



**NeuroD-WELL – Workshop on Early Language in Neurodevelopmental Disorders**  
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# **Selective attention to audiovisual communicative cues in infants with Down syndrome**

## **An eye-tracking study**

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# Audiovisual speech processing

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- Visual contributions to speech perception are well documented in the literature, suggesting a crucial role of visual information:

## ADULTS

- In decoding the speech signal under **noisy environments** (e.g., Drijvers & Ozyürek 2017; Buchan, Paré & Munhall 2008) or in contexts involving an **unfamiliar language** (e.g., Barenholtz, Mavica & Lewkowicz 2016; Navarra & Soto-Faraco 2007);

## INFANTS

- In **language acquisition and development** (e.g., Pejović 2019; Chandrasekaran, Trubanova, Stillitano, Caplier & Ghazanfar 2009; Rosenblum, Schmuckler & Johnson 1997; *inter alia*).

# Selective attention to audiovisual cues

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Shift in  
Selective  
attention



- Audiovisual speech processing in infants is characterized by a **shift** from the **eyes** region **to** an **increased attention to the mouth** by 8 months of age, coinciding with the **emergence of speech production** (Lewkowicz & Hansen-Tift 2012, Pejovic et al, in prep).

# Selective attention to audiovisual cues

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- Increased preference for the mouth interpreted as infants' ability to take advantage of articulatory information to acquire their native language:
  - Asynchronicity between speaker's face movements and auditory vocal production (e.g., Hillairet de Boisferon, Tift, Minar & Lewkowicz 2017; Lewkowicz 2010; Pons & Lewkowicz 2014);
  - Bilingual infants' preference for mouth as compared to monolinguals (e.g., Ayneto & Sebastián-Gallés 2017; Fort et al. 2018; Pons, Bosch & Lewkowicz 2015, but see Pejovic 2019).

# Selective attention to audiovisual cues

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- Several studies have suggested **impairments** on audiovisual speech perception and face tuning in atypical developing children with **Down Syndrome (DS)** (Pavlova et al. 2018; D'Souza, D'Souza & Karmiloff-Smith 2017; Lopez-Ramirez et al. 2017; D'Souza et al. 2016; *inter alia*):
  - In detecting a mismatch between auditory and visual speech information in 15 to 34-month olds;
  - In identifying negative emotions when looking at faces in 9 to 18-year olds.
- The role of visual attention to speaking faces in assisting language development in infants with DS was not explored yet.

# Selective attention to audiovisual cues

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- In European Portuguese (EP), this topic was already addressed for 5-6 month-old typical developing (TD) infants (Cruz et al. submitted; Cruz et al. 2018; Filipe et al. 2018).
- As in infants learning other languages, TD EP-infants attend longer to the eye region (over the mouth) before the onset of canonical babbling (Pejovic 2019; Ayneto & Sebastian-Galles 2017; Lewkowicz & Hansen-Tift 2012; *inter alia*).
- TD EP-learning 5-to-6-month olds attend longer to linguistic (face) than to extralinguistic (hand movement) audiovisual cues.

# Main goals

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- Explore the looking pattern of DS EP-learning infants (not studied so far).
- Compare it with the looking pattern observed for TD EP-learning infants (Cruz et al., submitted; Cruz et al. 2018; Filipe et al. 2018).



- Add to the knowledge of atypical developing infants' processing of audiovisual communicative cues.



implication for **early intervention**

# Methodology

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- **TD infants** (Cruz et al., submitted; Cruz et al. 2018; Filipe et al. 2018):
  - N=25 (15 boys); 5-6 months (M=5;25);
  - Typical development assessed through the application of 2 screening tools:
    - **CSBS-DP** adapted for EP (Frota et al. 2014-2016) at 6-24 months;
    - **CDI short forms** (Frota et al. 2016) at 8-30 months.
  - Social communication, language and symbolic functioning skills as expected for their age (including eye gaze, gestures, productive and receptive vocabularies).
- **DS infants:**
  - N=7 (3 boys); 5-7 months (M=6mos.)



# Methodology

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- Materials and Procedure:
  - Using **remote eye-tracking** (SMI RED500), infants' eye gaze was measured while watching a **4-second-long video** of a cartoon character (Noddy) talking and waving at the infant;
  - This video was the last event of each experimental block in a speech perception experiment (Butler et al. submitted). It had a **dual goal**: to allow measurement of eye gaze to talking faces and social gestures, and to keep infants engaged in the speech perception task.

# Methodology

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- Materials and Procedure:
  - 4 different exemplars of the video were created containing 4 different encouraging messages; the video is the same across exemplars
  - Order of presentation was fixed within participants and randomized across participants.
  - The following dynamic areas of interest (AOIs) were considered:
    - (a) linguistic: face, eyes, mouth
    - (b) extralinguistic: arm,
    - (c) non-linguistic: **background**



# Methodology

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- Materials and Procedure:
  - Total of 101 trials ( $M=3,74$  by infant) for TD infants and 27 trials ( $M=3,85$  by infant) for DS infants considered for analysis.
  - Inspection of infants' tracking ratio for each video trial:
    - For TD: trials with a tracking ratio  $<50\%$  were discarded;
    - For DS: only trials with a tracking ratio of  $0\%$  were discarded.



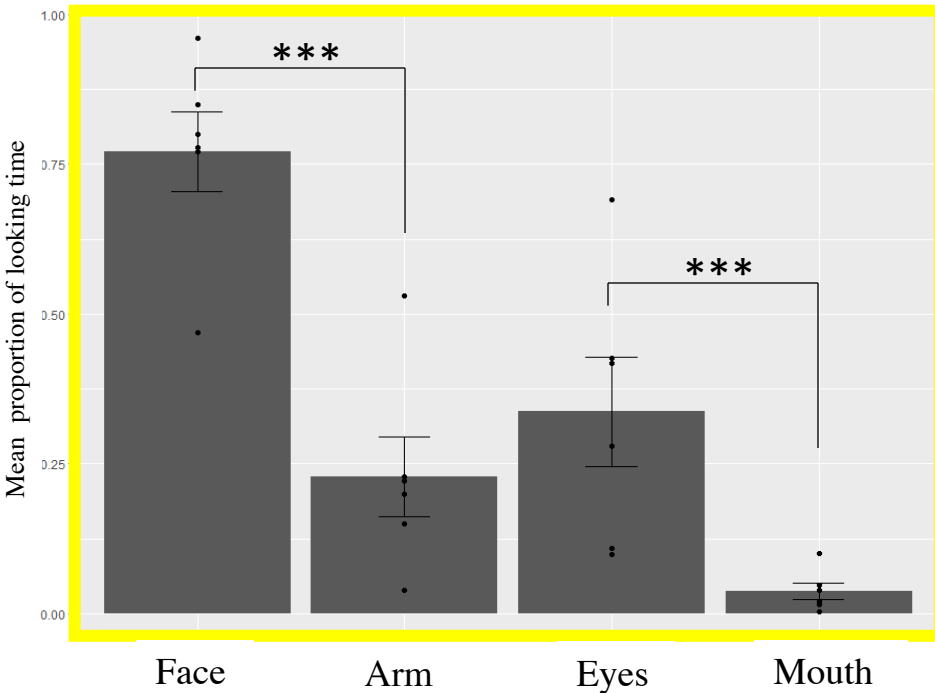
## Analysis

67 trials for TD (tracking ratio:  $M=89,04\%$ ,  $SD=39,89\%$ )

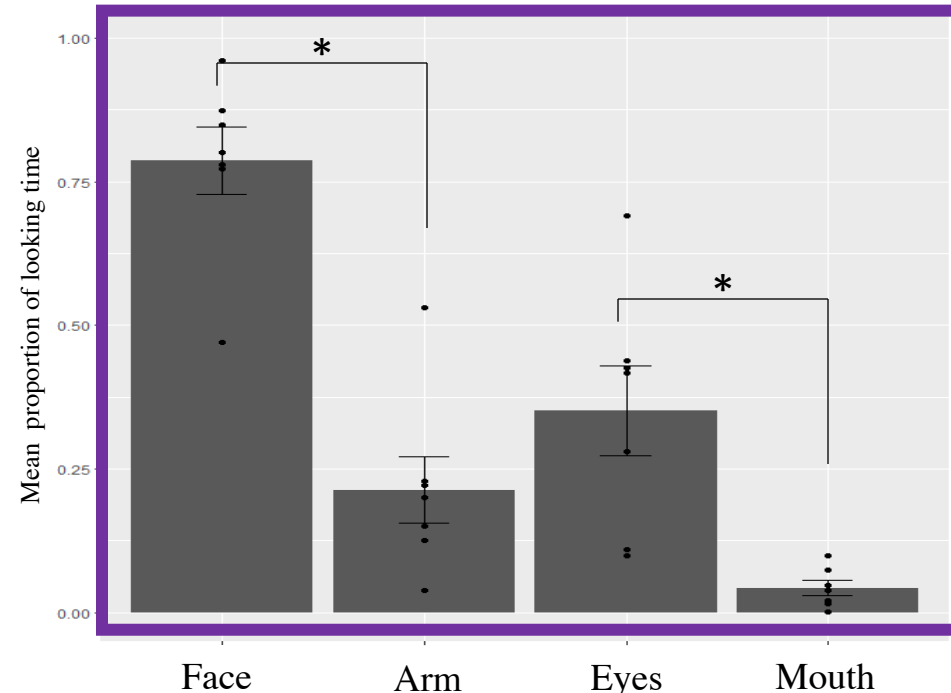
25 trials for DS (tracking ratio:  $M=73,68\%$ ,  $SD=26,35\%$ )

- Net dwell time(ms) and proportion of looking time were used as eye gaze measures. Entry Order & Latency across AOIs were also inspected.

# Results: Mean proportion of looking time /AOI



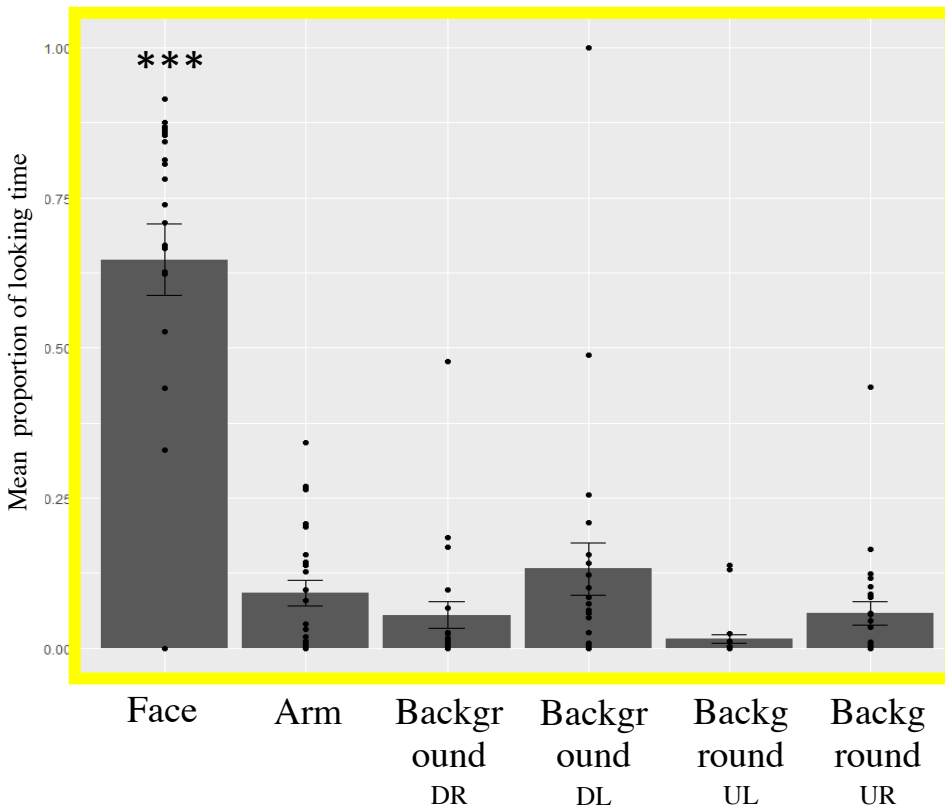
TD infants



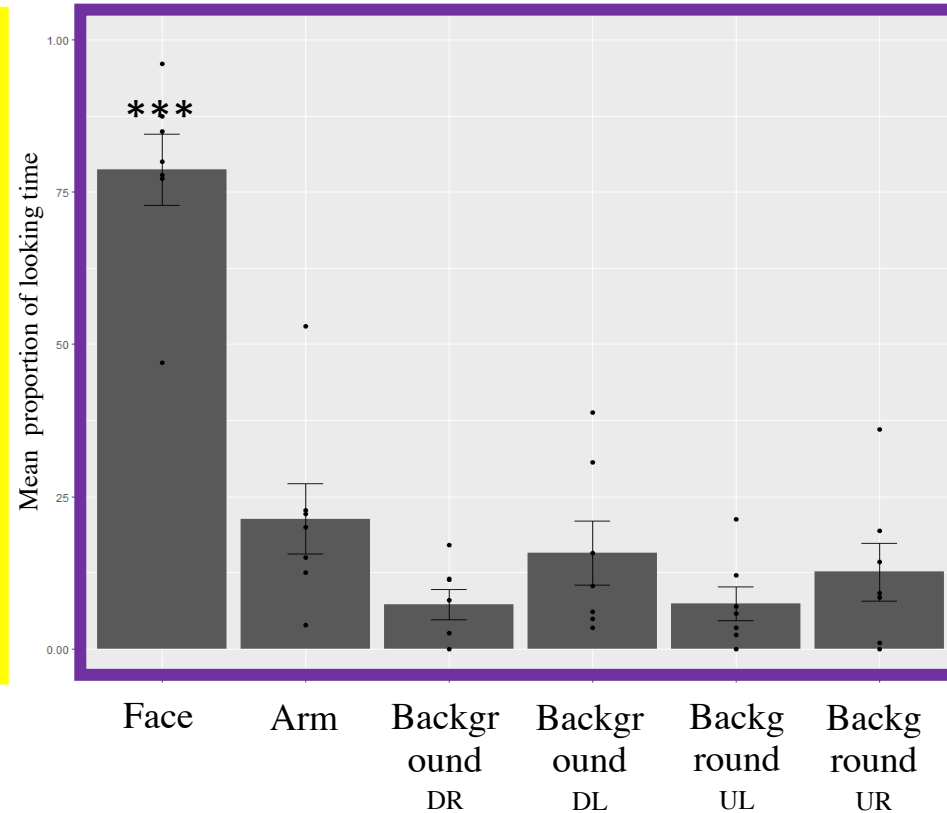
DS infants

- Both TD and DS infants attend:
  - + to the **face** than to the arm;
  - + to the **eyes** than to the mouth.

# Results: Mean proportion of looking time/AOI



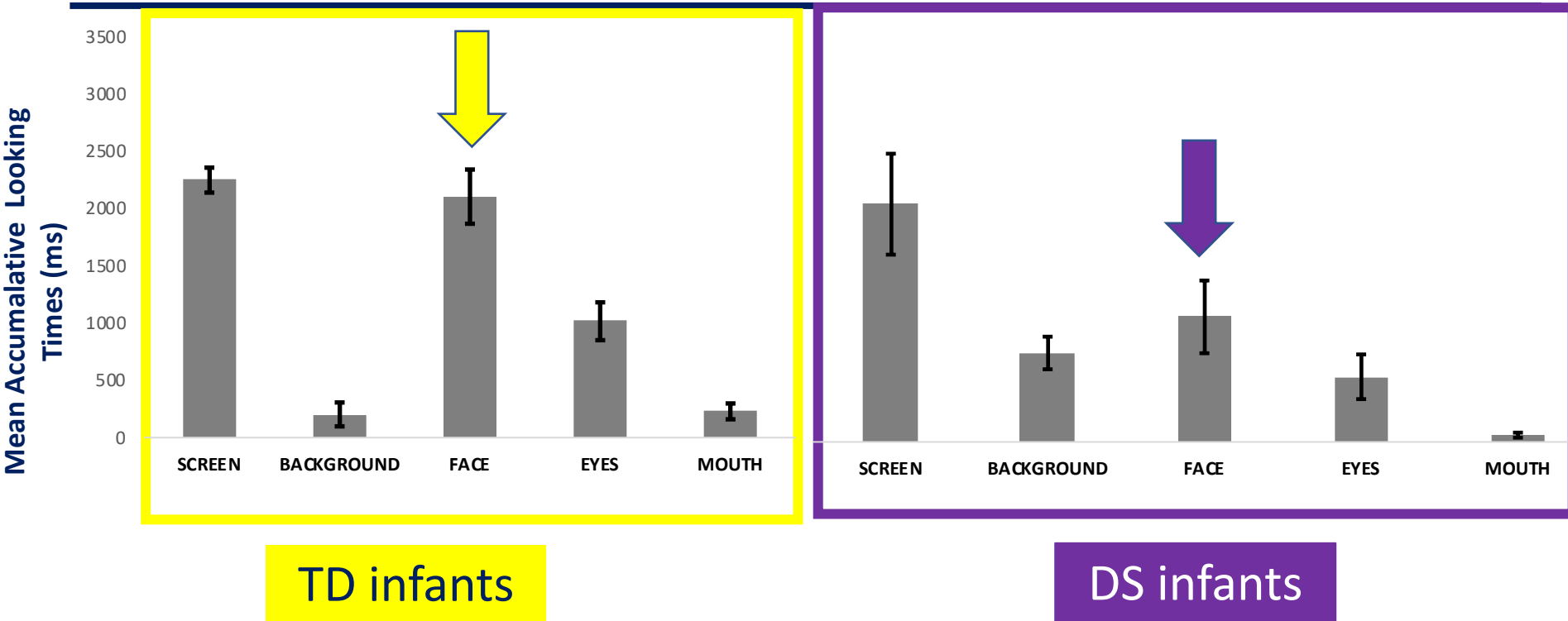
TD infants



DS infants

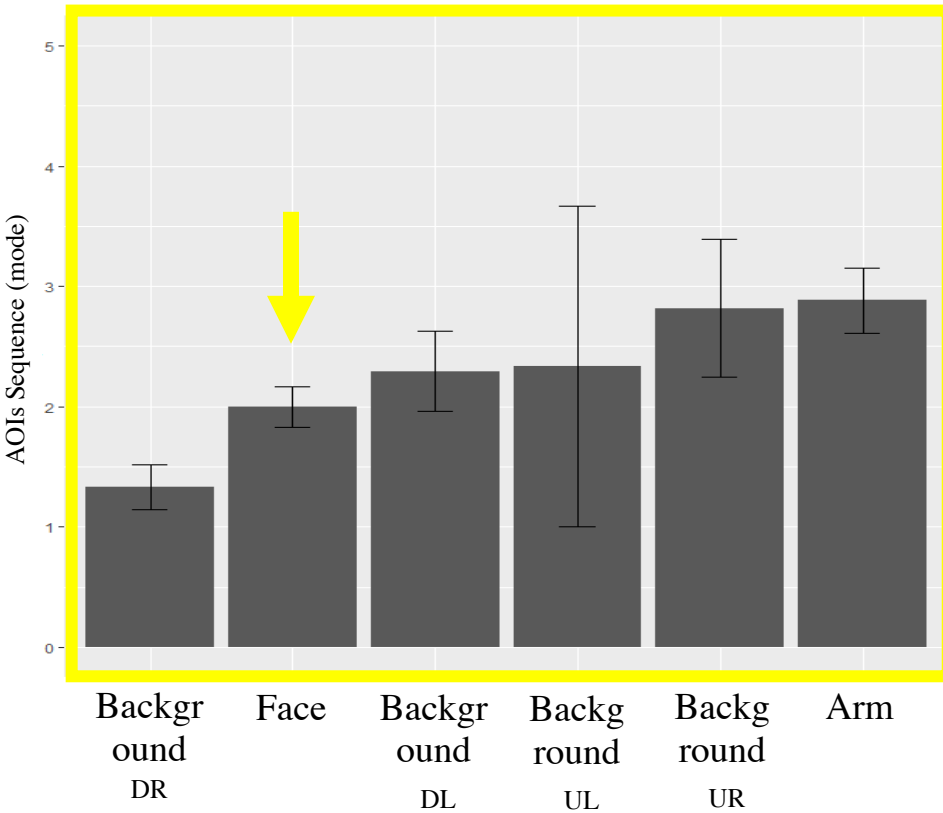
- Mean proportion of looking time in face is different from all other AOIs
- The arm is not more attractive than other background areas.

# Results: Mean looking time (ms)

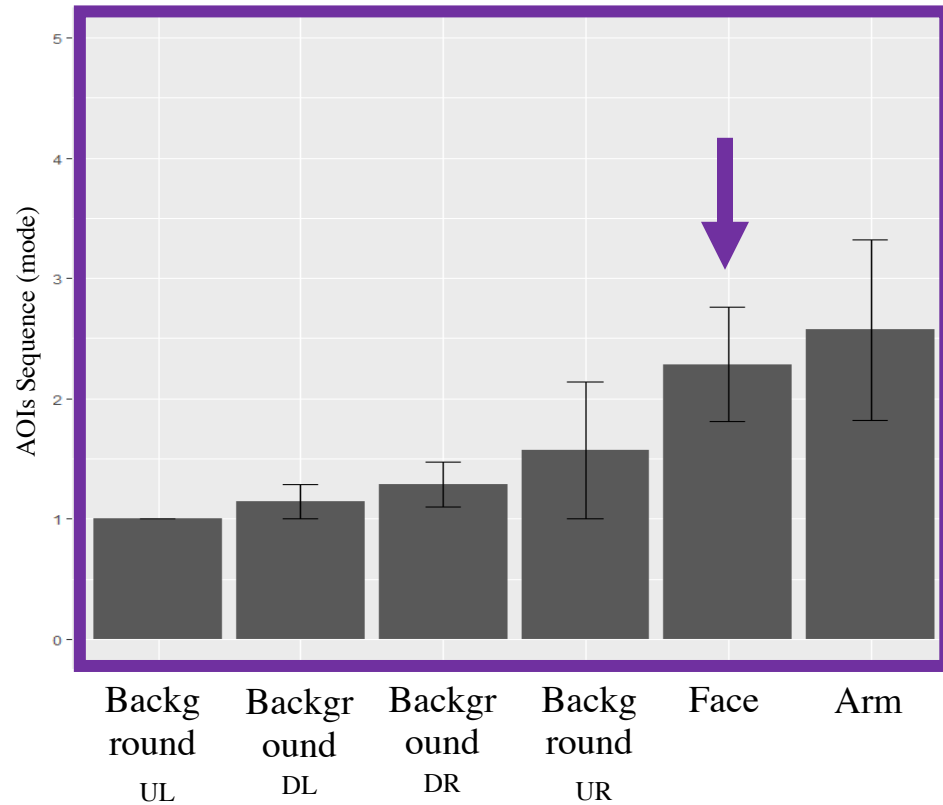


- TD and DS infants show similar mean looking times (ms) to the whole screen.
- Although showing similar looking patterns (screen<face<eyes<mouth), TD infants look **longer** to the **face** than DS infants.

# Results: Entry order per AOI



TD infants

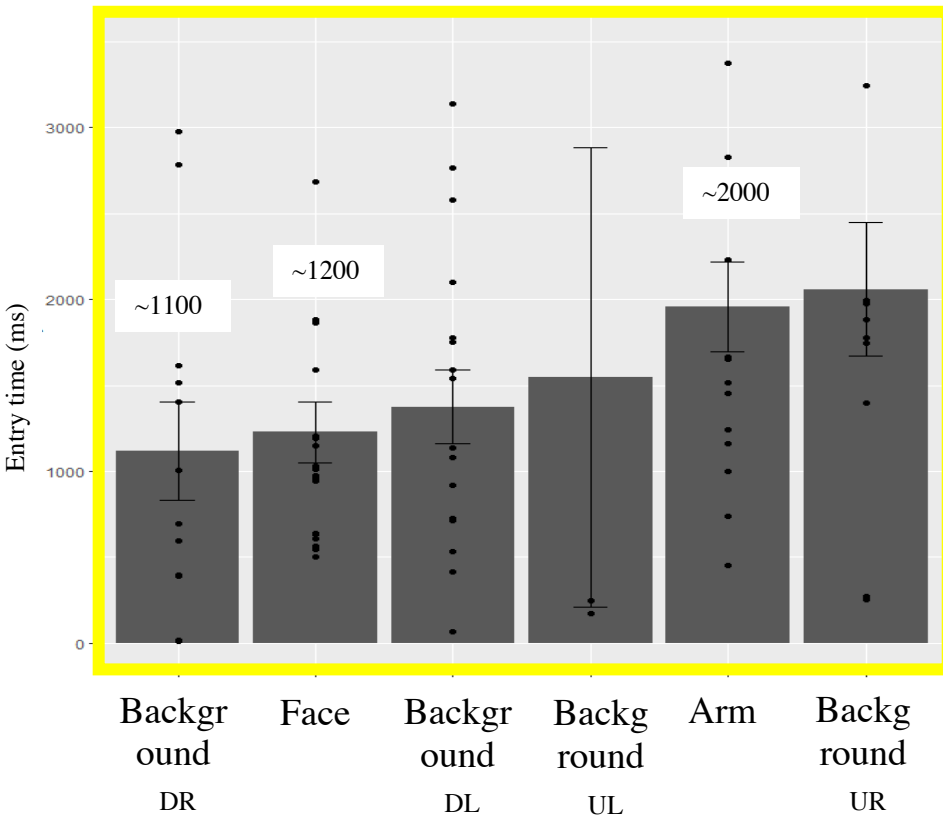


DS infants

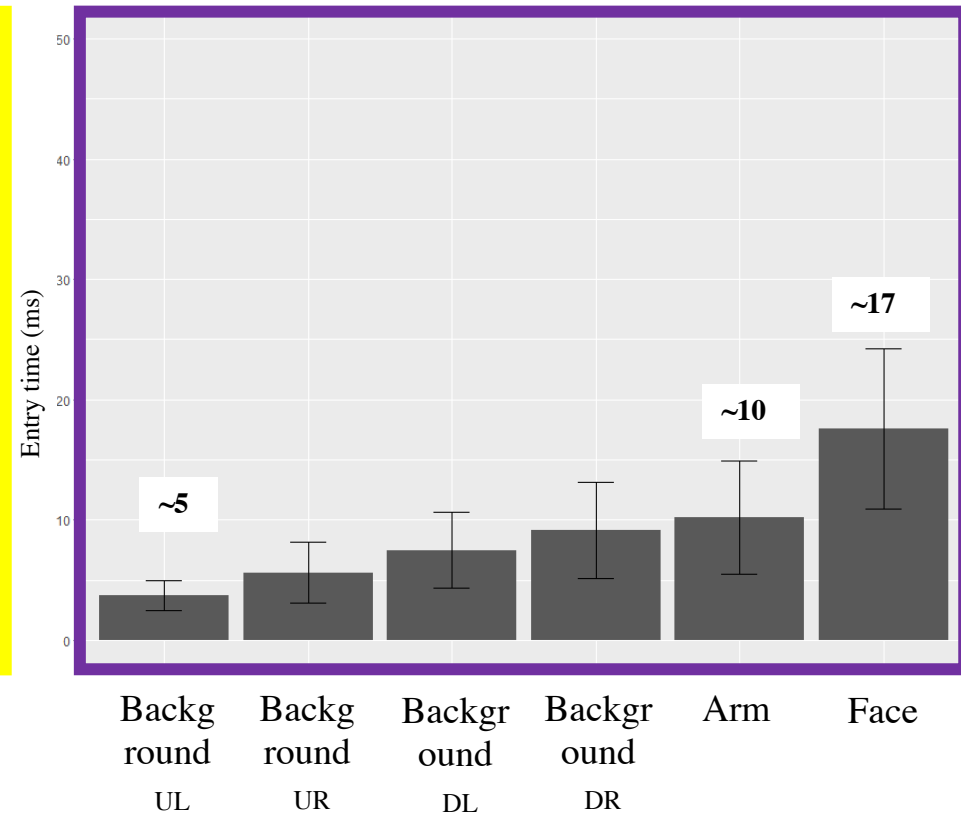
- Although not being the 1<sup>st</sup> target of their attention, TD infants look first to the face than DS infants.



# Results: Entry latency per AOI (1<sup>st</sup> visit)



TD infants



DS infants

- DS move across areas faster → less time to explore an area/ impaired sustained attention

# Discussion

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- Preliminary results of 5-7 months DS infants' processing of audiovisual communicative cues using eye tracking was implemented.
- DS infants behave **similarly** to TD infants in **selective attention**: they attend more to the face (over other AOIs), and more to the eyes (over mouth);
  - The role of gestures?
- Important **differences**:
  - In contrast to DS infants, TD infants set their gaze to the face before other areas and spent almost all of their looking time attending to the face
  - Difference in **sustained attention**: less evident in DS infants

(Atkinson & Braddick, 2012)

# Discussion

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- Delay or different strategy in DS looking patterns? How does this impact in language acquisition and development?

Exploratory analysis

Chronological age was considered (not mental age, considering also the language subscale)

**Selective attention** also needs to be explored (both for TD and DS infants) in order to observe whether there is a delay in the **shift** to the mouth, observed at 8- month olds in other languages.

**BUT**

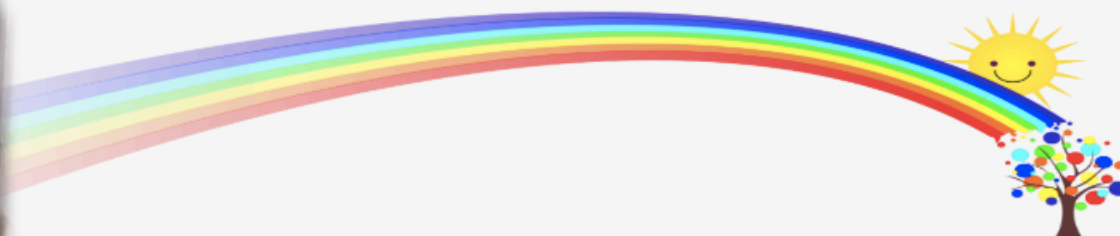
- Informative for intervention, as **different looking patterns** were found between TD and DS groups in terms of **general and/or sustained attention**, as early as 5-7mos.



# Thank you!



Horizon21: Early language development in Down Syndrome



PTDC/MHCLIN /3901/2014

Horizonte21: Desenvolvimento da linguagem em bebés com Síndrome de Down

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<http://labfon.letras.ulisboa.pt/babylab/horizon21/>



## NeuroD-WELL – Workshop on Early Language in Neurodevelopmental Disorders

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# Thank you!

# Obrigada!

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