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.

- 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 et 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)

- 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

- 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

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

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

  - **Test items**
    - Unfamiliar objects
    - 8 pairs: 2xhigh/high; 2xlow/low; 2xhigh/illegal; 2xlow/illegal

  - **Control items**
    - familiar objects
    - pseudo words
    - non-words

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

  - **bola**
  - **sopa**
  - **cama**
  - **papa**

  - words
## Method

### Structure of each block

<table>
<thead>
<tr>
<th>Learning Phase (30 s)</th>
</tr>
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<tbody>
<tr>
<td>Introduction</td>
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<tr>
<td>Presentation object 1 - naming (5 times)</td>
</tr>
<tr>
<td>Presentation object 2 - no naming</td>
</tr>
<tr>
<td>Presentation object 1 - naming (1 time)</td>
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<table>
<thead>
<tr>
<th>Test Phase (13.2 s)</th>
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<tbody>
<tr>
<td>Naming object 1 and object 2</td>
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<table>
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<tr>
<th>Test Control (13.2 s)</th>
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<tbody>
<tr>
<td>Naming control 1 and control 2</td>
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- **High frequency sound patterns**
- **Low frequency sound patterns**
- 1 object labeled 6 times
- familiar label
- unfamiliar legal
- unfamiliar illegal

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**Introduction**

Olá. Vamos dar um nome a este boneco.


Eu tenho um outro boneco. Também podes brincar com ele.

Eu gosto muito do padu.

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**Test Control (13.2 s)**

Olha!

Onde está a bola?

Olha!

Olha para a sopo.
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)

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)

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

Time course of infants target looking behavior

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

Test trials

General analysis (Repeated measures ANOVA): significant effect of learning condition - F(1,17) = 8.45, p < .01, η² = .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, η² = .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, η² = .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)
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 study.

Obrigada!

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