

# Infant Perception of Prosodic Boundaries Without the Pause Cue: An Eye-Tracking Study

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## Introduction

Prosody plays a crucial role in the organization of speech. Prosodic groupings chunk the speech continuum. Given that prosody interfaces with other linguistic domains, prosodic phrases relate to other constituents: e.g., the intonation phrase (IP) relates to a clause-like unit and sentence/clause boundaries usually align with IP boundaries. Thus prosody may facilitate language learning.

Infants are sensitive to prosodic boundaries and use them to segment speech. However, prosodic boundary cues vary across languages: e.g., the cue weighed higher is pitch in Am. English, pitch change and lengthening in German, pause in Dutch. Infants attune to the language-particular cues by 6-8 mos. [2, 3, 6, 7, 8, 9, 11, 12]



## Main Goals

- Investigate the perception of prosodic boundaries in European Portuguese-learning infants, by testing 9 month-olds' discrimination of utterances with and without an internal IP boundary, cued by pitch rising and final lengthening.
- EP displays an unusual combination of prosodic properties, described as a Romance and Germanic mix ([4]). For adults, pitch change and preboundary lengthening are robust cues IP boundaries; the pause is not a necessary cue.
- If EP-learning infants are sensitive to IP boundaries, and attunement to the language cues is manifested by 6-8 mos, discrimination is predicted.
- Novel features: use of delexicalized utterances, and eye-tracking
- First study to explore relations between infants' prosodic boundary discrimination abilities and later language outcomes. A positive correlation is predicted.

## Methods

### Participants

Fifteen typically developing infants from monolingual EP homes (7 females, mean age 9 months 10 days, range 8 months 6 days – 10 months 27 days); 5 other infants were rejected  
All infants included had > 1 s looking time to one of the conditions

### Stimuli

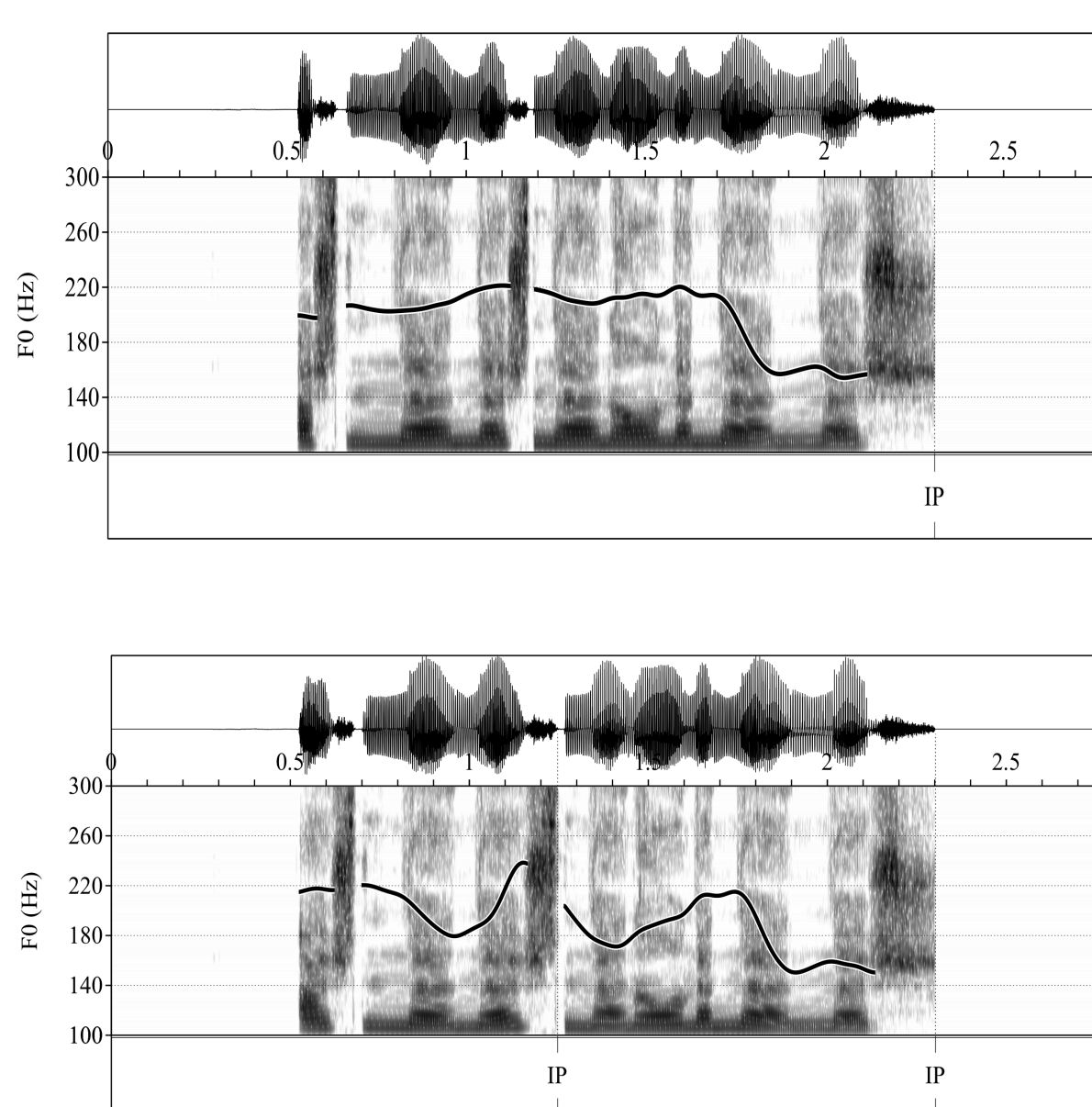
Pairs of short sentences with two distinct prosodic groupings:  
(As meninas deram bonecas)<sub>IP</sub>  
'The girls gave dolls'  
(Às meninas)<sub>IP</sub> (deram bonecas)<sub>IP</sub>  
'To the girls, (they) gave dolls'

Female native EP speaker  
2 productions per sentence (2x4)  
delexicalized using MBROLA:  
Vowels converted to [e]  
Coda consonants to [j]  
All other consonants to [n] (Fig.1)

**Table 1:** Acoustic properties of the stimuli at the target syllable and following syllable (mean values).

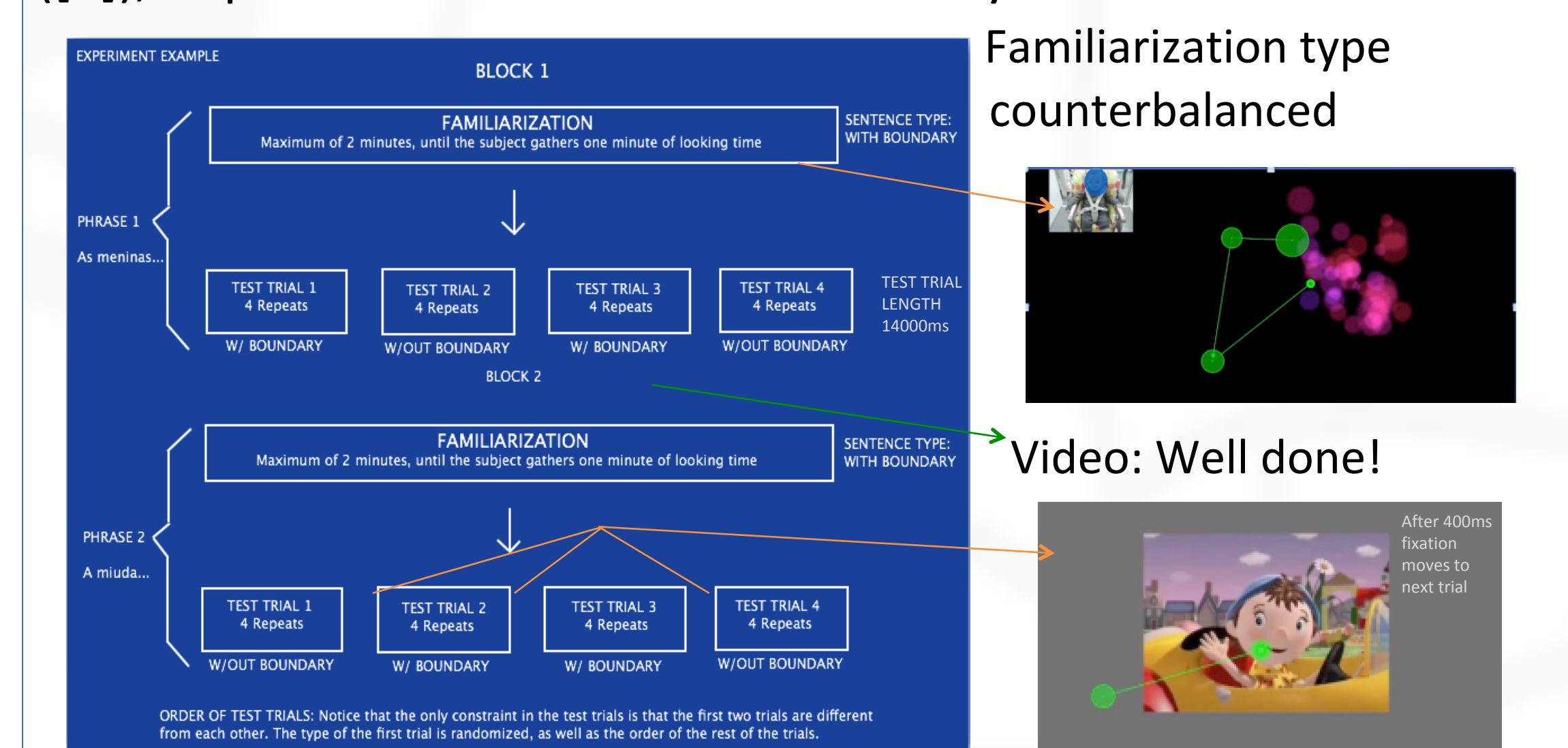
	With IP	Without IP
Pitch rise (target syllable)	75 Hz	14 Hz
Duration (target syllable)	283 ms	190 ms
Pitch height (following syllable)	171 Hz	217 Hz

**Figure 1:** Examples of delexicalized utterances without (top) and with (bottom) the internal IP. Target syllable marked with a red line.



### Procedure

Modified version of the familiarization-preference procedure ([1]), implemented with a SMI RED500 eye-tracker



### Measures of language outcomes

Infants' caregivers completed the EP version of the CDI short forms ([5]) at 12, 18 and 24 months: a parental checklist measure of the child's vocabulary, and of the ability to combine words.

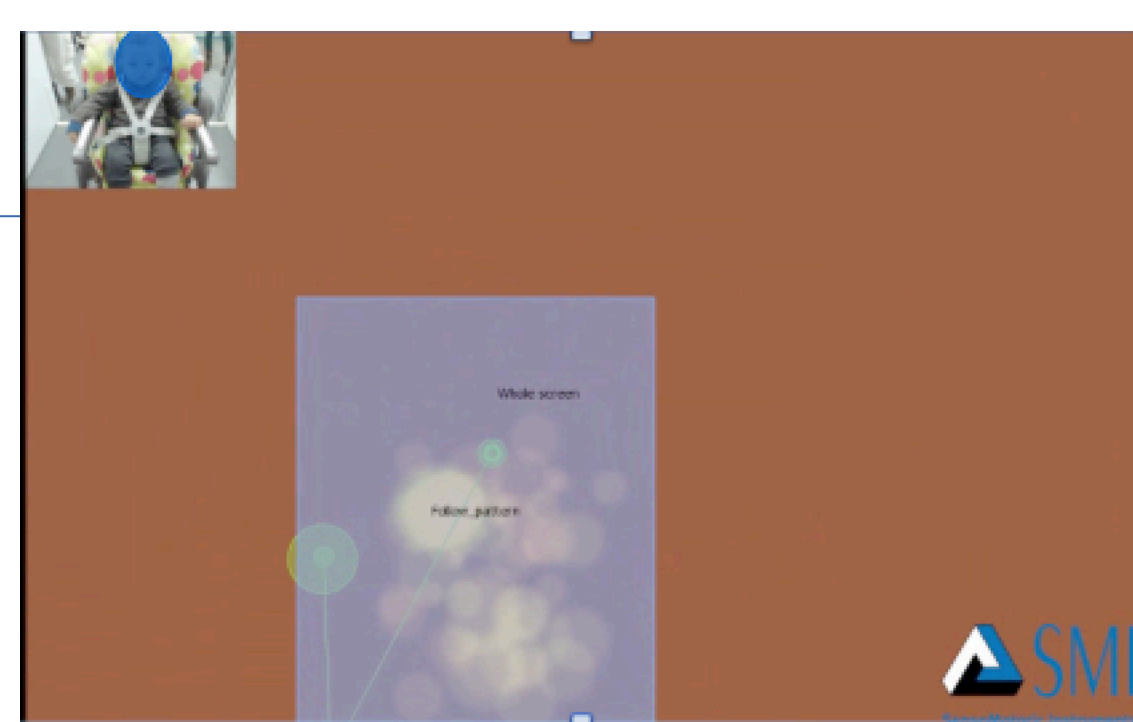
## Results

### Prosodic boundary discrimination

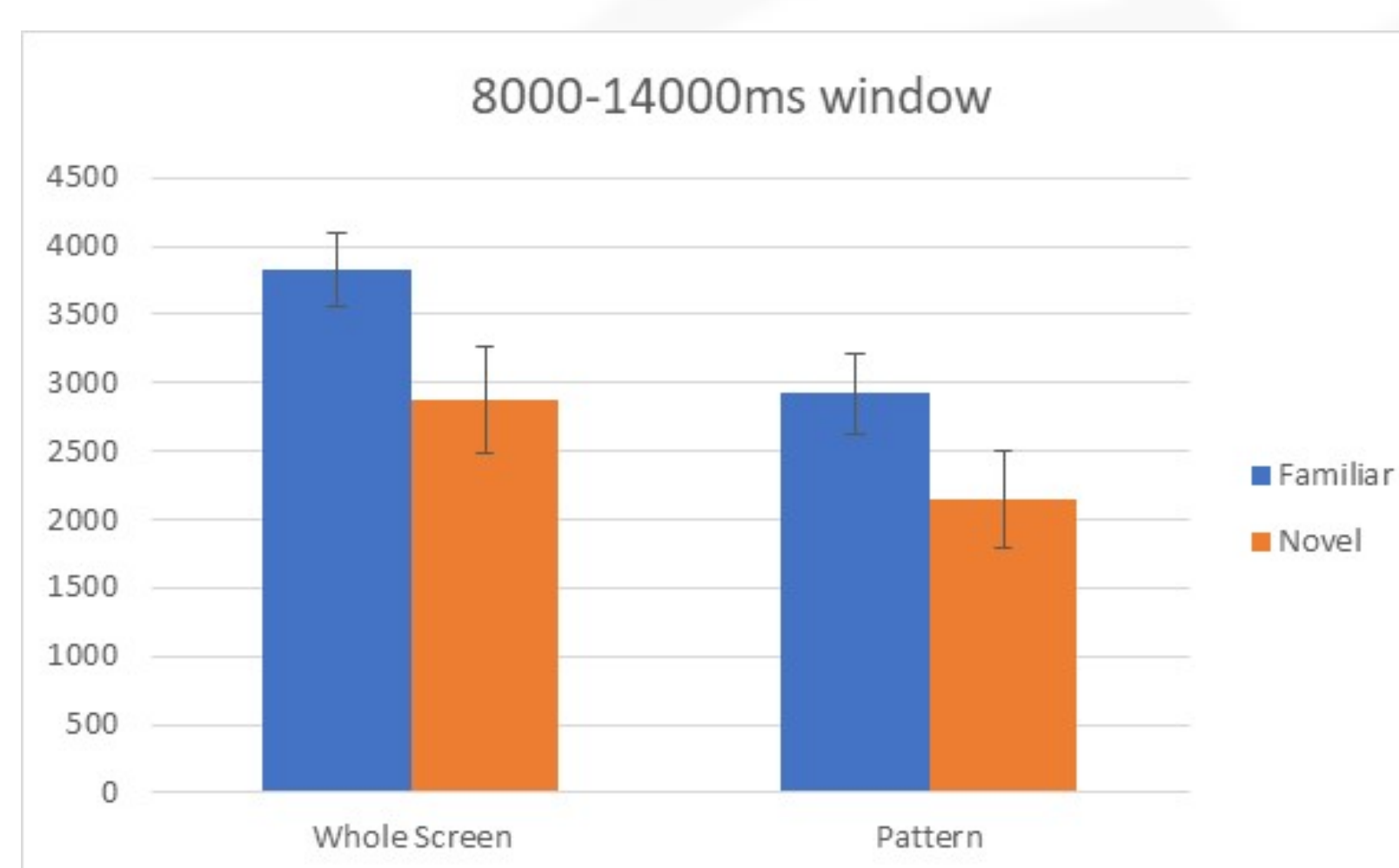
Two AOIs:  
AOI1 whole screen;  
AOI2 dynamic visual moving pattern

Time window of interest for the familiarity effect: 8000ms-14000ms (based on inspection of proportion of looks during time course of test trials)  
Any consistent difference in looking time between familiar and novel is taken as an indication of discrimination abilities

No difference in familiarization looking time between infants familiarized with sequences without-IP and with-IP ( $t(13)=.333, p=.745$ )



**Figure 2:** Mean looking times (ms) to familiar and novel across the two AOIs. Error bars indicate the standard error of the mean.



Evidence for discrimination

### Later language outcomes

Correlation between looks to familiar minus novel and EP-CDI scores for vocabulary and word combinations  
- Discrimination performance at 9 months and ability to combine words at 24 months:  $r=.871, p=.055$

**Table 2:** Repeated measures ANOVA: within-subject factor of familiarity (familiar, novel) and between subject factor of familiarization condition (without, with IP).

	AOI1	AOI2
Familiarity	$F(1,13)=5.536, p=.035, \eta^2=.299$	$F(1,13)=5.785, p=.032, \eta^2=.308$
Familiarization condition	$F(1,13)=.236, p=.635, \eta^2=.018$	$F(1,13)=.024, p=.879, \eta^2=.002$
Interaction	$F(1,13)=.246, p=.628, \eta^2=.019$	$F(1,13)=.010, p=.923, \eta^2=.001$

## Discussion

- EP-learning infants discriminate between utterances with and without an internal IP boundary.
- The pause is not a necessary cue by 9 mos in line with the language-specific adult pattern. This further supports **infants' attunement to the language-particular pattern of boundary cues during the 1<sup>st</sup> year.**
- EP infants' discrimination was not affected by the type of prosodic grouping heard during familiarization, unlike in German infants (who only succeed if familiarized without-IP, [12]). Further research needed to examine cross-linguistic differences in infants' perception.
- The use of delexicalized stimuli ascertains that **infants' successful discrimination could only rely on the processing of prosodic structure** (differently from [10]). This finding is relevant to prosodic bootstrapping theory, that holds infants can exploit prosodic boundary cues to learn about the lexicon and syntax. Our findings suggest that **perception of IP boundaries at 9 months may be related to early development syntax.**
- The use of **eye-tracking** offers more accurate (time window) and sensitive (AOIs) measures of discrimination abilities.

## References

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