Prosody facilitates word segmentation in infants at risk for language impairment

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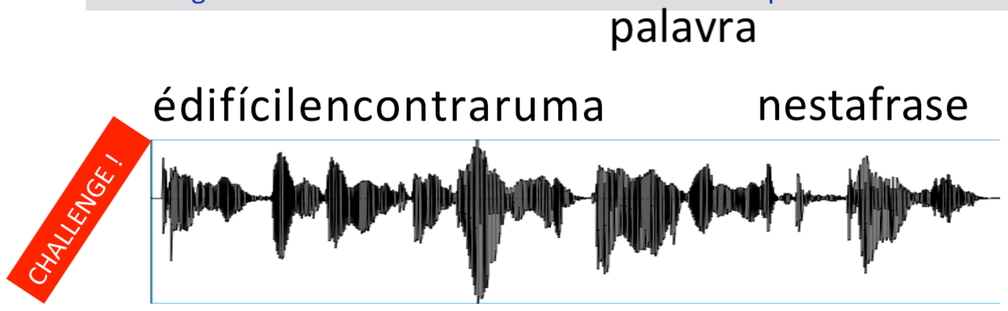
Introduction

The word segmentation problem: when and how infants begin to segment word-like forms from the continuous speech stream?



Segmentation abilities play a central role in language acquisition [1,2,3]; Develop differently across languages [5 - review]; Are modulated by prosodic structure [4,5]

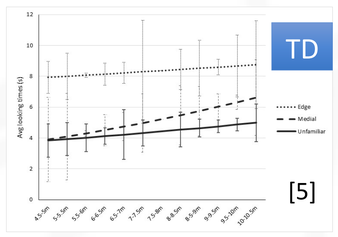
Infants at risk for language impairments (AR)

- Two studies on preterm infants with mixed findings [6,7]
- The role of prosody was not explored

Group	Language	Succeeded	Failed	Full-term
8-month olds (maturational)	Spanish Catalan	–	CVC, CCVC	Do it
6-month-old (post-natal)	French	CV	–	Do it

GOALS (extend [8])

1. Examine whether prosody facilitated word segmentation, as shown for typically developing (TD) infants [5]
2. Examine whether prosody modulated the relation between segmentation abilities and lexical knowledge



[5]

If similar mechanisms/trajectories guide word segmentation in AR, a similar pattern of results is expected, albeit possibly delayed.

Methods

Participants

21 AR infants/toddlers from monolingual EP homes (10 girls, mean age 15 months 17 days, range 6 to 26 months); preterm birth < 37 weeks (9), familial risk for autism or language disorder (9), other factors (3)

Stimuli *[listen to audio files]*

Targets: 4 monosyllabic CVC or CVG pseudo-words
2 passages for each word: utterance-edge-final position and utterance medial position
4 word-lists from different spoken exemplars
(Gostei daquela imagem do sau) $_{IP}$
'I liked that image of sau'
(A Maria tomou sau com limão) $_{IP}$
'(The) Mary took sau with lemon'
Female native EP speaker, in CDS

Table 1: Acoustic properties of the stimuli.

	Medial		Edge		
	Mean	SD	Mean	SD	
Sentence Length (ms)	2000.63	143.36	1952.88	154.91	1.11, p = .27
Syllable Duration Before Boundary (ms)	308.79	52.49	494.50	53.60	12.13, p < .001
Pitch Range (Hz)	-24.52	32.32	-59.58	21.83	4.4, p < .001
Tonal Event	-		L%		-

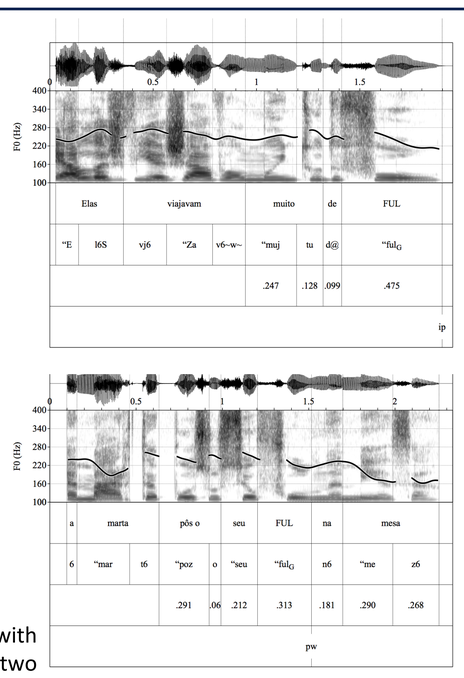
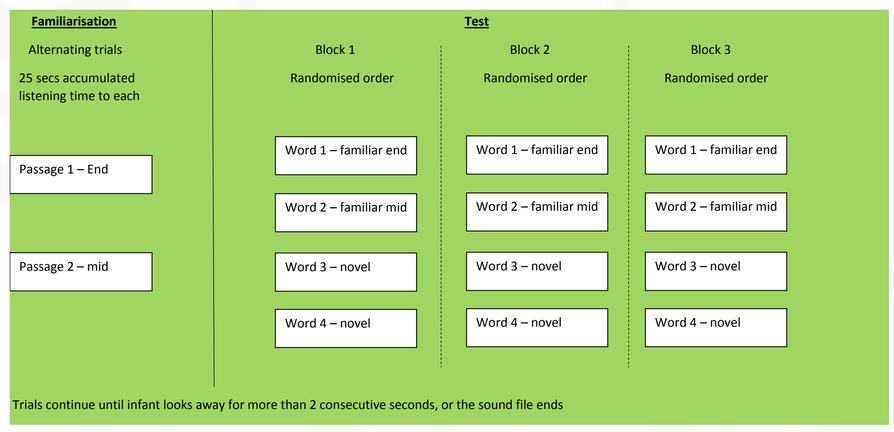


Figure 1: Examples of utterances with the target word-forms in the two prosodic conditions

Procedure *[see video file]*

Modified version of the visual habituation paradigm (as in [5])



Segmentation demonstrated by any consistent difference in looking times to familiar and unfamiliar word-forms

http://labfon.letras.ulisboa.pt/babylab/pt/CDI/

Measures of language abilities

Infants' caregivers completed the EP version of the CDI short forms at testing [9].

Results

Evidence for segmentation

Driven by the **prosodic edge**

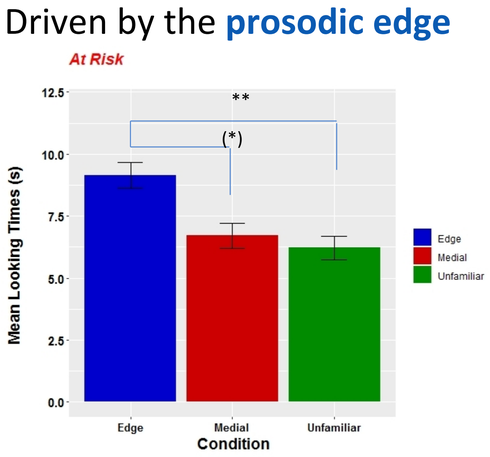


Figure 2: Mean looking times (s) for the three experimental conditions. Error bars indicate the standard error of the mean.

No effect of age

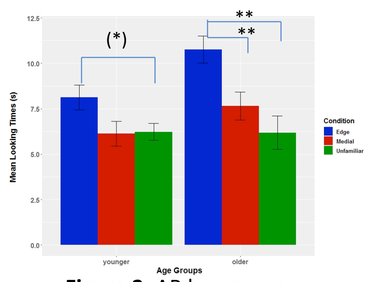


Figure 3: AR by age group.

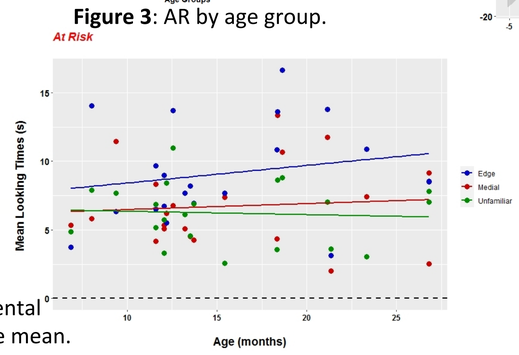


Figure 4: Individual data.

Concurrent language skills

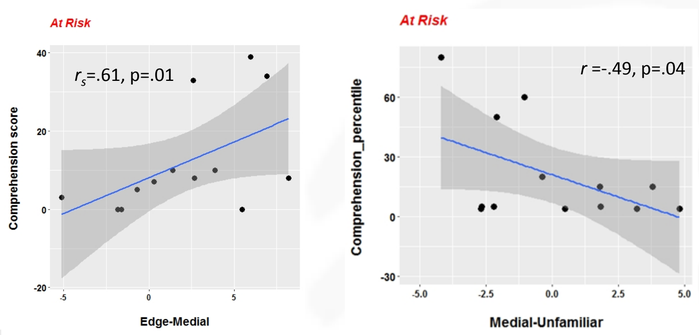


Figure 5: Correlation: looking time and receptive vocabulary

Comparing TD and AR

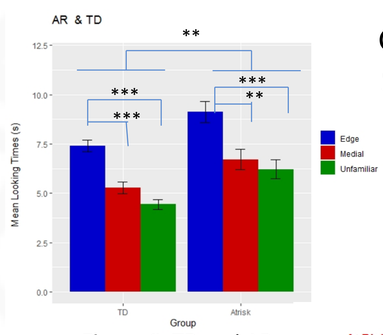


Figure 6: TD and AR.

Group effect: AR > TD
Same pattern:
Edge > Medial
Edge > Unfamiliar

Language abilities

More looks to **edge** ➔ better receptive vocabulary
More looks to **medial** ➔ lower receptive vocabulary

Within AR

Familiar risk > preterm
Effect of condition
Same pattern:
Edge > Others

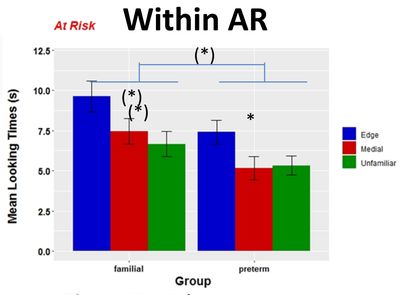


Figure 7: AR by group type.

Discussion

1. Prosody facilitated word segmentation? Yes.

- The first evidence for CVC/CVG segmentation for AR (Catalan and Spanish infants failed – [6]).
- Although following the TD developmental path, no emergence of segmentation in medial position yet. Segmentation abilities are delayed in the AR group.

2. Prosody modulated the relation between segmentation abilities and lexical knowledge? Yes.

- A link between segmentation skills and language acquisition, that had not yet been found for at risk infants and toddlers.

Similar mechanisms/trajectories guide word segmentation in TD and AR.
Future research should focus on subgroups of at risk babies.

References

[1] Singh, L, J. Steven Reznick, and L. Xuehua. 2012. Infant word segmentation and childhood vocabulary development: A longitudinal analysis. *Dev. Sci.*, 15(4), 482–495. **[2]** Kidd, E. et al. 2018. Individual Differences in Infant Speech Segmentation: Achieving the Lexical Shift. *Infancy*, 23(6), 770–794. **[3]** Hoareau, M., H. H. Yeung, and T. Nazzi. 2019. Infants' statistical word segmentation in an artificial language is linked to both parental speech input and reported production abilities. *Dev. Sci.*, 22(4), e12803. **[4]** Johnson et al. 2014. The edge factor in early word segmentation: Utterance-level prosody enables word form extraction by 6-month-olds. *PloS one*, 9(1), e83546. **[5]** Butler, J. and S. Frota. 2018. Emerging word segmentation abilities in European Portuguese-learning infants: New evidence for the rhythmic unit and the edge factor. *Journal of Child Language*, 45, 1294-1308. **[6]** Bosch, L. 2011. Precursors to language in preterm infants. Speech perception abilities in the first year of life., in Braddick et al. (Eds.), *Progress in Brain Research*, (pp. 239–257). Burlington: Academic Press. **[7]** Berdasco-Muñoz, E. et al. 2018. Early Segmentation Abilities in Preterm Infants. *Infancy*, 23(2), 268–287. **[8]** Frota, S. et al. 2020. Looking for the edge: emerging segmentation abilities in atypical development. Proc. 10th International Conference on Speech Prosody 2020, 814-818, DOI: 10.21437/SpeechProsody.2020-166. **[9]** Frota, S. et al. 2016. Infant communicative development assessed with the European Portuguese MacArthur-Bates CDI Short forms. *First Language*, 36(5), 525-545.

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