Early interpretation of stress and pitch contrasts in European Portuguese

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1. Introduction

Acquisition of phonology requires learning to interpret phonetic variation. Across languages, prosodic properties may vary in their acoustic correlates and the phonological domains they signal.

The task for the young learner: Which variation is meaningless? Which variation conveys meaning, at what prosodic level (word level/phrasal level)?

Discrimination studies have shown (i) early sensitivity to pitch as a general ability, but not early sensitivity to stress; (ii) both language-specific stress perception and lexical tone perception by 9 months (e.g. Nazzi et al. 1998, Mattock & Burnham 2006, Mattock et al. 2008, Weber et al. 2004, Skoruppa et al. 2009, Höhle et al. 2009)

Word recognition studies have shown that stress and pitch are relevant to English learning infants by 7½ months; pitch register is discarded by 9 months; pitch contour interacts with stress (Jusczyk et al. 1999, Singh et al. 2008, Fikkert & Chen, in press)

Recent research has shown that English infants at 1;0 use stress in **word learning**, and at 2 ½ disregard pitch contours as lexically relevant (Curtin 2009, Quam & Swingley 2010)

The present study:

We tested whether European Portuguese (EP) learners were sensitive to stress and pitch contrasts in a word learning task, using an eyegaze-based procedure.

Will young learners notice stress differences and/or intonation differences in 'new words' ?

When do young learners interpret phonetic variation at the appropriate levels according to the native language?

2. Stress and Pitch in EP

European Portuguese (EP) is an intonation language with lexical stress

Stress is a word level property: Duration is the main cue to word stress (Andrade & Viana 1989, Delgado Martins 2002); stress can be contrastive.

Pitch is a property of phrase level phonology: Pitch contrasts signal phrase level meanings; Sparse pitch accent distribution (Frota 2002, Vigário & Frota 2003)

The acquisition of stress and pitch contrasts in EP:

- No prior perception studies
- Early word production: level stress, weak-strong patterns, stress shift (Frota & Vigário 2008, Frota & Matos 2009, Correia 2010; Matos 2010)

3. Method I: Procedure

Eyegaze-based procedure: visual fixation to the labelled picture is the response variable.

1. Animation phase

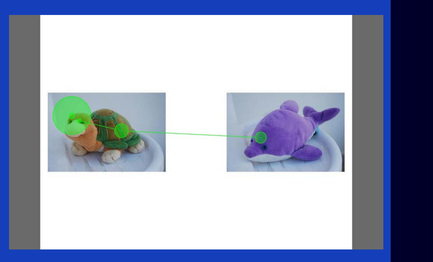
A doll introduces two toys, but only one of them is labelled (the 'A' toy)

2. Ostensive labelling

The 'A' toy is repeatedly labelled

3. Test phase

Pictures of the two toys appear side by side while children listen to the trained word and to stress/pitch deviant versions



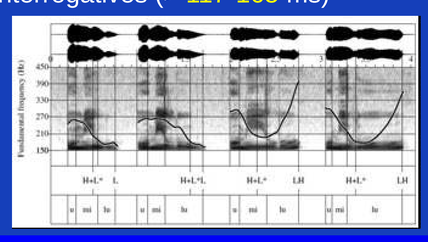
An SMI eye-tracker was used (the measure taken: Dwell time)

3. Method II: Materials

Auditory stimuli recorded by a native EP speaker in CDS: The disyllabic word form **[milu]**

Stress contrast: penult / final ['**mi**lu] / [mi'**lu**]: Cued by relative duration (stressed > 58-132 ms) and by the alignment of the pitch fall (through the stressed syllable)

Pitch contrast: declarative / interrogative (H+L* **L%** / H+L* **LH%**): Cued by the low versus rising boundary and by the longer duration of the final syllable in interrogatives (> 117-165 ms)



Trained pronunciation: penult-decl; final-decl; penult-int
Deviant pronunciations: stress change (SC), intonation change (PC), both
Test phase included 4 trained trials + 8 change trials (4+2+2)

3. Method III: Participants and Coding for analysis

	Participants	Mean age (months)	Children included	Mean age (months)	CDI mean score (%)
Group 1	26	16.9	14	16.4	24.08
Group 2	24	29.7	18	29.8	63.76
Group 3	26	42.4	19	41.8	84.18
Group 4	17	53.5	15	53.3	88.78

93 children between 1;0 and 4;9 were tested, from monolingual EP homes. 66 children have successfully performed the task (i.e. learned the trained word: >50% fixation to the labelled picture)

Coding for analysis: Proportion looking time at the labelled object picture 'A', within a specified time window after the onset of the target word: 367-2000 ms (Fernald et al. 1998, Swingley & Aslin 2002, Gredebäck et al. 2010, Fikkert & Chen in press)

4. Results

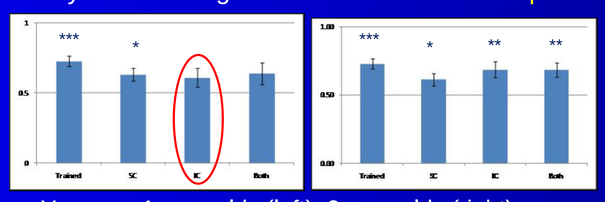
No bias towards any of the object pictures before the target word was heard (mean =.48, t(92) = -.09, p = .38)

Only children that learned the trained word were included in the analysis (fixation to the labelled picture > 50% - mean = .74, t(65) = 13.47, p < .001)

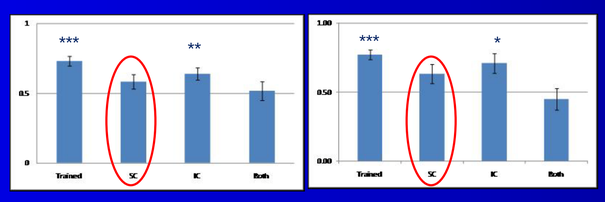
Did children respond to the deviant pronunciations (conditions SC, PC, both)?

ANOVA on the % looking time to the labelled picture: Significant main effect of condition (*F* (2.624,133.843) = 4.62, p < .01)
Significant interaction between condition and age [younger=groups 1-2 vs. older=groups 3-4 (*F*(2.624,133.843) = 3.39, p <.05)

Children's response to the deviant pronunciations by age: Sensitivity to any of the changes as fixation the labelled picture NOT above chance



Younger: 1-year olds (left), 2-year olds (right)



Older: 3-year olds (left), 4-year olds (right)

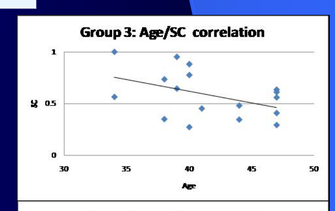
Proportion looking time at the labelled object picture across the 4 conditions, by age.

Development from sensitivity to **pitch** to sensitivity to **stress**

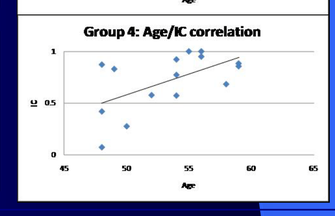
Sensitivity to	Number (n=18)	
None	6	(33,3%)
IC (+Both)	5	(27,8%)
SC (+Both)	4	(22,2%)
SC+IC / Both	3	(16,7%)

Individual data from Age 2: variation. No trend with age.

Age 3: Negative correlation between age and SC, i.e. sensitivity to SC is (still) improving
r = -.437, p < .05 (one-tailed)



Age 4: Positive correlation between age and IC, i.e. sensitivity to IC is (still) decreasing
r = .574, p < .05 (one-tailed)



5. Discussion

Pitch contour variation is regarded as relevant in new words by 1-year olds, whereas stress pattern variation is not, **at odds with native language phonology**.
2-year olds seem to be struggling to interpret phonetic variation
Only at 3;0 do young learners interpret phonetic variation at the appropriate levels **according to the native language**.
This grammatical tuning is still developing along the 4th and 5th years.

Is stress variation too subtle a phonetic difference in EP (unlike in English – Curtin 2009)?
1-year olds have difficulties in detecting subtle phonetic contrasts when learning novel words (e.g., Werker & Yeung 2005, Swingley & Aslin 2007).
Production studies for EP have also shown difficulties with stress contrasts in early word production (e.g. Correia 2010).
A later acquisition of the phonology of word stress in EP.

The pitch change results match the results reported for English (Quam & Swingley 2010): pitch contour differences are discarded by 2-year olds.
But **it is not known** whether English-learning 1-year olds include pitch contours among the dimensions of variation relevant to lexical meaning.
Is the **early sensitivity to intonation contrasts** in word learning a more general property (akin to early sensitivity to pitch in discrimination) or a language-specific feature?
Perception and production: Production studies for EP showed that pitch contrasts are produced early in the 2nd year and that words form single-word prosodic phrases until the end of the 2nd year (Vigário et al. 2011)

Our results suggest that phonological development proceeds from pitch to stress, by fine tuning to the dimensions relevant in the native phonology

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