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Infants' perception of intonation: Is it a statement or a question?

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Introduction

Infant speech perception

- Developmental change in acquisition of sound categories during the first year of life:
 - Discrimination of non-native contrasts declines
 - Discrimination of native contrasts is maintained, improved or learned: Language-specific discrimination is established between 6 and 12 mos (Werker & Tees, 1984; Kuhl 2004; Saffran et al. 2006)
- Most studies examined segmental categories. Prosody?
 - Infants prefer rising contours, high pitch, expanded melody (from birth); Are sensitive to changes in melodic contours (newborns; 8 mos); Higher & variable pitch have a facilitation effect on speech discrimination (1-11 mos) >> No linguistic information (musical note sequences)



Introduction

Infant speech perception

- Grammatically relevant prosodic differences? Studies on infant's perception of prosodic categories include lexical stress, lexical tone, and lexical pitch accent:
 - Lexical stress: discrimination in the presence of segmental variation is a **newly developed ability after 6 months**, and only for learners of variable stress languages (Jusczyk et al. 1993, Skoruppa et al., 2009,2011)
 - Lexical pitch accent: **native contrast perceived only at 6-8 mos**, suggesting a sensitivity gain similar to that found for lexical stress (Sogabe et al., 2006, on Japanese)
 - Lexical tone: non-native discrimination declines from 6 mos (English, French), whereas **native discrimination is maintained** (Chinese - Mattock & Burnham, 2006; Mattock et al., 2008)



Introduction

Intonation and language acquisition

- **Intonation?** Like stress or tone, intonation varies across languages and impacts on meaning: phrasal/sentence meanings, such as sentence types.
- Importance to language acquisition:
 - Statements and questions are basic sentence types: the ability to distinguish them is crucial to process most input sentences
 - Infant directed speech tends to show a higher proportion of questions (Newport et al. 1977; Frota & Vigário 1993)
 - Cross-linguistically questions, unlike statements, tend to show the prosodic features that infants prefer (high pitch, rising contours – cf. Frequency code; but no universal, e.g. Chickasaw, UNB; Ladd 2001, Gussenhoven 2002, Rialland 2007)
 - Questions (and answers) are crucial to communication and social interaction (Fernald 1989; Koegel et al. 2010)



Introduction

Yes-no questions across languages

The distinction between statements and yes-no questions across languages is marked:

- **Both by morphosyntax and intonation** (e.g., English, French, Catalan), -
- **Not by intonation** (e.g., Shekgalagari, Vata, Cantonese – Hyman & Monaka 2011; Riailand 2007; Wong et al. 2005)
- **By intonation only** (e.g., Portuguese, Spanish).

- Intonational marking also varies across languages:
 - **Boundary tones**: H%/LH% (Dutch, French, Japanese), HL% (Hungarian, Neap. Italian), L% (Catalan, Chickasaw, Bininj Gun-wok)
 - **Peak alignment** (late): Russian, Neap. Italian
 - **Peak height** (higher): Russian, Japanese
 - **Register expansion / less downdrift**: Wollof, Danish
 - **Final lengthening**: Nateni



Introduction

Infant speech perception again

- Cross-linguistic variation in question/statement marking, importance of utterance types for language acquisition, role played by intonation > But very few studies on infants' perception of intonation
- Only two studies on declarative/yes-no question discrimination, both for English
 - Soderstrom et al. (2011): uninverted yes-no questions. No discrimination, a general bias towards questions
 - Geffen (2010), Geffen & Mintz (2012): word order + intonation cues. Familiarity effect at 7 mos (discrimination). No results at 8-9 mos.
- General attention bias for higher/rising pitch?
- Cues? Developmental course of infants' perception?



Introduction

The present study

- We examined 5-6 and 8-9 month old infants' perception of declaratives and yes-no questions in European Portuguese (EP)
- EP (standard variety) marks this contrast **only by prosodic means** (Frota 2002)
 - Boundary tone: declarative: H+L***L%**; question: H+L***LH%**
 - Longer durations of nuclear and post-nuclear syllables in questions
 - Higher first peak in questions is optional
 - The prosodic contrast is perceived by adult native speakers (Falé & Faria 2005)



Introduction

The present study

- Research question
 - Is infants' discrimination of intonation maintained (akin to lexical tone discrimination), learned (akin to lexical stress or word pitch accent discrimination) or neither (as in Soderstrom et al's results for English), in a language where intonation processing is crucial to learning the distinction between statements and yes-no questions?
 - If discrimination is successful, prosody may facilitate the acquisition of the grammar of the two sentence type categories very early in development



Methodology

Material

Two validation pre-tests:

Nonwords

- Initial subset of 16 nonwords were generated ('CVCV, all sonorant)
- These were presented to 19 undergraduates (with 16 real words), that were asked to decide if they heard a real word or a made up word
- All words identified significantly above chance. 13 nonwords (milo, nórro, rina, réno, róno, môla, lâmo, málo, méla, nirra, nurra) were correctly identified significantly above chance (>65% correct responses); 3 nonwords (limo, runa, léma) performed at chance and were thus replaced in the final materials (with lemu, rano, luma)

Contours

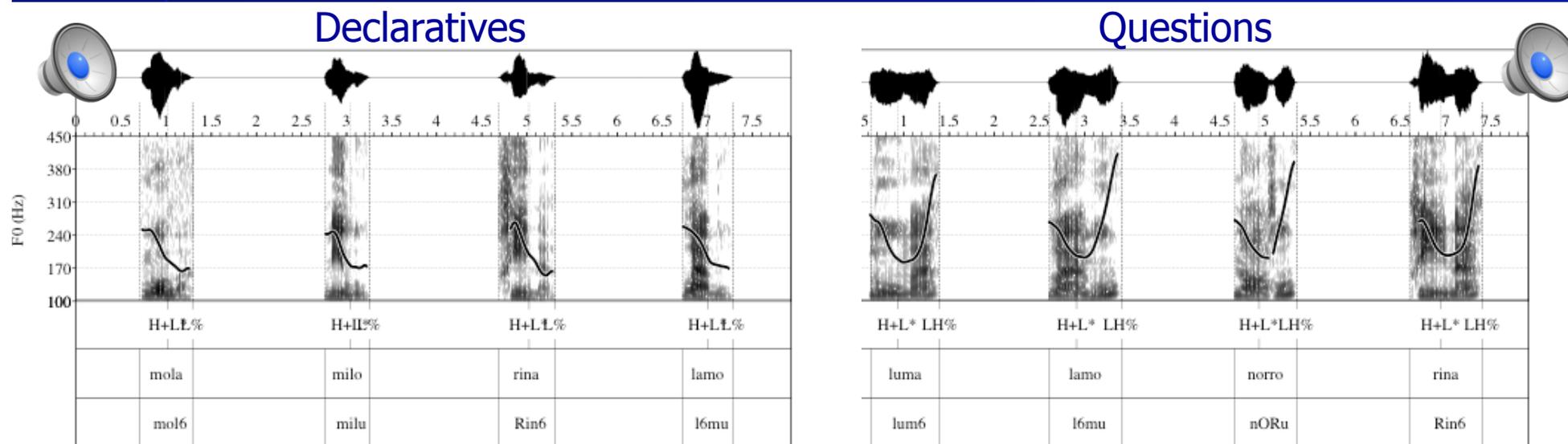
- Natural decl and int one-word stimuli, and 2 manipulated versions (decl with int contour, decl with matching range to int)
- Both natural and manipulated forms presented to 10 undergraduates, that were asked to identify the utterances as declaratives or questions
- Declarative and declarative with manipulated range were selected as declarative significantly above chance ($p < .001$). Interrogative was selected as question significantly above chance ($p < .001$), but decl manipulated with int contour varied between decl and question response
- In the experimental materials, **natural decl and interrogatives were used**, and decl were manipulated to match the range of the fall of int (first peak similar height)



Methodology

Material

- **Stimuli:** Segmentally varied one-word utterances produced by a female native speaker in infant-directed speech



Final F0 values ($t(15) = 23.61, p < .001$)

F0 range within final syllable ($t(15) = 23.46, p < .001$)

F0 range for the fall, manipulated decl ($t(15) = .13, p = .9$)

Duration ($t(15) = 11.91, p < .001$)



Methodology

Participants

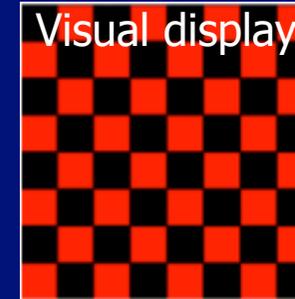
- 32 Portuguese learning infants from European Portuguese monolingual homes
 - 16 younger (mean age 5 months 26 days)
 - 16 older (mean age 8 months 16 days)
- 7 additional infants tested (4 younger, 3 older) but not included due to crying, fussiness, a parent who was not Portuguese, an older autistic sibling and software failure

Methodology Procedure

Attention getter



Visual display



- Infants tested using the visual fixation paradigm (Stager & Werker, 1997)
- Infants sat on the caregivers lap in the centre of the test booth, in front of a computer monitor, with speakers hidden behind
- Habituated with lists of nonwords, half the infants habituated with declarative, half with question intonation
- Test phase presented infants with a list of different nonwords in both declarative and question intonation
- Presentation of test stimuli counterbalanced between infants (same/switch trial first)
- *Look* software (Meints & Woodford, 2008) was used to control stimuli presentation and to record looking times to each trial (recording with experimenter blind to stimuli presentation)
- **If infants were sensitive to the intonational contrast, they should display longer listening times to the switch trials**



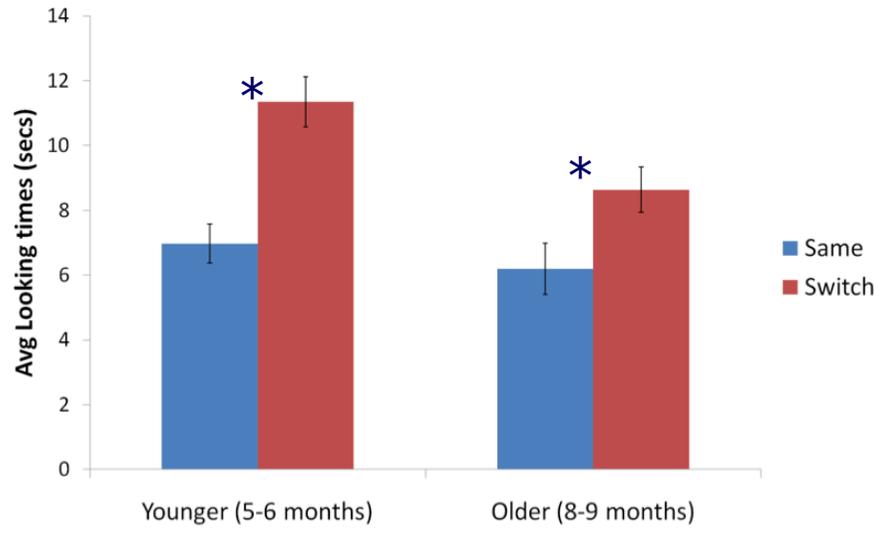


Results

- There was no difference in the number of habituation trials needed between younger and older infants (younger mean = 12.75, older mean = 11.38, $t(30) = .87$, $p = .39$)
- There was no difference in the number of habituation trials needed between declarative and question for younger infants (decl mean = 12.25, ques mean = 13.25, $t(14) = .39$, $p = .7$)
- Older infants habituated significantly quicker to the question trials (decl mean = 13.63, ques mean = 9.13, $t(14) = 2.71$, $p < .05$)
- Younger infants display significantly longer looking times to the first 4 habituation trials (younger mean = 13.6, older mean = 11.58, $t(30) = 2.78$, $p < .01$)
- The shorter looking times to the first 4 habituation trials by older infants, with the fewer habituation trials needed for question trials, suggest that older infants become disinterested in the task quicker, and that questions are somehow easier for them.



Results



Average looking times (secs) to the same/switch test trials, across the two age groups

- 14/16 infants in each group display longer looking times to the switch trials
- **Significant difference between same and switch test trials** ($F(1,30) = 48.5, p < .001, \eta^2 = .62$)
- No effect of group ($F(1,30) = 3.78, p = .061, \eta^2 = .12$)
- No interaction between trial and group ($F(1,30) = 3.95, p = .06, \eta^2 = .12$)
- However, age effect is borderline
 - Older infants seem to become disinterested in the task quicker, and find the question contour easier, as shown by looking times to habituation trials



Discussion

- Results show infants learning European Portuguese demonstrate a **discriminate ability** for the statement/question contrast **as early as 5 months**.
- First study to show early discrimination on the basis of **prosodic cues** only.
- This ability is **maintained** during the first year (akin to lexical tone development, but unlike lexical stress or word pitch accent discrimination which seem to be newly developed abilities for native learners after 6 months of age).



Discussion

- Recent research has shown that this intonation contrast is used by 1 and 2 year olds when learning novel word-object pairs, at odds with native language word-level phonology (Frota et al., 2012), suggesting that it is a **very salient contrast** in the language.
- This early discrimination ability based on **prosodic cues only** may facilitate the acquisition of the grammar of declarative sentences and yes-no questions, given the relation between intonation and the grammatical distinction in sentence type, in European Portuguese.



Obrigado, Thank you

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