowel-lateral transition durations) in perceptual categorization by young children. **Method.** By varying formant values and vowel-lateral transition durations, continua between minimal pairs were created and presented to child (3 and 5 years) and adult listeners in an alternative-forced-choice identification task. **Results.** (a) All groups used the primary cue (formant values) in phoneme categorization; children's categorization slopes were shallower and showed greater variability than those of adults, especially in the youngest group; (b) only adults used the secondary cue. **Discussion.** The study provides evidence that phoneme boundary sharpening in this lateral contrast is not yet fully established at age 5, and that use of secondary cues develops only after this age.

Keywords: first language acquisition, phonemic contrasts, understudied languages, laterals

1. INTRODUCTION

Theories about developmental trends in phonetics and phonology are mainly informed based on data from some of the major languages. This study aims to look at children's perception of the typologically rare phonemic contrast /l/-/l/ (a distinction between the alveolar clear lateral /l/ and the alveolar dark lateral /l/, in all syllable positions) in an understudied language, Albanian. Albanian is an isolated branch of the Indoeuropean language family spoken in the Balkan peninsula. The few studies on the phonetics of Albanian that exist ([8], [3], [7]) look only at adult language. Child data from other languages show that perception of phonemic contrasts differs from that of adults and develops over an extended period of time; this holds especially true for contrasts where several acoustic cues are involved ([6], [11], [12], [14], [13],

[9]), similar to the Albanian /l/-/l/ contrast.

In the Albanian /l/-/l/ contrast, the main acoustic cue distinguishing the two phonemes is the distance between F2 and F1 ([3],[10]). However, a comparison of American English, Catalan, and Italian, where clear and dark laterals occur on an allophonic level, indicates that formant transitions from a preceding vowel into an intervocalic lateral start earlier in the vowel, if the lateral is dark, and later, if it is clear ([16]). This temporal difference can constitute a secondary cue to the phonemic distinction of /l/ and /l/.

The questions addressed in this study are twofold: (1) To what extent do adults use these two cues in the lateral contrast? and (2) Does children's perception of the contrast differ from that of adults? If so, how?

2. METHODS

2.1. Materials

2.1.1. Target words

Four target words (two minimal pairs) were recorded in a recording studio by a female professional speaker of Albanian, who repeated each target word six times: *pula* 'chicken', *pulla* 'postal stamp', *hala* 'fishbones', and *halla* 'paternal aunt'.¹ These words were the best candidates for this contrast from an exhaustive pool of 25 minimal pairs,² given that they had to be (a) imageable and (b) easily graspable by children.

2.1.2. Stimuli

The stimuli were prepared using Praat (version 5.3.51, [2]): The target words were resynthesised up to a frequency of 3 500 Hz; the original signal for each target word of the region above 3 500 Hz was then pasted onto the resynthesised part in order to obtain more natural sounding stimuli where the speaker's non-linguistically relevant idiosyncratic resonance characteristics were preserved. The lateral in each stimulus was manipulated using Linear Predictive Coding (LPC)-resynthesis along the following two parameters: formant values (F1, F2,

F3), and temporal onset of formant transitions into the lateral. Formant values were based on the average values of the six repetitions of *hala*, *halla*, *pula*, and *pulla*, respectively. More specifically, the formant values for step 2 (“dark”) of the continua were based on *halla* or *pulla*, while the values for step 4 (“clear”) were the average values of *hala* or *pula*. Formant values for the stressed vowels (/a/ in “hala” and “halla”, /u/ in “pula” and “pulla”) were based on the average values of F1, F2, and F3 across all 12 repetitions of *hala* and *halla*, *pula* and *pulla*, respectively. Details are provided in Tables 1 and 2. The formant values for F1 and F2 for the remaining continuum steps (step 1 (“very dark”), step 3 (“medium”), and step 5 (“very clear”)) were calculated from the values obtained empirically for steps 2 and 4. Likewise, F3 values were averaged from the F3 values obtained from the original recordings, and values for the other three steps were calculated accordingly.

Table 1: Formant values in the stable portion of the lateral and in the stable portion of the stressed vowel /a/ (V1): hala-halla continuum.

| | F1 (Hz) | F2 (Hz) | F3 (Hz) |
|----------------------------|---------|---------|---------|
| <i>step 1 (very dark)</i> | 444 | 967 | 3064 |
| <i>step 2 (dark)</i> | 436 | 1168 | 3093 |
| <i>step 3 (medium)</i> | 429 | 1398 | 3122 |
| <i>step 4 (clear)</i> | 421 | 1661 | 3151 |
| <i>step 5 (very clear)</i> | 413 | 1973 | 3182 |
| /a/ | 948 | 1402 | 2889 |

Table 2: Formant values in the stable portion of the lateral and in the stable portion of the stressed vowel /u/ (V1): pula-pulla continuum.

| | F1 (Hz) | F2 (Hz) | F3 (Hz) |
|----------------------------|---------|---------|---------|
| <i>step 1 (very dark)</i> | 312 | 662 | 3316 |
| <i>step 2 (dark)</i> | 317 | 913 | 3157 |
| <i>step 3 (medium)</i> | 322 | 1217 | 2965 |
| <i>step 4 (clear)</i> | 326 | 1591 | 2870 |
| <i>step 5 (very clear)</i> | 331 | 1661 | 2736 |
| /u/ | 334 | 936 | 3057 |

Transitions were linearly interpolated between the vowel-specific values of F1 to F3 and the lateral-specific values given in Tables 1 and 2. On- and offset times were kept constant for the lateral-to-unstressed-vowel transitions; while the offset of the stressed-vowel-to-lateral transition remained at the same point in time, transition onset time varied. Results obtained by Recasens and Farnetani ([16]) in a

comparison of American English, Catalan, and Italian indicate that the vowel-to-lateral onset transition starts approximately after the first third of the vowel in the case of a dark lateral and after two-thirds of the vowel for a clear lateral. Based on these findings, the transition durations presented in Table 3 were used as values in the transition duration-based darkness continuum.

Table 3: Duration values for stimuli on the transition duration-based darkness scale (Cue2). Step interval = 25 ms.

| | transition duration (ms) |
|----------------------------|--------------------------|
| <i>step 1 (very dark)</i> | 135 |
| <i>step 2 (dark)</i> | 110 |
| <i>step 3 (medium)</i> | 85 |
| <i>step 4 (clear)</i> | 60 |
| <i>step 5 (very clear)</i> | 35 |

2.2. Participants

Three groups of participants were tested:

- 3-year-olds: n=20; age range=3 years 1 month – 3 years 7 months; mean age = 3 years 4.05 months; sd = 1.72 months;
- 5-year-olds: n=22; age range = 4 years 8 months – 5 years 5 months; mean age = 5 years 2.81 months; sd = 2.73 months;
- adults: n=18; age range = 19 years 3 months – 26 years 4 months; mean age = 22 years 11.6 months; sd = 24 months.

All participants were monolingual native speakers of Albanian.

2.3. Task

An alternative-forced-choice identification task was used to test participants’ perception of the /l-/l-/contrast. Stimuli were played over Beyerdynamic DT770 headphones in a random order; for each stimulus, the participant was presented with two pictures representing either of the target words (*pula* ‘chicken’, *pulla* ‘stamp’, *hala* ‘fishbone’, *halla* ‘aunt’) on a laptop computer touchscreen. Listeners were instructed to touch the picture that they identified as represented best by the stimulus. Intermixed with the test trials were control trials which paired pictures of *pula* ‘chicken’ or *pulla* ‘stamp’ with either *hala* ‘fishbone’ or *halla* ‘aunt’. The stimuli used for the control trials were taken from the extreme corners of the continuum grid described under Section 2.1.2. These trials were included to test whether participants, especially the children, were able to carry out the task as instructed. The exper-

iment was implemented through Percy ([4]), a web-based tool for perception experiments.

3. RESULTS

3.1. Control trials

A response by a participant in the control trial was labelled correct if a stimulus taken from the endpoints of the *hala-halla*-continuum was identified with the picture of either *hala* ‘fishbone’ or *halla* ‘aunt’, but incorrect if it was identified with a picture representing either *pula* ‘chicken’ or *pulla* ‘stamp’; and vice versa. Participants were retained for analysis of the test trials if they achieved at least 75% correct answers in the control trials. Average achievement rates for the three groups can be found in Table 4. This control measure reduced the number of participants whose data entered the analysis (Section 3.2) to 11 (3-year-olds) and 19 (5-year-olds) in the child groups, respectively. All adults passed the control trial test.

Table 4: Control trials: Percentages of correct answers per group.

| | <i>mean</i> | <i>sd</i> |
|-----------------|-------------|-----------|
| 3 – year – olds | 0.841 | 0.079 |
| 5 – year – olds | 0.914 | 0.066 |
| adults | 0.9934 | 0.014 |

3.2. Test trials

The analysis of the responses by the three groups of participants were carried out in R ([15]), using the package *lme4* ([1]), through a linear mixed effects model for each minimal pair. Fixed effects were Cue 1 (formant values), Cue 2 (duration transition) and Agegroup (adults vs. 3-year-olds vs. 5-year-olds) as well as interaction terms of Cue 1 with Agegroup and Cue 2 with Agegroup. Random intercepts were included for participants and by-participant random slopes for the effect of Cue 1 and Cue 2.

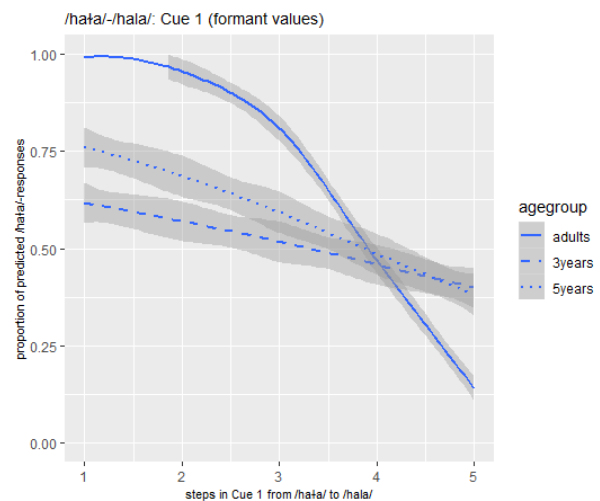
3.2.1. Cue 1 – Formant values

Predicted changes in the odds of perceiving a dark lateral vs. a clear lateral depending on changes in the formant values of the lateral are summarized in Table 5 for the three groups and visualized in Fig. 1 and 2.

Table 5: Test trials: Predicted changes in the odds of perceiving a dark vs. a clear lateral for changes in Cue1 (formant values of the lateral). Bold face indicates $p < 0.05$; an asterisk indicates $p < 0.0001$.

| | <i>halla – hala</i> | <i>pulla – pula</i> |
|-----------------|---------------------|---------------------|
| 3 – year – olds | –24% | –37% |
| 5 – year – olds | –45%* | –38% |
| adults | –88%* | –91%* |

Figure 1: Predicted changes in the odds of choosing *halla* ‘aunt’ over *hala* ‘fishbone’, for Cue 1 (formant values).



3.2.2. Cue 2 – Transition duration

Predicted changes in the odds of perceiving a dark lateral vs. a clear lateral depending on changes in Cue 2 (vowel-lateral transition duration) are summarized in Table 6 for the three groups and plotted in Fig. 3 and 4.

Table 6: Test trials: Predicted changes in the odds of perceiving a dark vs. a clear lateral for changes in Cue 2 (vowel-lateral transition duration). Bold face indicates $p < 0.05$.

| | <i>halla – hala</i> | <i>pulla – pula</i> |
|-----------------|---------------------|---------------------|
| 3 – year – olds | +6% | +5% |
| 5 – year – olds | –2% | +3% |
| adults | –27% | –7% |

Figure 2: Predicted changes in the odds of choosing *pulla* ‘stamp’ over *pula* ‘chicken’, for Cue 1 (formant values).

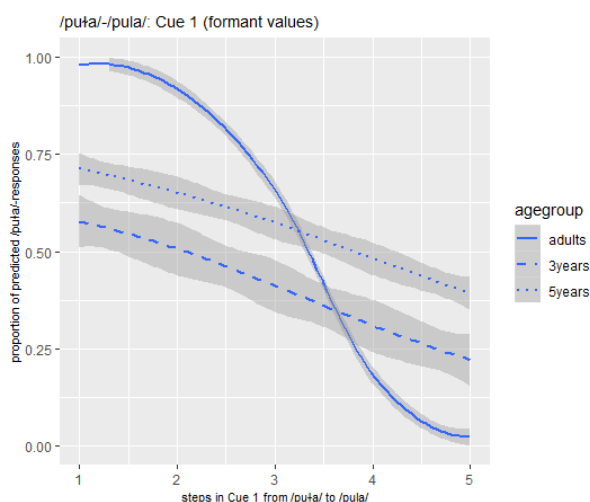
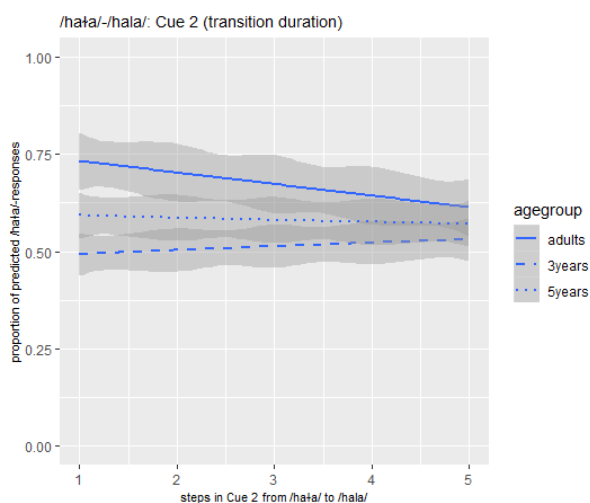


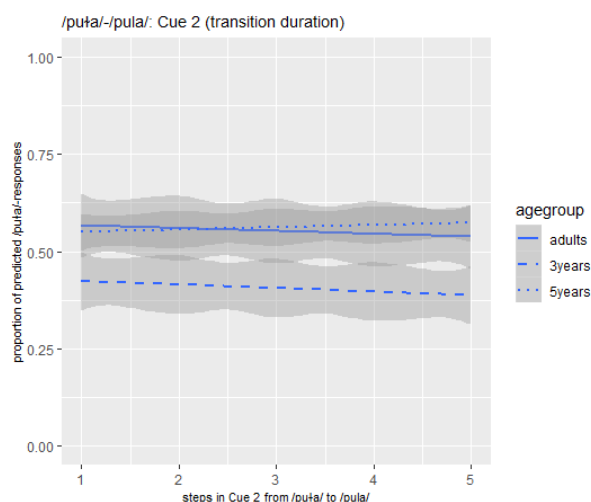
Figure 3: Predicted changes in the odds of choosing *halla* ‘aunt’ over *hala* ‘fishbone’, for Cue 2 (transition duration).



4. DISCUSSION

This study is the first study that sheds light on the perceptual weighting of acoustic cues in the Albanian contrastive pair /l-/ɫ/ (a distinction between the alveolar clear lateral /l/ and the alveolar dark lateral /ɫ/). Data from adults show that the distinction between /l/ and /ɫ/ in intervocalic position relies primarily on the formant values of the lateral. Vowel-lateral transition durations, however, are used by adults to distinguish only the pair *halla-hala*. This may be due

Figure 4: Predicted changes in the odds of choosing *pulla* ‘stamp’ over *pula* ‘chicken’, for Cue 2 (transition duration).



to more dynamic transitions into a lateral from /a/ than from /u/.

By contrast, examination of the perception data from children shows that they use formant values for both minimal pairs; transition durations are used for neither. In addition, phoneme boundaries are far less sharp than those of adults, with a developmental trend for boundary sharpening in the minimal pair *halla-hala*. Regarding the other minimal pair, 3-year-olds show a preference for *pula* ‘chicken’, presumably because, despite having been trained prior to the experiment, the concept of *pulla* ‘postal stamp’ is perhaps somewhat unfamiliar to them.

These general findings are consistent with prior work suggesting that learning to use multiple cues develops over an extended period of time in childhood ([6], [11], [12], [14], [13], [9]). For example, Idemaru and Holt ([6]) found that American English-speaking children between the ages of 4- and 5.5-years old already use the primary cue in perception to distinguish between the dark lateral approximant /ɫ/ and the retroflex central approximant /ɻ/ (e.g., *lice* vs. *rice*); however, consistent use of the secondary cue is not yet fully developed even in 8.5-year-old children.

In order to track these aspects of phonological development to maturity for Albanian, further work is needed along two directions: (a) production and perception of the /l-/ɫ/ contrast, in all syllable positions, by children 3-12 years old (cf. [5]), and (b) comparison of /l-/ɫ/ perception and production with other contrasts such as /t/-/d/ or /ɛ/-/a/.

5. ACKNOWLEDGEMENTS

We would like to thank the student assistants Amarildo Çorape and Erdit Mimani, who ran the perception task for adults. Funding for this study was provided through a Research Fellowship at the Center for Advanced Studies of LMU Munich, awarded to the first author. The second author acknowledges the generous support of Alexander von Humboldt Foundation through a Georg Forster Research Fellowship.

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¹ The digraph *ll* denotes the dark alveolar lateral, the grapheme *l* the clear alveolar lateral.

² The list of minimal pairs was compiled from a 30,000-word dictionary of Albanian.