

Language abilities in infants with Down Syndrome: An experimental study on early perception of intonation

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Introduction



- Children with Down Syndrome (DS)
 - Genetic perturbation known as trisomy 21
 - Most common genetic cause of intellectual disability
 - Affects language development and language processing
 - Language comprehension and production deficits: phonology, vocabulary, syntax
- Few studies examined early language abilities in **infants with DS**
 - Initial strengths and weaknesses ?
 - Early language interventions to support language development

Stoel-Gammon, 2001; Abbeduto et al., 2007; Roberts et al., 2007; McDuffie & Abbeduto, 2009; Stojanovik, 2011; Kover et al, 2012; Kent et al., 2013; D'Souza et al., 2016; Mason-Apps et al., 2018; Frota et al., 2020; Filipe et al., 2022; Filipe et al., 2024



Intonation (pitch)



- Pitch encodes phrase and sentence-level meanings
 - Sentence type: statements, questions
 - Other pragmatic distinctions
- Intonation/pitch and language learning
 - Typically developing (TD) infants display an early sensitivity to prosody, and **pitch** in particular
 - TD infants and toddlers exploit the prosodic cues available in speech to learn about many different properties of their native language(s)
 - E.g., word segmentation, word learning, word categories, word order in syntax

Morgan, 1986; Morgan & Demuth, 1996; Jusczyk, 1997; Höhle, 2009; Shukla et al., 2011; Johnson & Seidl, 2008; Bion et al, 2011; Shi et al, 2006; Christophe et al., 2003; Gervain & Werker, 2013; Butler & Frota, 2018; Frota et al., 2020; Gervain et al., 2020



Current study



- Early perception of intonation in DS
 - Are infants with DS also sensitive to pitch cues?
 - Is intonation processing an initial strength or weakness?
- **Strong discrimination abilities** for intonation
 - Intonation might be used in early intervention as a tool to boost language learning
- **Poor discrimination abilities** for intonation
 - Less able to exploit pitch cues to learn the language
 - Prosody/intonation as a domain of difficulties to be targeted in early intervention

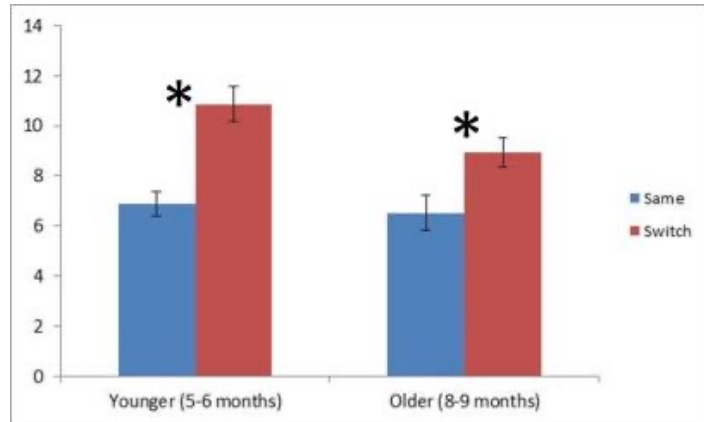


1. Introduction

Frota, Butler & Vigário (2014), *Infancy*



Joe Butler Marina Vigário



TD Infants are able to discriminate utterances that differ only in the prosodic features that cue statements and questions, as early as by 5-6 months of age



Brief Report

<https://doi.org/10.1111/inf.12037>

Infants' Perception of Intonation: Is It a Statement or a Question?

Sonia Frota, Joseph Butler ✉, Marina Vigário 2014

Intonation discrimination in DS



Method



■ Participants

- 21 infants with DS from monolingual EP homes recruited from collaborating clinical institutions

Full-term, normal hearing to mild hearing loss (according to clinical screening)
Normal or corrected-to-normal vision, no history of seizures/other medical or neurological conditions

10 females, mean age 7 months 18 days, range 5;03 to 13;08

One other infant was tested but excluded due to fussiness



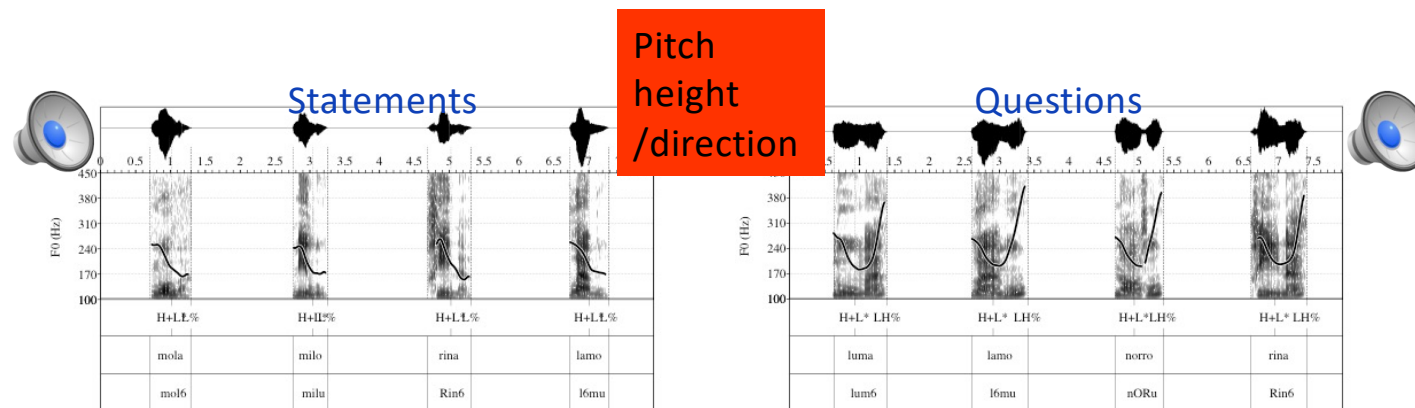
Method



■ Materials (same stimuli sound files from Frota et al., 2014)

Segmentally varied, single pseudo-word (bisyllabic sequences with initial stress) utterances produced by a female native speaker in IDS, with statement and question intonation

4 Stimuli sound files, 2 for each intonation type, with 8 utterances, and total length of 16 sec



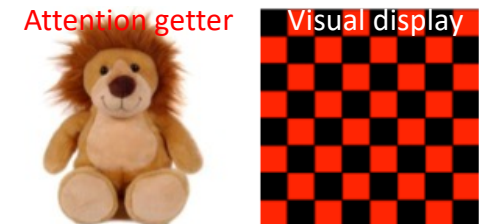
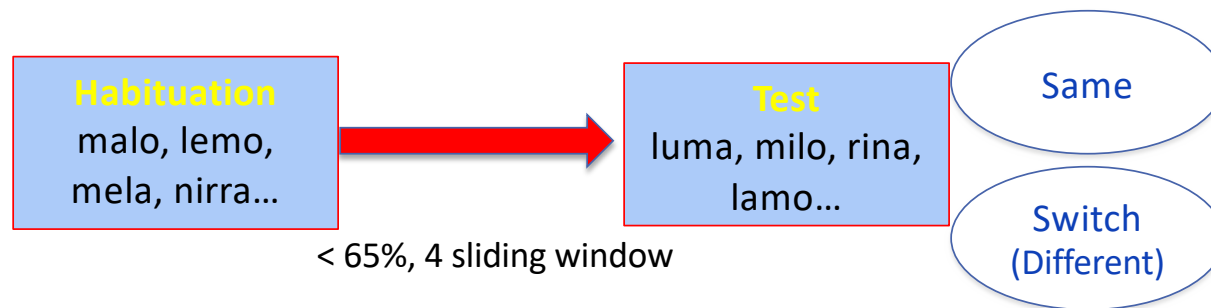
Stimuli available at http://labfon.lettras.ulisboa.pt/babylab/Infants_Perception/Infants_perception_intonation_supporting_materials.htm



Method



- **Procedure:** Modified version of the visual habituation paradigm (same as in Frota et al., 2014)



Habit2 software (version 2.2.10)
Oakes et al., 2019

Discrimination demonstrated by longer listening/looking times to Switch test trials compared with Same test trials



Method



Results (I)



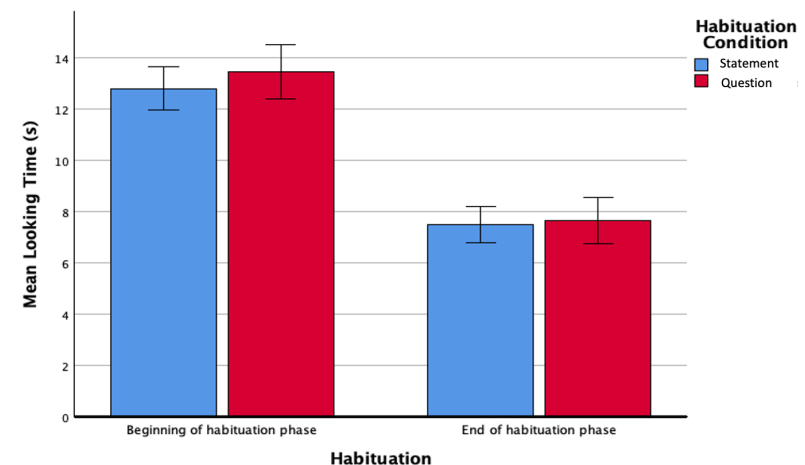
- **Habituation:** Replicated the analysis from Frota et al. (2014) with the data from the infants with DS

A 2 (hab phase beginning/end) x 2 (condition) RM ANOVA was conducted on the looking time data.

Main effect of **habituation phase**:
 $F(1, 19) = 55.470, p < .001, \eta^2 = .75$

No effect of habituation condition:
 $F(1, 19) = .158, p = .696, \eta^2 = .008$

Comparison DS and TD groups on the #trials needed to habituate: $\chi^2(2, N = 61) = 1.206, p = 0.547$



Similar performance in the habituation phase



Results (II)



- **Test:** Replicated the analysis from Frota et al. (2014) with the data from the infants with DS

A 2 (trial type) x 2 (hab condition) RM ANOVA was conducted on the looking time data.

Main effect of **trial type**:

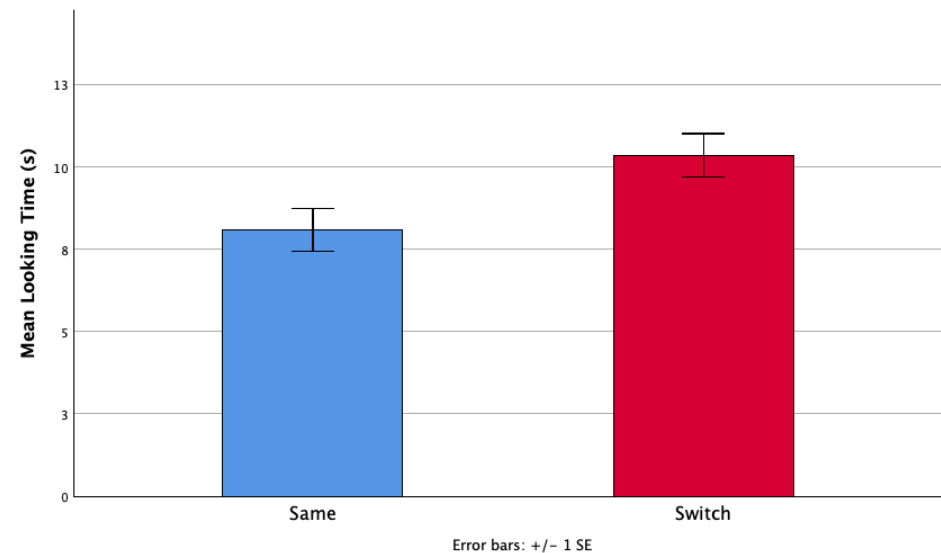
$F(1, 19) = 5.329, p .032, \eta^2 = .032$

No effect of habituation condition:

$F(1, 19) = .329, p = .573, \eta^2 = .017$

No interaction:

$F(1, 19) = .239, p = .630, \eta^2 = .012$



Infants with DS looked longer at the switch trials



Results (III)



■ Cross-group comparison: DS and TD

TD younger, < 7mos (N=20)

DS younger, < 7mos (N=13)

TD older, > 7 mos (N=20)

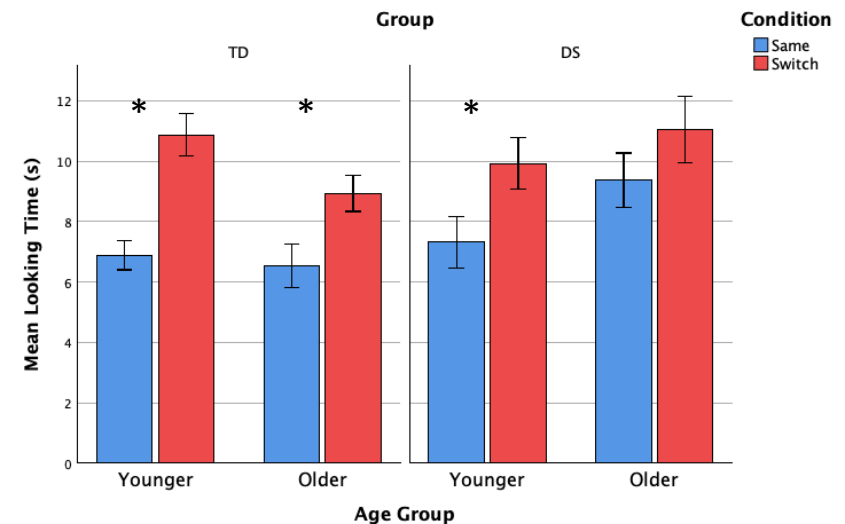
DS older, > 7 mos (N=8)

GLMM:

Fixed effects	F	df	Denominator df	p-value
Trial type (same/switch)	25.485	1	29	<.001
Group (TD/DS)	2.948	1	32	.096
Age Group (young/older)	.177	1	31	.677
Trial type*Group	1.090	1	33	.304
Trial type*Age Group	1.546	1	33	.223
Trial type*Group*Age Group	3.385	1	72	.039

Analysis of the significant interaction

Younger TD infants	$\beta = -3.979$, SE = .635, $t = -6.260$, $p < .001$, 95% CI -5.242, -2.716
Older TD infants	$\beta = -2.405$, SE = .530, $t = -4.536$, $p < .001$, 95% CI -3.455, -1.355
Younger infants with DS	$\beta = -2.612$, SE = .953, $t = -2.742$, $p = .008$, 95% CI -4.524, -.701
Older infants with DS	$\beta = -1.667$, SE = 1.634, $t = -1.020$, $p = .319$, 95% CI -5.059, 1.726



Differently from TD infants, older infants with DS were unable to discriminate



Discussion



- Like TD infants, infants with DS also exhibit an **early ability to discriminate** the sentence type intonation contrast, in the challenging context of phonetic variability
- Unlike TD peers, this early sensitivity to intonation appears to **decrease** in **older infants with DS**, who fail to discriminate the intonation contrast
- Early perception of intonation in DS
 - Are infants with DS also sensitive to pitch cues?
 - Is intonation processing an initial strength or weakness?

Yes, but within a sensitive time-window

Initial strength, but only in the very early stages



Discussion



- Initial strong discrimination abilities for intonation
 - Highlight a crucial developmental window when intonation might be used in early interventions to support language learning
 - Infants with DS might be able to exploit the pitch cues to learn the language
 - E.g., TD infants use pitch cues to facilitate early word segmentation from 4 months of age
 - Prosody/Intonation, which have not been included in early interventions in DS (Moraleda-Sepúlveda et al., 2022; Seager et al., 2022), should be added as a tool in language and communication interventions from birth



Discussion

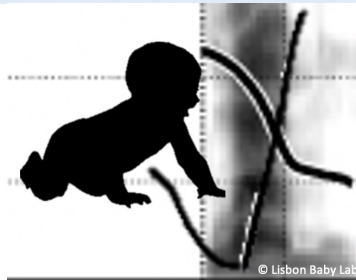


- **Poor discrimination abilities** for intonation after 7 months
 - Older infants with DS are less able to exploit pitch cues to learn the language
 - E.g., using pitch to facilitate word segmentation, to learn the different sentence types
 - Prosody/intonation is a domain of difficulties to be targeted in early intervention
 - Prosodic/intonation training should be included in language and communication interventions for older infants, and toddlers with DS, to support their language development



Take home message

Prosody/Intonation play an important role in early language development, also in infants with DS



Sensitive time-window for exploring strong pitch discrimination abilities to boost language learning



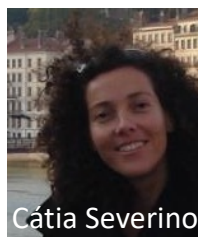
Implications for early intervention strategies age-tailored to better support language and communication outcomes in children with DS



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Obrigada!
Thank you!



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