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INNOVATION WEEK

From sounds to words: An eye-tracking study of infant word learning

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Introduction

Developing a lexicon: Associating sound sequences to meaning

Infants demonstrate a perceptual sensitivity to speech sounds that becomes tuned to their native language during the 1st year of life

CHALLENGE !

- How does the knowledge about the sounds (speech perception abilities) interact with the knowledge about the words (early word learning) ?

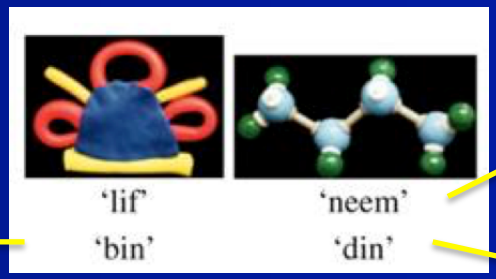
Introduction

- Word learning is critical for language acquisition (i.e., syntax, further phonological and lexical development – Newman et al., 2006; Christophe at al., 2008; Law & Roy, 2008)

- The beginnings of sound-meaning associations not only correlate with later language outcomes, but may signal risk for language impairments (Kuhl et al., 2013; Kemp et al., 2016)

Introduction

- Unlike other methods, eye gaze paradigms revealed early word learning abilities for similar sounding target words (Yoshida et al., 2009)



14 mos

14 mos

17 mos

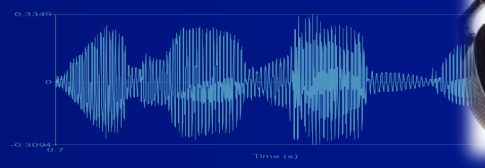
- Phonotactic frequency impacts infant word learning: constraints on the possible sequences of sounds and their positions in words (Gonzalez-Gomez et al., 2013)
  - French-learning infants

CVC words, more frequent C pattern (/p/V/t/) → 14 mos

CVC words, less frequent C pattern (/t/V/p/) → 16 mos

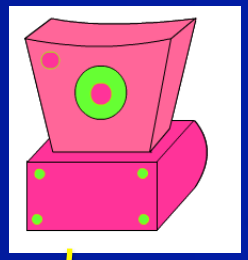
Present study

- Explore the link between sound sequences and word learning, using an eye gaze task



Sound patterns

Word ?



High frequency sound patterns

Low frequency sound patterns

Illegal sound patterns

- Focus on infants over 17 mos because they have been shown to be able to associate objects with similar sounding words in laboratory tasks

Method

- Participants:
  - 19 infants from monolingual homes in the Lisbon area (7 girls, mean age 20m 8d, range 17m 14d – 21m 28d)
  - No hearing and visual problems; No familial risk for language/speech impairment

- Stimuli:
  - Object stimuli: Test items same as in Gonzalez-Gomez et al. (2013)
  - Speech stimuli
    - C1VC2V disyllables with high frequency C1, C2, low frequency C1C2, or an illegal prosodic word C1. Vowels were the same across conditions

    (token frequency computed from the FrePoP database, over 2 million words – Frota et al., 2010. http://frepop.letras.ulisboa.pt)

Method

- Object Stimuli:

Gonzalez-Gomez et al. (2013) doi:10.1371/journal.pone.0059601.g001

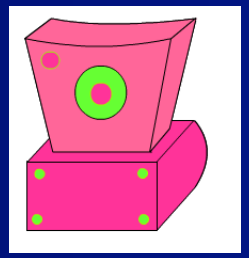
Test items
Unfamiliar objects

Control items
familiar objects

Based on the EP-CDI Short forms – Frota et al. (2016)

Method

- Speech Stimuli: produced by a female native speaker in IDS



High frequency sound sequence > satu

Low frequency sound sequence > raju

Illegal sound sequence > nhagu

pseudo words

non-words

Test items
Unfamiliar objects

8 pairs: 2xhigh/high; 2xlow/low; 2xhigh/illegal; 2xlow/illegal

bola

sopa

cama

papa

words

Control items
familiar objects

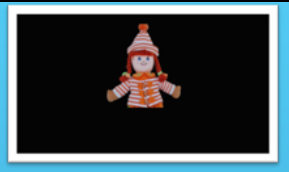
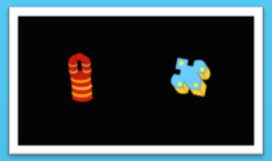
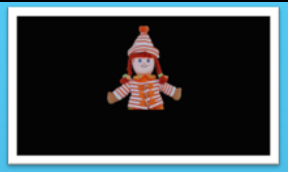
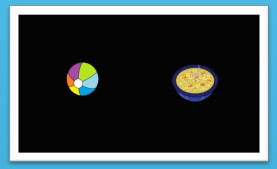
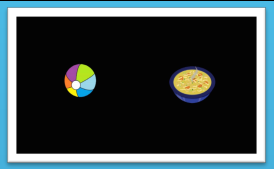
Based on the EP-CDI Short forms – Frota et al. (2016)

Method

High frequency sound patterns

Low frequency sound patterns

Structure of each block

Learning Phase (30 s)			
Introduction	Presentation object 1 - naming (5 times)	Presentation object 2 - no naming	Presentation object 1 - naming (1 time)
Olá. Vamos dar um nome a este boneco.	Este é o *padu*. Olha para o *Padu*. Vamos brincar com o *padu*. *Padu*. Olha para ele. *Padu* é bonito.	Eu tenho um outro boneco. Também podes brincar com ele.	Eu gosto muito do *padu*.
Test Phase (13.2 s)			
Naming object 1 and object 2			
 Olha!	 Onde está o *maku*?	 Olha!	Olha para o *padu*.
Test Control (13.2 s)			
Naming control 1 and control 2			
Olha!	 Onde está a *bola*?	Olha!	 Olha para a *sopa*.

1 object labeled 6 times

familiar label

unfamiliar legal

unfamiliar illegal

Method

- Procedure:
  - 8 blocks, with side of target image and order of test trials counterbalanced within subjects
  - order of blocks pseudo randomized, so that the first 4 blocks are one each of the 4 types of 'word' pairings
  - target image/sound association counterbalanced between subjects
  - A SMI RED500 eye-tracker was used and the experiment lasted around 8 minutes
- Data analysis:
  - Net dwell time for each of the two dynamic AOIs (target and distracter) was extracted
  - Proportion of looks at each AOI in the prenaming and postnaming phases

Predictions

1. Overall learning effect regardless of learning condition (high frequency/low frequency): object-label recognition > main effect of sound type (familiar vs. unfamiliar)

Phonological grammar effect!

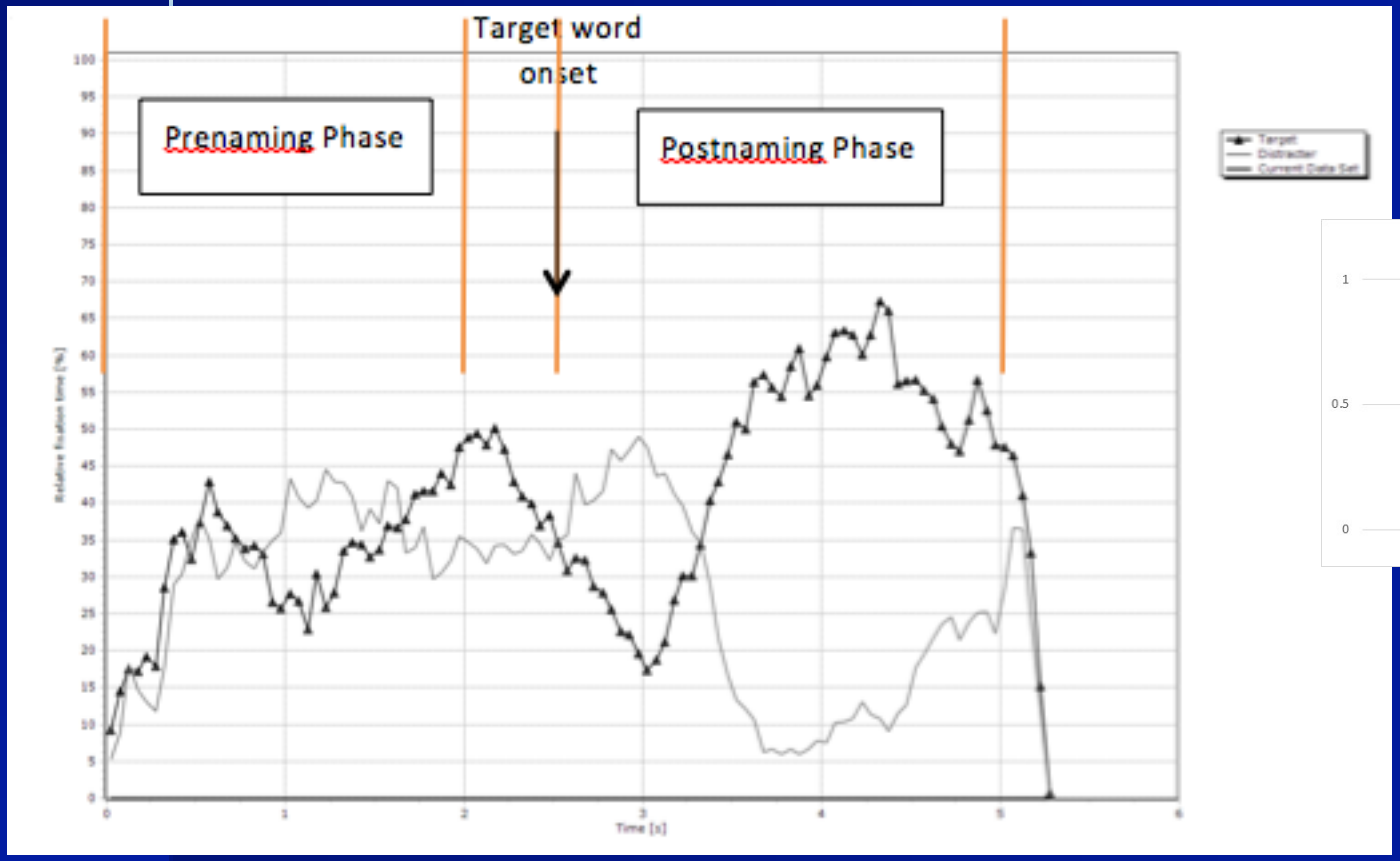
2. Learning effect regardless of learning condition (high frequency/ low frequency) but modulated by sound type: object-label recognition > main effect of sound type (familiar, unfamiliar legal, unfamiliar illegal)

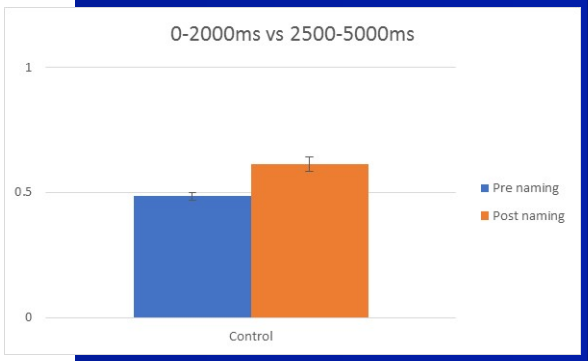
Phonotactic frequency effect !

3. Learning effect dependent on learning condition (high frequency/low frequency): main effect of learning (with or without interaction with sound type)

Results

Control trials





Significant difference ($t(18) = 3.88$, $p < .01$)

Time course of infants target looking behavior

Results

Test trials

General analysis (Repeated measures ANOVA): significant effect of learning condition - $F(1,17) = 8.45$, $p < .01$, $\eta^2 = .33$

No other effects or interactions

Prenaming phase: No significant effects

Postnaming phase:

Significant effect of learning condition ($F(1,18) = 7.78$, $p < .05$, $\eta^2 = .3$) but not for sound type ($F(2,36) < 1$), and no interaction between learning condition and sound type ($F(2,36) = 1.6$, $p = .22$, $\eta^2 = .08$)

For the learning condition High frequency, looking times were above chance (mean .55, $t(18) = 2.14$, $p < .05$

For the learning condition Low frequency, looking times were not above chance (mean .5, $t(18) = .14$, $p = .89$

Discussion

Phonotactic frequency effect !

- Word learning depends on the learning condition: phonotactic frequency guides infants' early knowledge of words, with high frequency sound patterns facilitating word learning

Ongoing work – Examining early word learning in clinical populations and at-risk groups

Thanks to all the infants and families that have taken part in this studiy.

Obrigada!

EBELa: EXCL/MHC-LIN/0688/2012
H21: PTDC/MHC-LIN/3901/2014

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