

Infants' Sensitivity to Vowel Harmony and its Role in Word Segmentation

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Introduction

- The *word segmentation problem*:
In listening to continuous speech, how do infants identify the sound sequences that correspond to words in their language?

Introduction

Word Segmentation Cues

- Previous research:
Infants locate word boundaries in speech using cues such as stress and statistical information about syllable sequences.

Introduction

This Research

- Investigates the following:
 - Are infants sensitive to sequences of similar vowels, i.e. **vowel harmony**?
 - Is vowel harmony among the cues infants use to locate word boundaries?

Introduction

Organization

1. Background.
2. Research question and general method.
3. Exp. 1: harmony for color (backness/rounding), high-mid vowel sequences.
4. Exp. 2: color harmony, mid-high vowel sequences.

Background

Word Segmentation Problem



- Unlike printed text, a space does not regularly occur between words in continuous speech.
- Gaps in the acoustic signal may fall within words.

Background
Cues to Word Boundaries

- **Statistical information**
 - Transitional probabilities between successive syllables.
(Aslin, Saffran, & Newport, 1998; Saffran, Aslin, & Newport, 1996)
- **Stress**
 - 7–9 month old infants use stress as a parsing strategy.
(Curtin 2002; Curtin, Mintz, & Christiansen, 2005; Johnson & Jusczyk, 2001; Jusczyk, Houston, & Newsome, 1999; Polka, Sundara, & Blue, 2002, among others)
- **Each cue is only partially reliable.**

Background
What is Vowel Harmony?

- Processes or constraints that cause vowels to match for certain dimensions, such as backness or height.
- Vowel harmony generally operates within words (lexical or phonological).

Background
Example: Backness Harmony

- **Turkish** (Clements and Sezer, 1982)
- Vowels in native words match in backness.

| <u>Gloss</u> | <u>Nom. sg.</u> | <u>Gen. pl.</u> | |
|--------------|-----------------|-----------------|---------|
| 'rope' | ip | ip-ler-in | [-back] |
| 'stamp' | pul | pul-lar-ın | [+back] |

Background
Harmony & Word Segmentation

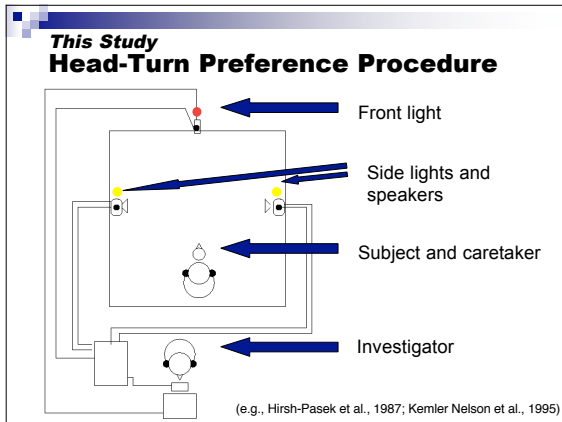
- In studies involving nonce words, adult speakers of languages with vowel harmony posit word boundaries at points of disharmony.
(e.g., Suomi, McQueen, & Cutler 1997; Vroomen, Toumainen, & de Gelder, 1998)

This Study
Research Question

- Do infants recruit vowel harmony to aid word segmentation?
- Points of disharmony in a speech stream could provide a signal for possible word boundaries.
- Infants might be universally predisposed to use harmony among their segmentation cues.

This Study
Subjects

- Test 7-month-old English-learning infants
 - Universal sensitivities should be evident in younger infants.
 - 7-month-olds show sensitivity to segmentation using other cues (e.g., Saffran et al., 1996).



This Study
General Method

1. Familiarization Phase

- Subjects familiarized to a string of CV syllables.
- A repeated sequence of two-syllable nonsense "words" containing vowels that harmonized for color.
...ditepubobidetupo...
- Synthesized, monotone, continuous speech.

This Study
General Method

2. Test Phase

- Presentation of two-syllable subsequences from familiarization string.
- Half of the items were "words," with harmonizing vowels.
- Half were "part-words," with vowels that did not harmonize.
- Listening times for test items were measured.

This Study
Prediction

If infants used harmony to segment the familiarization stream, listening times for words and part words should *differ*.

This study
Color Harmony

- Vowel color (backness/rounding) matched in words.
- Vowel height differed in words.
- Vowels restricted to:

| | Front | Back |
|------|-------|------|
| High | i | u |
| Mid | e | o |

Exp. 1
High-Mid Sequence

Experimental condition

- Familiarization stream**
 - 45 repetitions, about 50 sec total.
...ditepubobidetupo...
- Familiarization words**
 - 4 two-syllable words: *dite*, *bide*, *pubo*, *tupo*.
 - Consonants provide no boundary cue.
 - No statistical boundary cues.

Exp. 1
High-Mid Sequence

▪ **Test items**

- Words: *dite, tupo*

...ditepubobidetupoditepubobidetupo...

- Part-words: *podj, detu*

...ditepubobidetupodjdetupodjdetupo...

Exp. 1
High-Mid Sequence

Control condition:

Provides a baseline of infants' inherent preferences for word or part-word test items, apart from exposure to them in a familiarization stream.

Exp. 1
High-Mid Sequence

Control condition

▪ **Familiarization stream**

- Consonant voicing changed from original stream.

▪ **Test items**

- Same items as in experimental condition, i.e. test items were not actual words or part words in control familiarization.

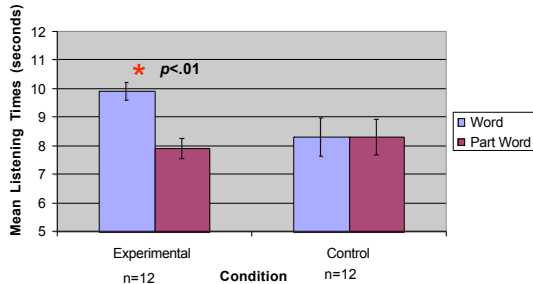
Exp. 1
High-Mid Sequence

Control condition prediction:

If differences in the experimental condition are due only to word segmentation, then infants should not show a preference for words or part-words in the control condition.

Exp. 1
Results: High-Mid Sequence

Listening Times By Condition



Exp. 1
High-Mid Sequence

▪ **Findings**

- Infants segment words based on color harmony.
- Subjects showed a familiarity preference, listening longer to items they recognize.

Exp. 2
Mid-High Sequence

Experimental condition

- **Familiarization stream**
 - 20 repetitions, about 30 sec total.
...*detipobubeditopu*...
- **Familiarization words**
 - 4 two-syllable words: *deti, bedi, pubo, topu*.

Exp. 2
Mid-High Sequence

▪ **Test items**

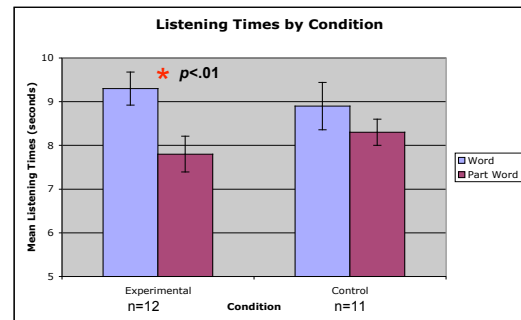
- Words: *deti, topu*
...*deti**pobu**bedi**topu**deti**pobu**bedi**topu*...
- Part-words: *pude, dito*
...*deti**pobu**bedi**topu**deti**pobu**bedi**topu*...

Exp. 2
Mid-High Sequence

Control condition

- **Familiarization stream**
 - Consonant voicing switched from original stream.
- **Test items**
 - Same as in experimental condition.

Exp. 2
Mid-High Sequence



Exp. 2
Mid-High Sequence

▪ **Findings**

- As in Exp. 1, infants used color harmony to identify word boundaries.
- Subjects showed a familiarity preference.

Conclusions

▪ **Two major findings:**

1. 7-month-olds are sensitive to vowel harmony patterns.
2. They use harmony as a cue to word segmentation, positing a boundary at points of disharmony.

Conclusions

- 7-month-olds showed sensitivity to vowel harmony even though their language environment does not contain harmony patterns.
- This suggests they are universally sensitive to harmony.

Further Questions

1. Do infants show greater sensitivity to some vowel harmony patterns over others?
2. How does sensitivity to harmony change over time?
3. What are the implications for early linguistic representations?

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