Give me more! Increasing relevant acoustic variability aids 14-month-old children in learning minimal pairs

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In a seminal study, Stager and Werker (1997) [1] found that 14 month-old children struggle to learn novel words that are phonologically highly similar (*bih* vs. *dih*) even though they are able to discriminate them. However, that study used a minimal pair where the vowel adjacent to the crucial consonant conveying the contrast was always the same (/ɪ/). We hypothesised that presenting the consonant-place contrast in multiple contexts that vary in the vowel following the crucial consonant would enhance the distinction between the two consonants and lead to better learning outcomes. In consonant-vowel combinations as in /bV.../ versus /dV.../, formant transitions to the vowel crucially depend on the preceding consonant [2, 3] and thus are essential for identifying the consonant. In this study, we assess the role of such contextual variability in word learning. Due to the dependency of formant transitions on consonantal place, we predict that this kind of informative contextual vowel variability would aid in learning the word *buk* (compared to *duk*).

In a word-learning task following the procedure of Thiessen (2011) [4], we first familiarised two groups of monolingual German-learning 14-month olds (20 children in each) for 40s to syllables with vowel variability (*bak, dak, bek, dek, bik, dik, bok, dok, buk, duk;* informative variability group) or syllables without vowel variability (*puk, tuk, fuk, luk, nuk, muk, buk, duk;* uninformative variability group). Subsequently, in a habituation phase, each child had to learn the novel word *buk* (a single token from one speaker) by associating it to a novel object. Afterwards, in a test phase, this association was probed with Same trials (*buk*) and Mismatch trials (*duk*), both showing the previously presented object. A Novel trial (*loek* for an unseen object) at the end of the test phase was included to ensure that children were still attentive.

Measurements of formant transitions in the familiarisation stimuli exhibit the expected vowel-dependent transitions (Fig. 1). Crucially, in the /iː/ context (the context most similar to Stager & Werker's [1]), the formant transitions are comparable across the labial and coronal context, whereas differences become evident when looking at all other vowels: For example, in /baː/–/daː/, we find at least one clear contrast in F2 transition (for /baː/ an expected F2 rise towards the vowel but a fall for /daː/). In /buː/–/duː/ the differences are even more salient. For this reason, we chose the /buːk/–/duːk/ minimal pair as the test words in our study.

Results show that children familiarised with informative variability learnt the word *buk*. Babies in this group demonstrate a surprise reaction in Mismatch trials (shown by longer looking times compared to Same trials, $p<.001$) in which a phonologically minimally different word *duk* is presented (Fig. 2). This is not the case for children in the uninformative variability group ($p=.242$).

It has been shown previously that providing several word tokens (from multiple speakers) has a beneficial role in minimal pair word learning [5, 6]. We propose that in addition to a positive effect of variability in speaker identity, it is the relevant acoustic variability that aids in minimal pair word learning because, as we show with this study, a brief exposure to the consonantal contrast in varying phonological contexts is sufficient. Contextual phonetic variability from a single speaker can increase young children's ability to mentally represent a newly learnt word as distinct from a minimally different word (regarding the consonant-place contrast) by highlighting the relevant acoustic properties (i.e. formant transitions) in the signal that mark this phonological contrast. In order to strengthen this argument we are currently collecting data from another group of children with uninformative variability that occurs at the final consonant (*bup, dup, but, dut, bun, dun, bum, dum, buk, duk*). The results will be included in the conference presentation.

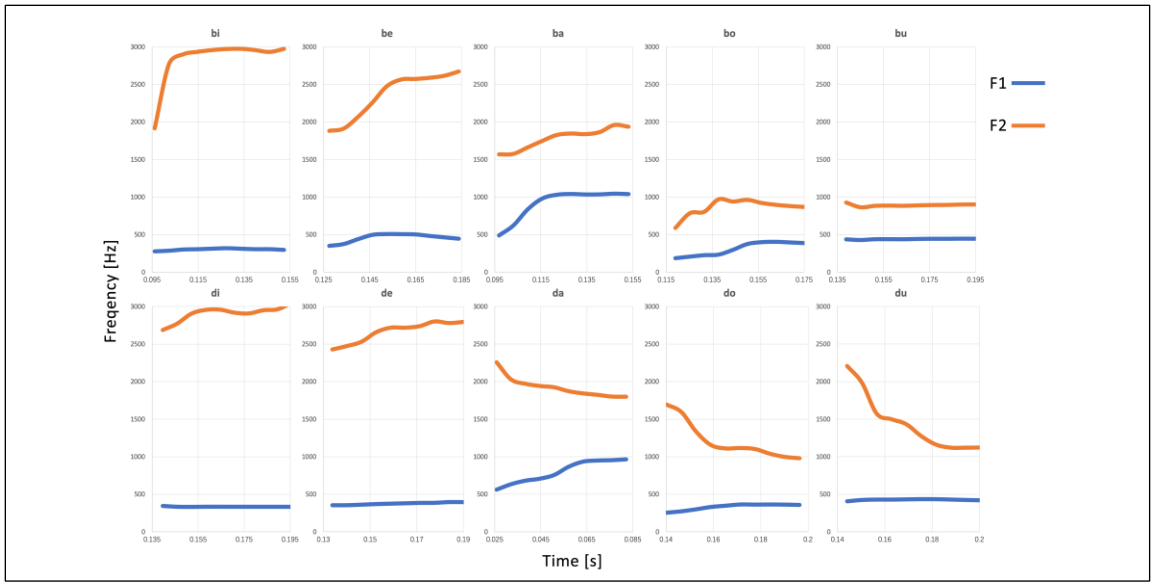

Figure 1. *Formant transitions (F1, F2) across the different vowels in our German /bVk/ and /dVk/ familiarisation stimuli. The pattern of formant transitions replicates, as expected, that reported in the classic study by Liberman et al. [2] on American English.*

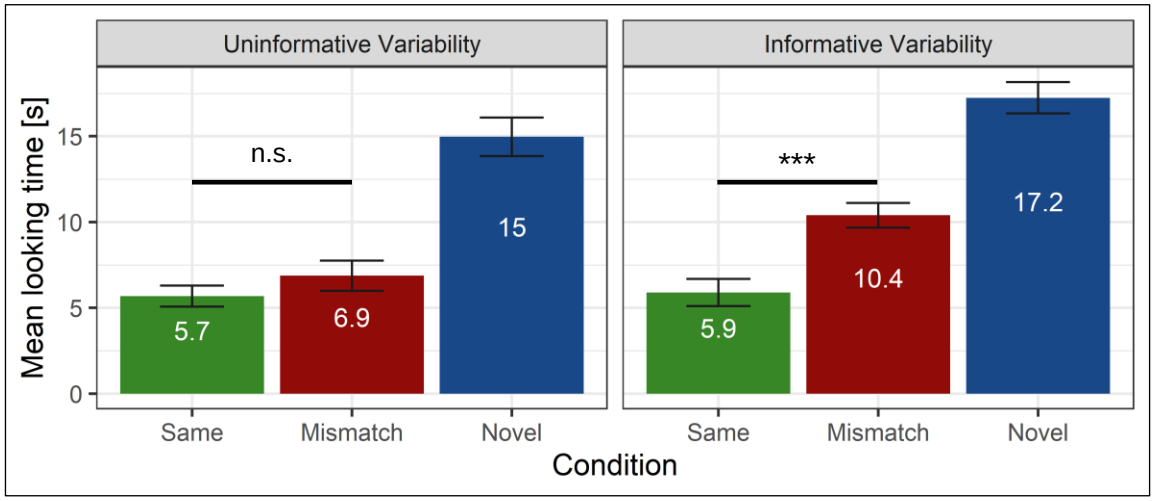

Figure 2. *Mean looking times in the three test conditions after familiarisation with »Uninformative Variability« (puk, tuk, fuk, luk, nuk, muk, buk, duk, left panel) and »Informative Variability« (bak, dak, bek, dek, bik, dik, bok, dok, buk, duk, right panel).*

References

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