Sensitivity to Temporal Synchrony and Selective Attention in Audiovisual Speech in Infants at Elevated Likelihood for Autism in the First Year: A Longitudinal Study

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Audiovisual Processing in Infancy

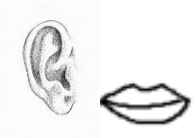
Source: Shutterstock

Socio-communicative contexts – vast amount of information from different sensory modalities (e.g., visuo-tactile)

↓

Adults provide infants with multimodal, *redundant* events, especially audiovisual (AV)

↓

AV speech (speaking faces) 

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Linking what infants see and hear: **a perceptual challenge**

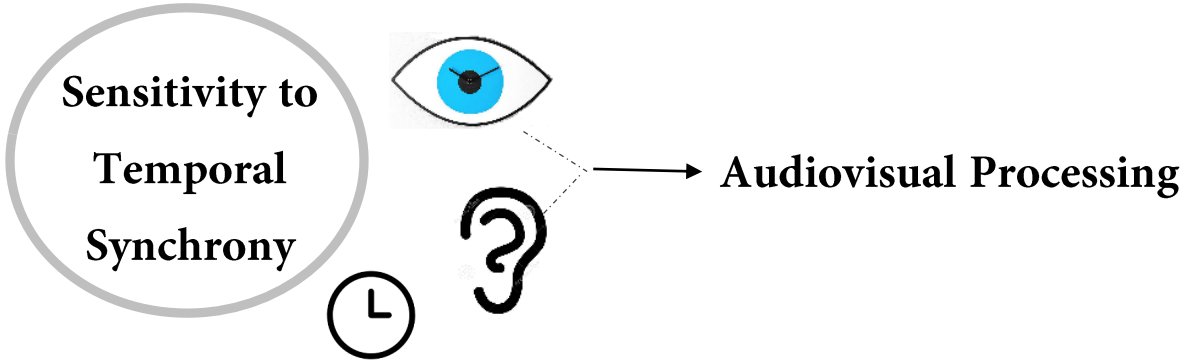
But How Do Infants Succeed in AV Processing of AV speech?

Two main mechanisms in the 1st year of life

- **Sensitivity to Temporal Synchrony**

- **Selective Attention to Facial Features**

Sensitivity to Temporal Synchrony (STS)



'What happens at the same time, goes together'

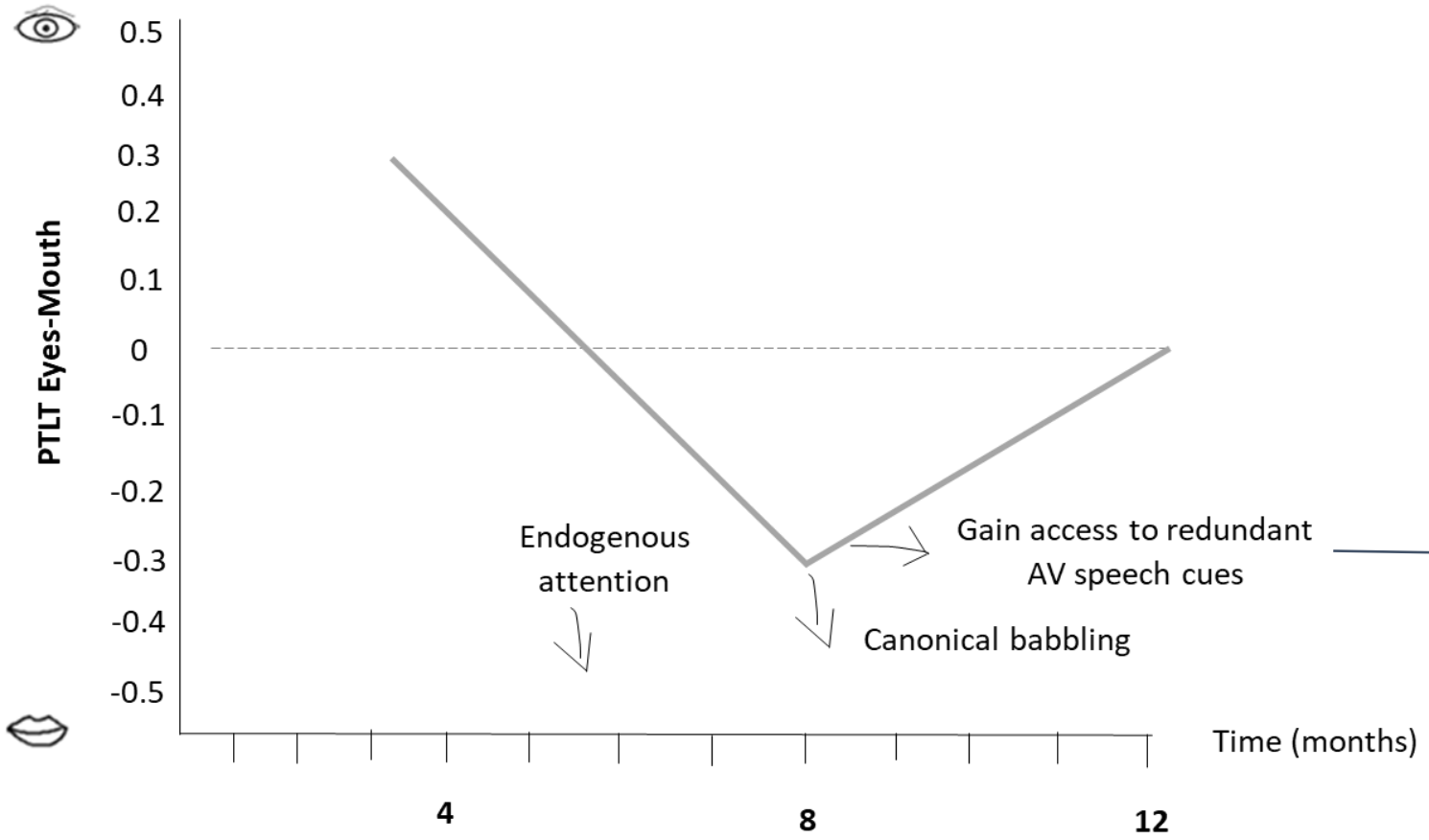
Bahrick & Lickliter (2012); Lewkowicz & Bremner (2019)

In AV speech - 8 months;

Hillairet de Boisferon et al., 2017;

Pons & Lewkowicz, 2014

Selective Attention (SA) to Facial Features – The Eyes & Mouth



Lewkowicz & Hansen-Tift (2012)

Morin-Lessard et al., (2019)

Pons et al., (2015)

Better language development in toddlerhood

Bastianello et al., (2022)

Belteki et al., (2022)

Lozano et al., (2022)

Tsang et al., (2018)

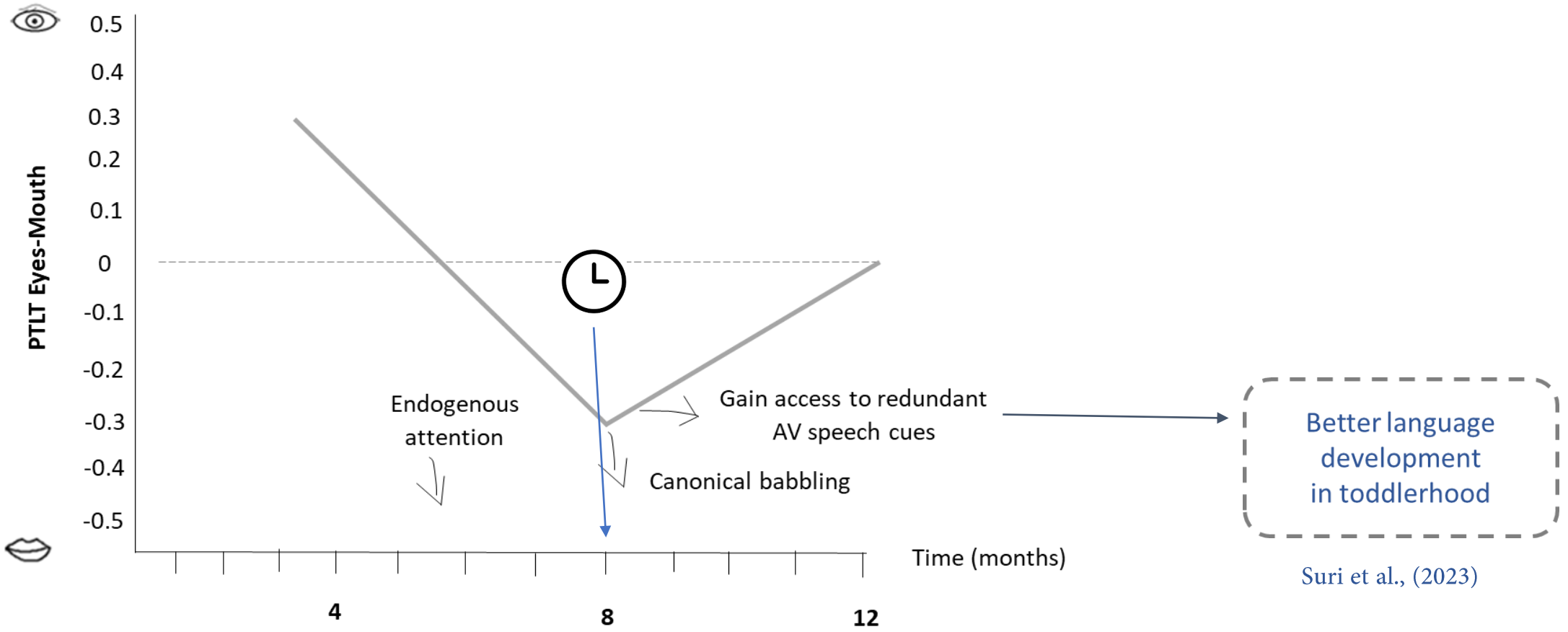
The Role of Mouth-Looking in Language Development in Infancy

Source: Shutterstock

Matching articulatory movements with auditory phonemes

(Bastianello et al., 2022; Belteki et al., 2022; Lewkowicz & Hansen-Tift, 2012; Tomalski et al., 2013)

SA and STS - Intertwined Mechanisms



Hillairet de Boisferon et al., (2017);
Pons & Lewkowicz (2014)

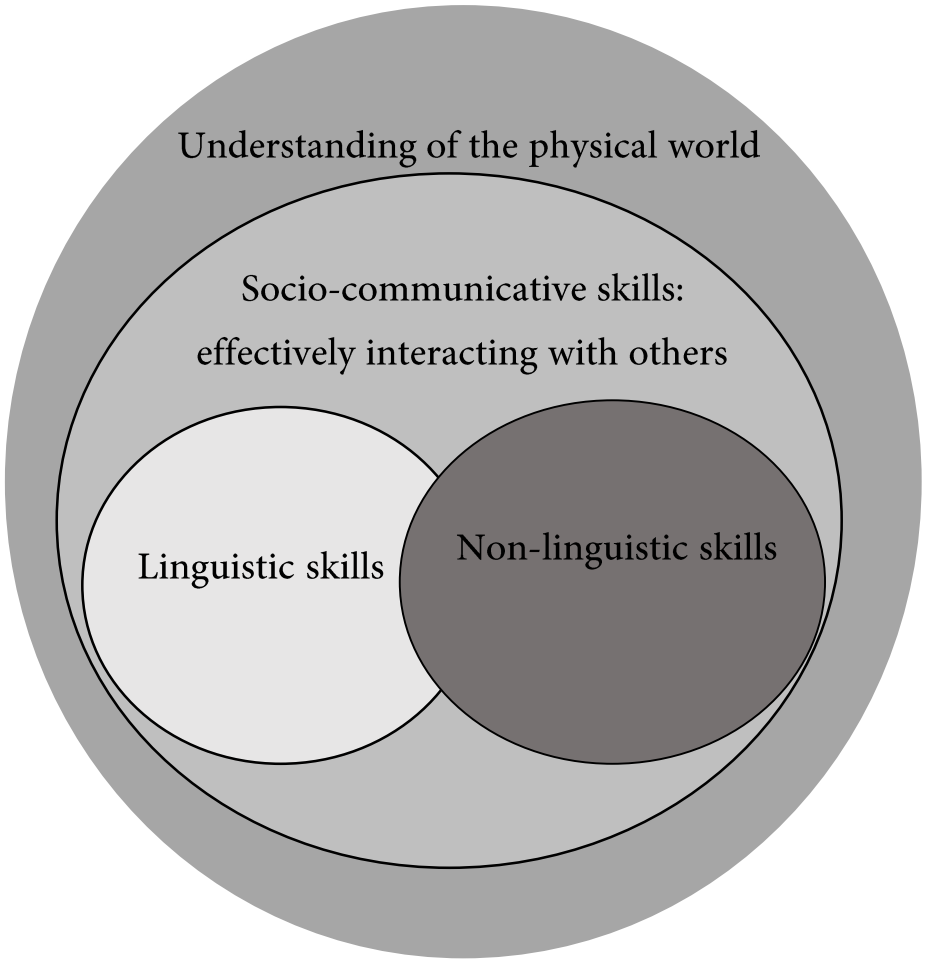
Suri et al., (2023)

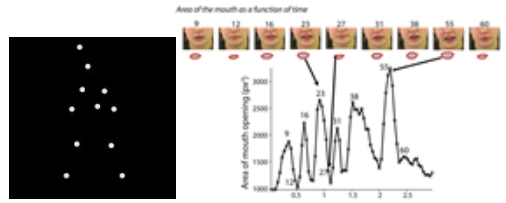
The Role of STS & SA in Development

'Social contexts are characterized by being highly unpredictable, dynamic and complex'

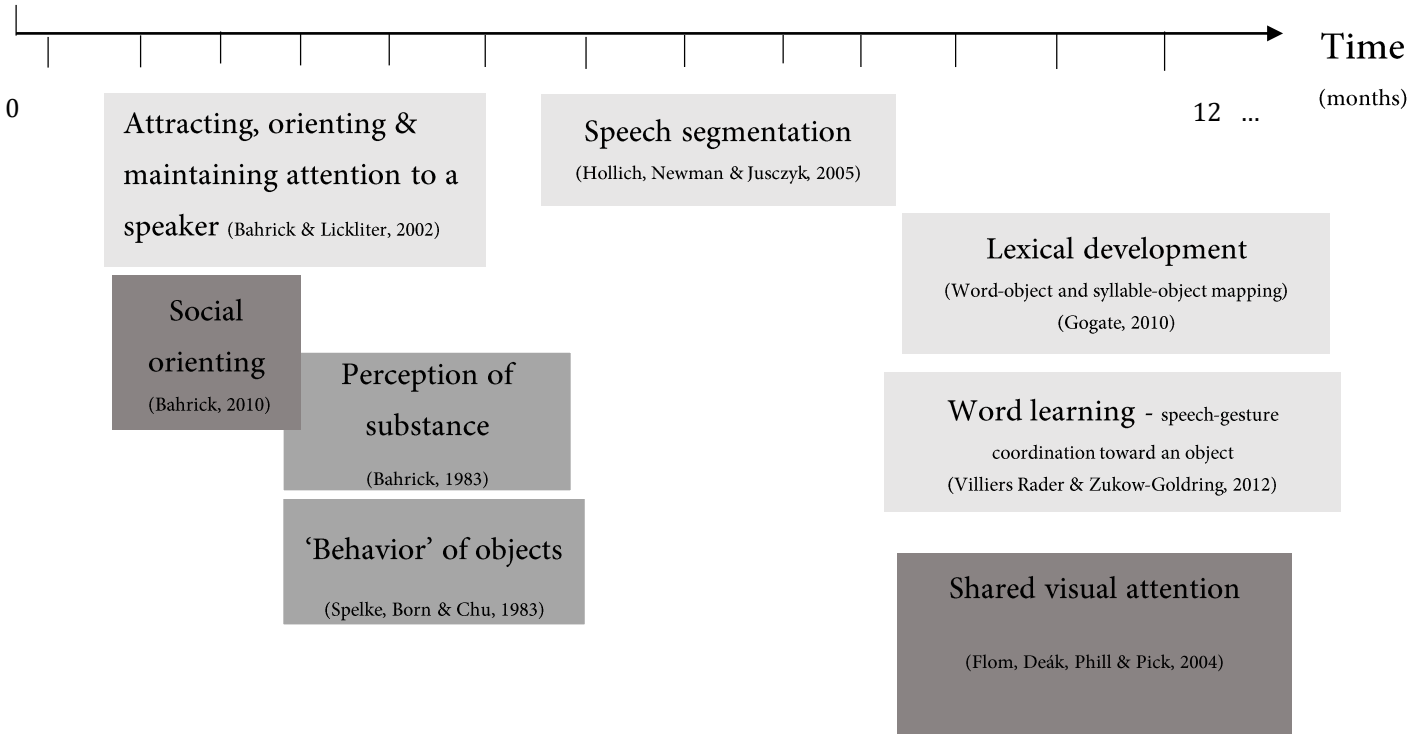
(Elsabbagh & Johnson, 2016)

Domain-general but…





Chandrasekaran et al., 2009



When AV Redundancy May Not Help: Differences in STS in Autism

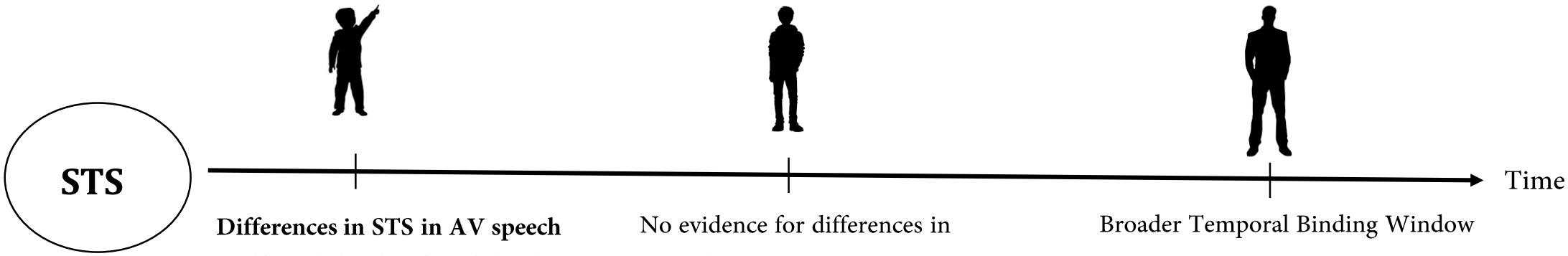
Core differences in **social functioning** define and distinguish autism from other neurodevelopmental conditions (Tager-Flusberg, 2010)

Autism

DSM-5 (American Psychological Association, 2013)

Neurodevelopmental condition involving differences in two dimensions:

- Social interaction & communication
- Repetitive & restrictive behaviors (& sensory differences)



Differences in STS in AV speech

Bebko et al., (2006); Righi et al., (2018)

No evidence for differences in multisensory integration

de Boer-Schellekens, Eussen & Vroomen, (2013)

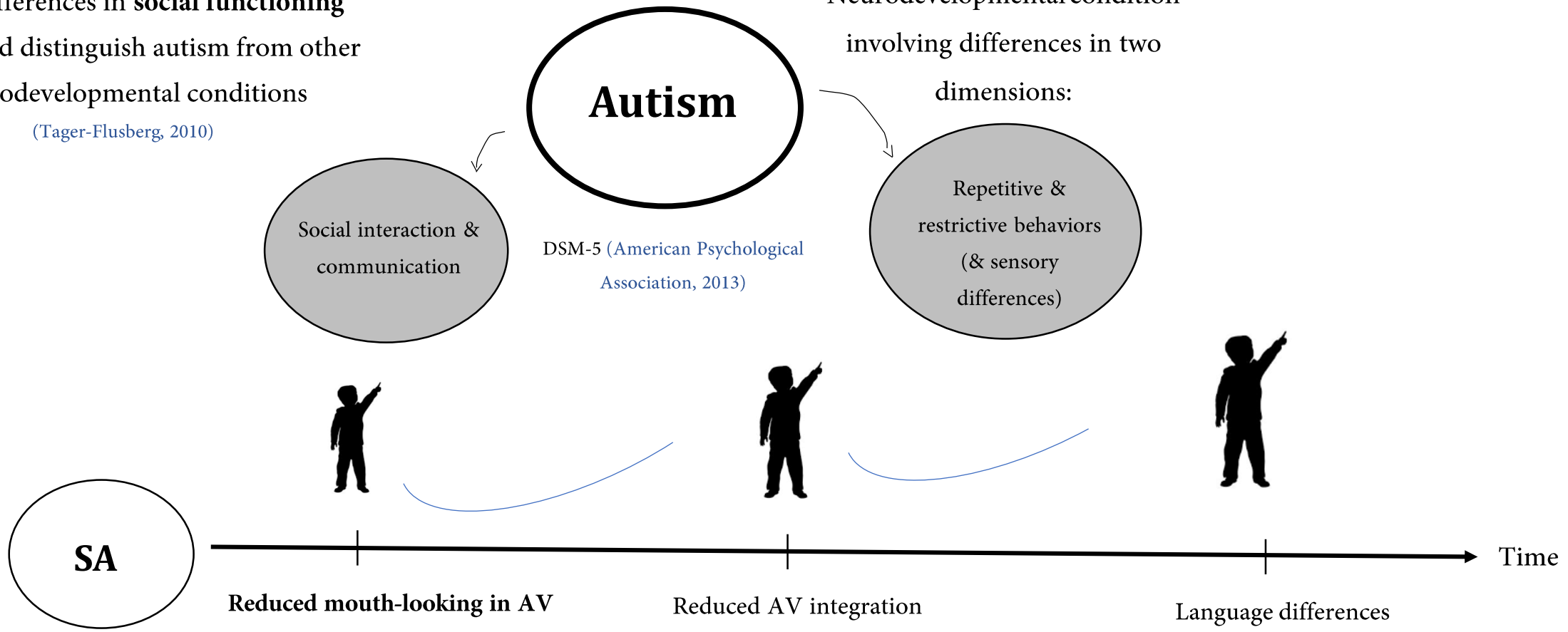
Broader Temporal Binding Window

Foss-Feig et al., (2010)

Wallace & Stevenson (2014)

When SA May Not Help: Differences in SA in Autism

Core differences in **social functioning** define and distinguish autism from other neurodevelopmental conditions (Tager-Flusberg, 2010)



Neurodevelopmental condition involving differences in two dimensions:

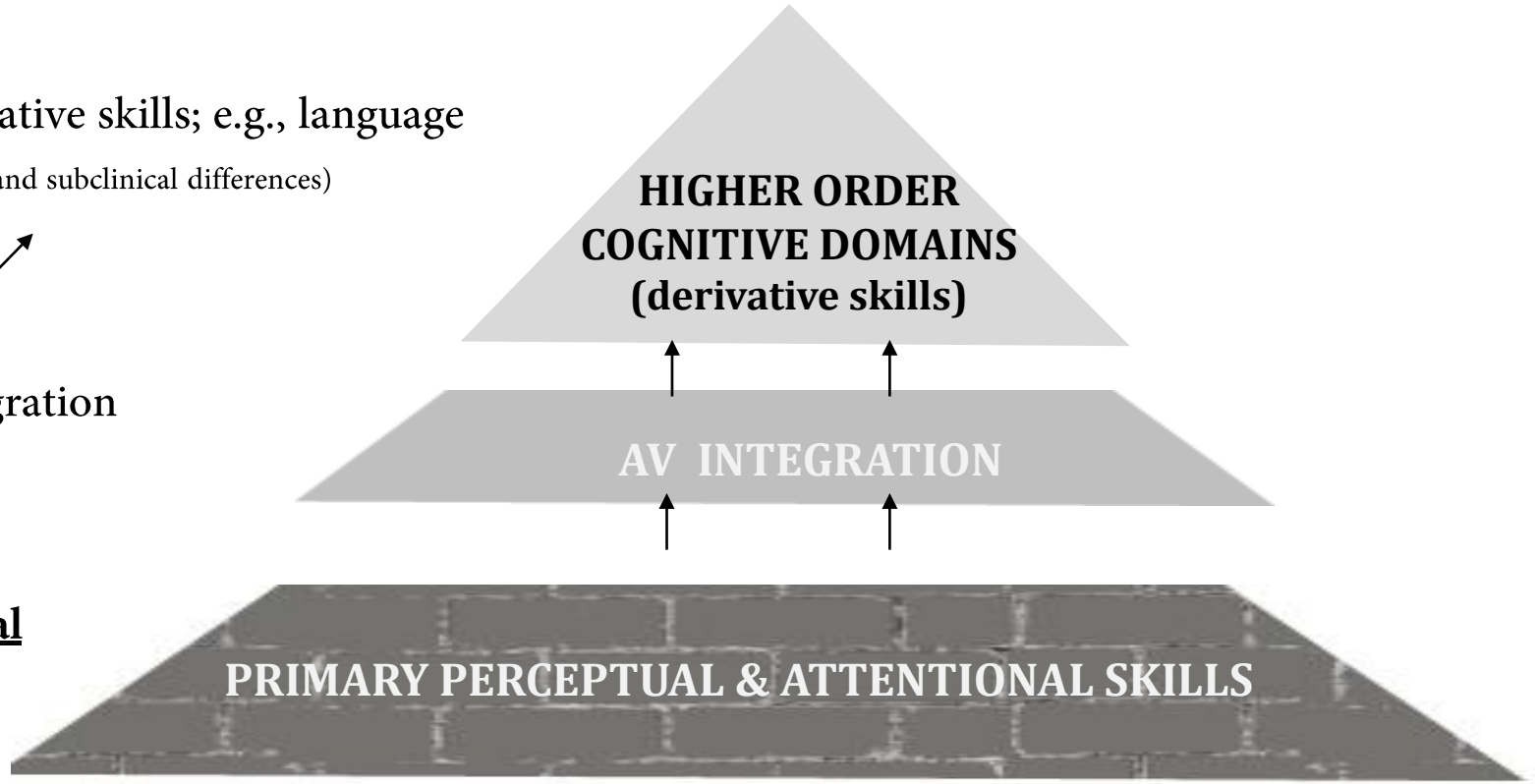
The *Intersensory Impairment Hypothesis* (*IIH*) for Autism: Differences in STS as 'Primary'

Differences in socio-communicative skills; e.g., language

(Autistic symptoms and subclinical differences)

Differences in AV integration

Differences in Sensitivity to **Temporal Synchrony & Selective Attention**



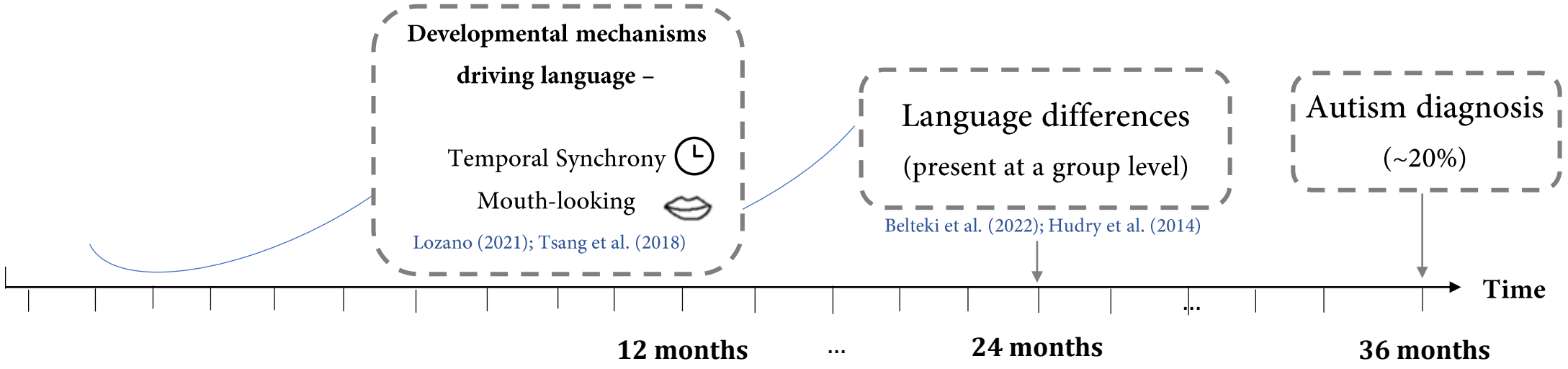
Robertson & Cohen (2017)

Baum, Stevenson & Wallace (2015)

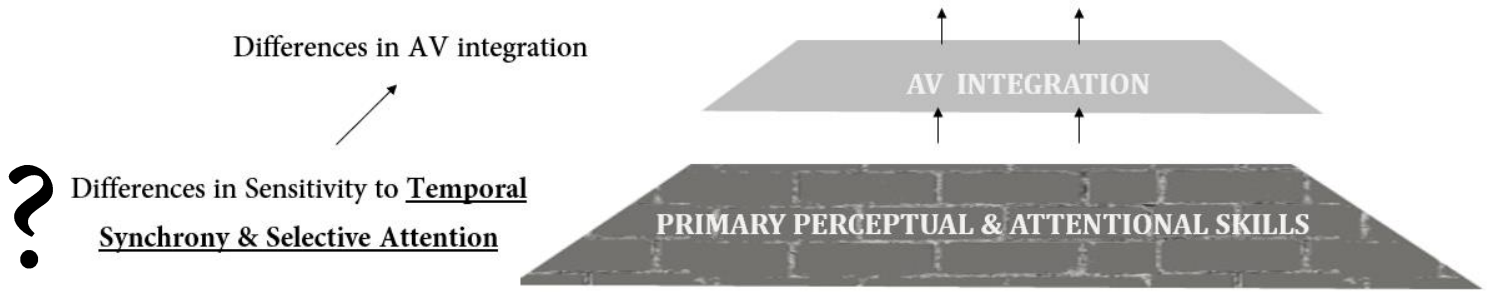
Bahrick (2010); Bahrick & Todd (2012)

Infants at Elevated Likelihood for Autism (EL-infants): a Unique Opportunity

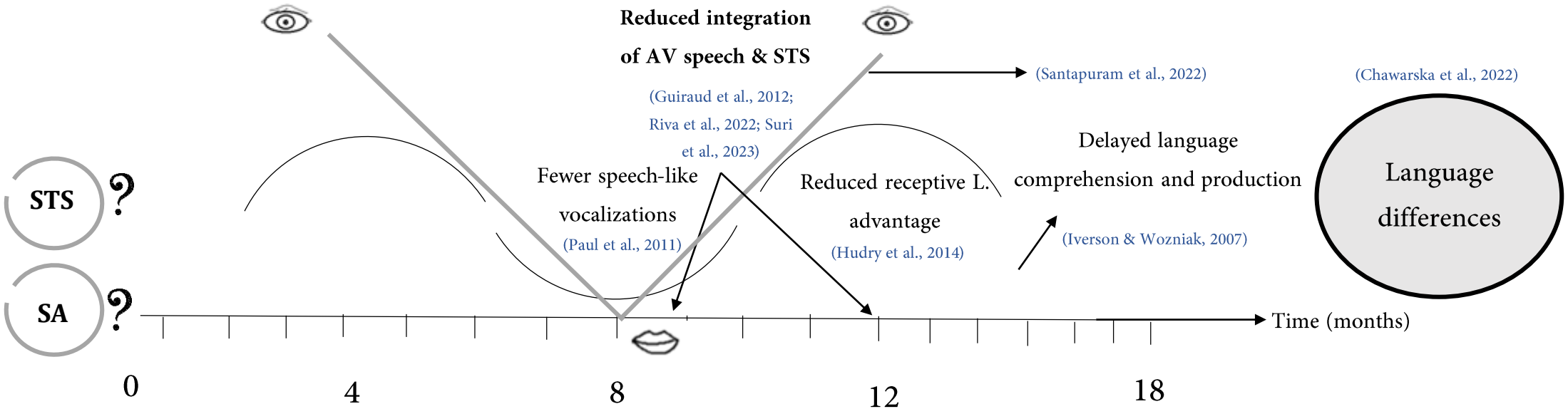
- Autism is highly heritable (Bai et al., 2019; Tick et al., 2016)
- **Language differences** extend to 1st degree relatives (Hudry et al., 2014)
- Infants with an older sibling diagnosed with autism (Ozonoff et al. 2024)
- Increased familial likelihood for autism (~20%) & **language differences**
- **Opportunity** to target potential **differences** in **early developmental mechanisms** before language differences emerge



EL-infants: An Opportunity to Test the *IIH*



Bahrick (2010); Bahrick & Todd (2012)



Aims

1. To investigate whether EL-infants differ from their peers at low likelihood for autism (LL-infants) in their **sensitivity to detect temporal synchrony** in audiovisual speaking faces during the first year of life.

2. To examine whether EL-infants differ from LL-infants in their pattern of **selective attention to facial features (the eyes and mouth)** of a talking face in the first year of life.

Lozano, I., Belinchón, M., & Campos, R. (2024b). *Infant Behav. Dev.*, 76, 101973
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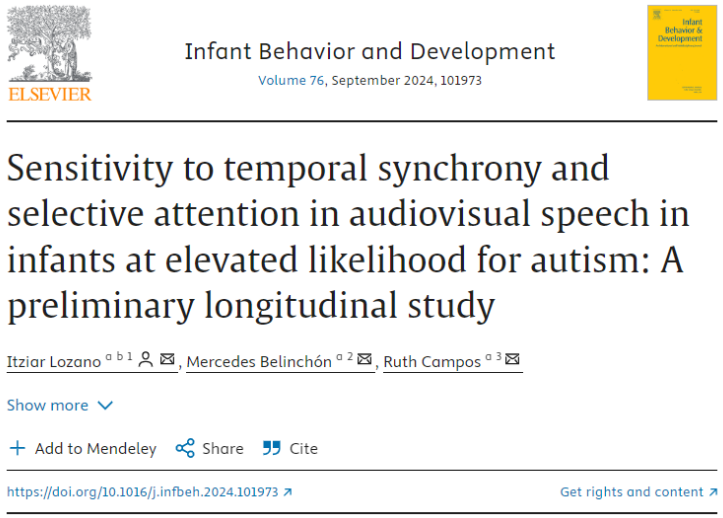


Research Questions

RQ 1. Do EL-infants differ from LL-infants in their **sensitivity to detect temporal synchrony** in audiovisual (AV) speaking faces in the first year of life?

RQ 2. Do EL-infants differ from LL-infants in their pattern of changes in **selective attention to facial features (the eyes and mouth)** in audiovisual speaking faces in the first year of life?

a. Within-group changes over time

b. Between-group differences across time

Hypotheses

H1. LL-infants will discriminate temporal synchrony in **AV *fluent* speech** during the first year (at 8 & 12 months; Pons & Lewkowicz, 2014), while **EL-infants** will show a **reduced sensitivity** to this cue across this entire period (Campos et al., 2019; Elsabbagh & Johnson, 2016); thus, we expect group differences at 8 & 12 months, but not at 4 months.

H2.

a. LL-infants will **increase** their attention to the mouth and show a *u-shaped* pattern of attention to the eyes vs. mouth over the first year of life. In contrast, **EL-infants will keep their mouth-preference** (and eyes vs. mouth preference) **constant** over this same period, indicated by **no differences** in their preferences for facial features between time-points.

b. Relative to LL-infants, EL-infants will show reduced mouth-looking only at 12 months (Elsabbagh & Johnson, 2016)

Design & Participants

N=29;

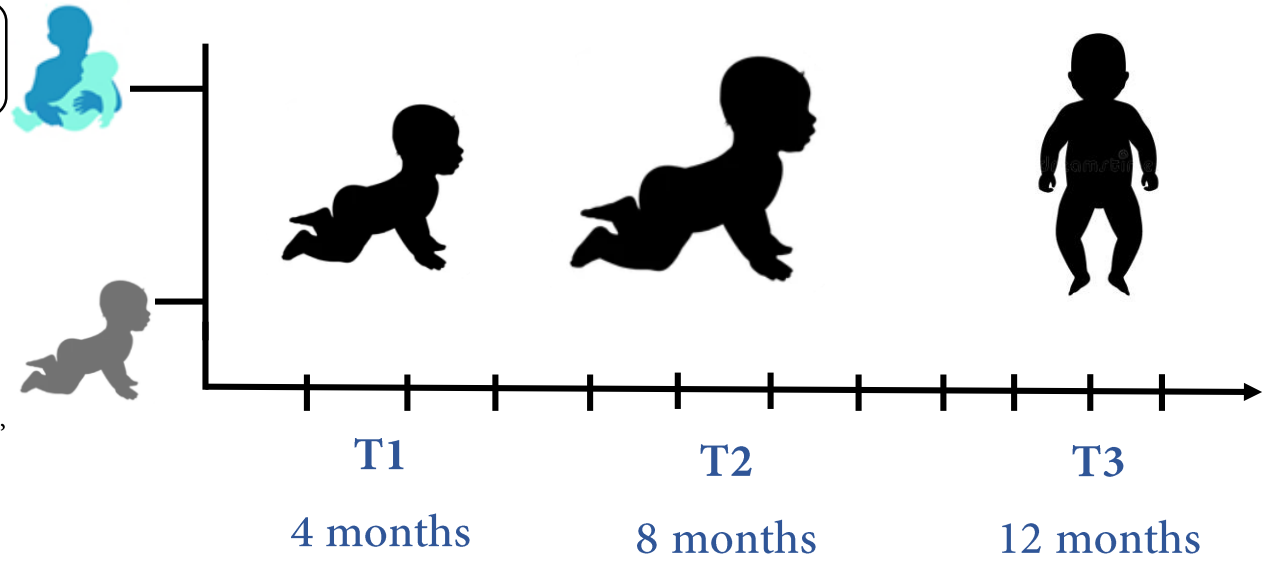
41.37 % females

Infants at elevated likelihood for autism (EL-infants); N=14

Our website; Associations of autistic individuals (AMITEA, ALANDA, CAE)

Infants at low likelihood for autism (LL-infants); N=15

Incidental sampling (word of mouth, ads, our website)



Longitudinal design

1st year

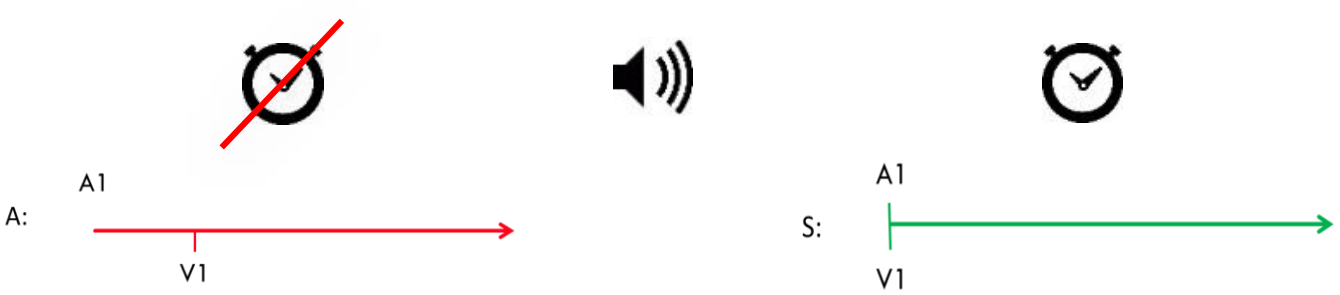
Part of a larger prospective longitudinal project (TRABERITEA)

Perceptual Narrowing of AV Speech & domain-general differences in EL-infants (Campos et al., 2019; Bahrick & Todd, 2012; Elsabbagh & Johnson, 2016; Lewkowicz & Hansen-Tift, 2012)

Table 1
Descriptive statistics (mean, standard deviation, and range) of final sample participant characteristics and group comparisons on age, sex and general development.

	Elevated likelihood for ASD (*N*=14; 8 males)			Low likelihood for ASD (*N*=15; 9 males)			Group comparisons[a]
	4 m (n = 11)	8 m (n = 13)	12 m (n = 10)	4 m (n = 14)	8 m[b] (n = 13)	12 m (n = 13)	[c] *t*-test/[d] Mann-Whitney (p value)
	M (*SD*) Range	*M* (*SD*) Range	*M* (*SD*) Range	*M* (*SD*) Range	*M* (*SD*) Range	*M* (*SD*) Range	
Age (days)	133.63 (13.05) 107-159	250.15 (11.83) 223-270	368.10 (9.13) 348-378	134.64 (11.67) 109-155	249.57 (7.41) 235-260	375.30 (9.05) 356-388	[c] p = .84; p = .87; p = .07
MSEL_VR	42.18 (4.87) 34-47	51.00 (7.63) 37-64	53.30 (9.46) 41-74	49.14 (6.38) 34-58	52.23 (10.00) 37-80	58.76 (6.66) 47-74	[d] p = .005**; p = .97; p = .06
MSEL_FM	46.09 (6.13) 35-54	53.00 (12.78) 32-68	65.00 (8.48) 55-77	44.85 (4.58) 35-54	55.76 (7.36) 38-68	62.30 (7.53) 49-74	[d] p = .56; p = .83; p = .50
MSEL_GM	47.27 (8.87) 37-65	43.69 (12.09) 23-65	46.70 (14.06) 31-73	47.78 (8.84) 30-61	44.92 (7.75) 30-56	37.38 (9.56) 20-53	[c] p = .88; p = .76; p = .07
MSEL_RL	46.90 (10.80) 28-66	40.53 (9.28) 23-61	48.00 (8.81) 35-64	46.57 (12.47) 20-66	49.00 (5.14) 38-56	46.92 (6.88) 35-60	[d] p = 1.0; p = .004**; p = .87
MSEL_EL	48.18 (5.05) 42-55	46.38 (6.04) 33-55	49.30 (10.79) 37-66	51.50 (6.58) 34-55	46.76 (7.35) 33-60	50.61 (7.50) 40-62	[d] p = .07; p = .81; p = .63
MSEL_ELC	91.81 (8.19) 77-104	95.53 (11.58) 70-111	107.70 (12.96) 89-127	96.07 (8.44) 82-108	102.38 (7.01) 93-117	109.38 (8.71) 97-122	[d] p = .21; p = .08; p = .71

Stimuli & Procedure



- AV fluent speech (IDS and GDS; Kitamura et al., 2014)
- Female Spanish speaker
- Preferential looking paradigm
- 10 trials (10 secs/each). Total length: ~2 min.
- Level of asynchrony: range (500 & 666 msec.), unlike 666 msec
- Order of misalignment: A-V

Data collection & pre-processing

- Tobii TX300
- **AOIs (dynamic):** Synch., Asynch., Face, Mouth, and Eyes
- **Metric:** Total Visit Duration (without zeros)
- 3 DVs:

  Percentage of Total Looking Time (%)

  PTLT to the Mouth; Hillairet de Boisferon et al., (2017)

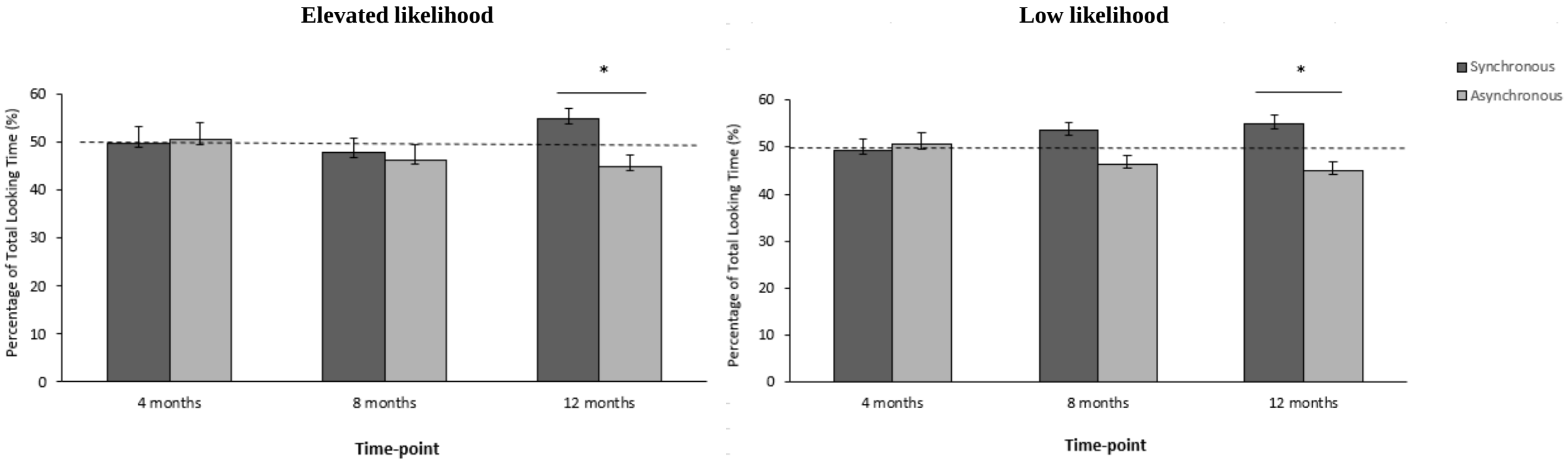
  PTLT Eyes-Mouth; Morin-Lessard et al., (2019)

Asynchronous Synchronous

- Inclusion criteria:
  - **Trials:** >15% of looking time to the speakers' face from trial length (Kleberg et al., 2019); no fussiness/crying; & no bias side
  - **Infants:** - 2 out of 10 valid trials (as in Falck-Ytter et al., 2018); >25% valid gaze sample
    - Born at term (>36 weeks); monolingual (<20% of exposure to L2); no hearing or visual difficulties or NDCs

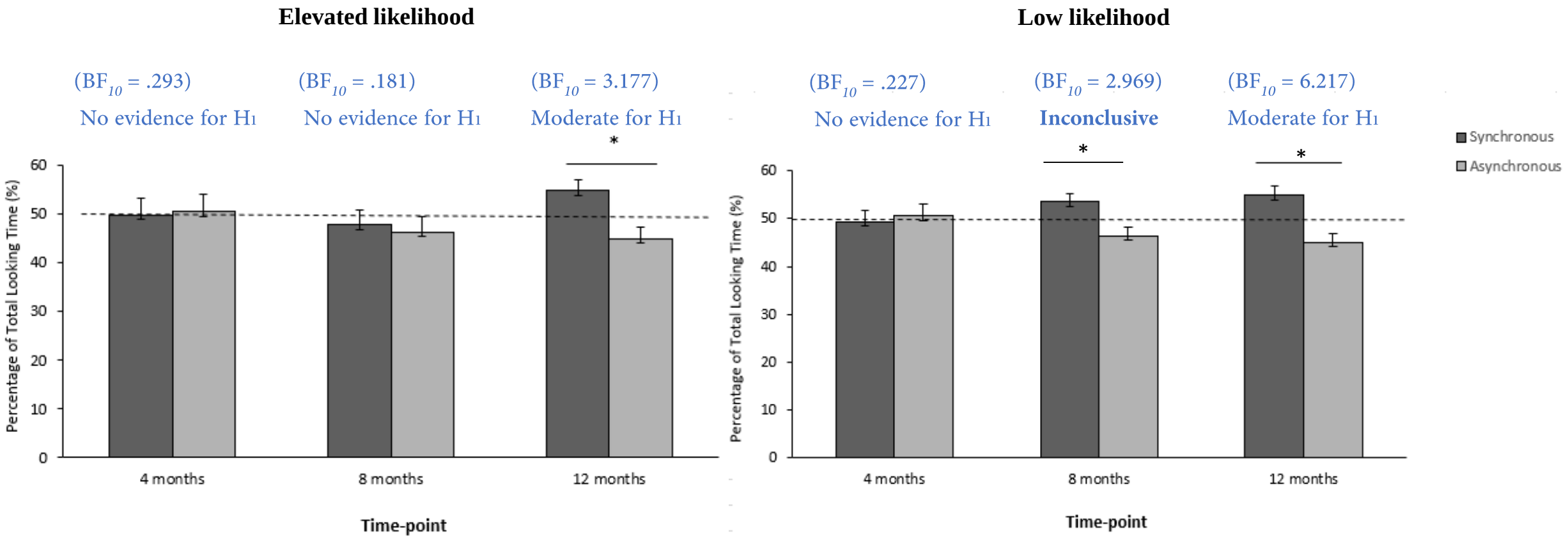
Results – Sensitivity to Temporal Synchrony

LMMs; Redundancy × Timepoint, $F(2, 138) = 4.5$, $p = .01^{*}$, $r = 0.19$



Results – Sensitivity to Temporal Synchrony – Follow up

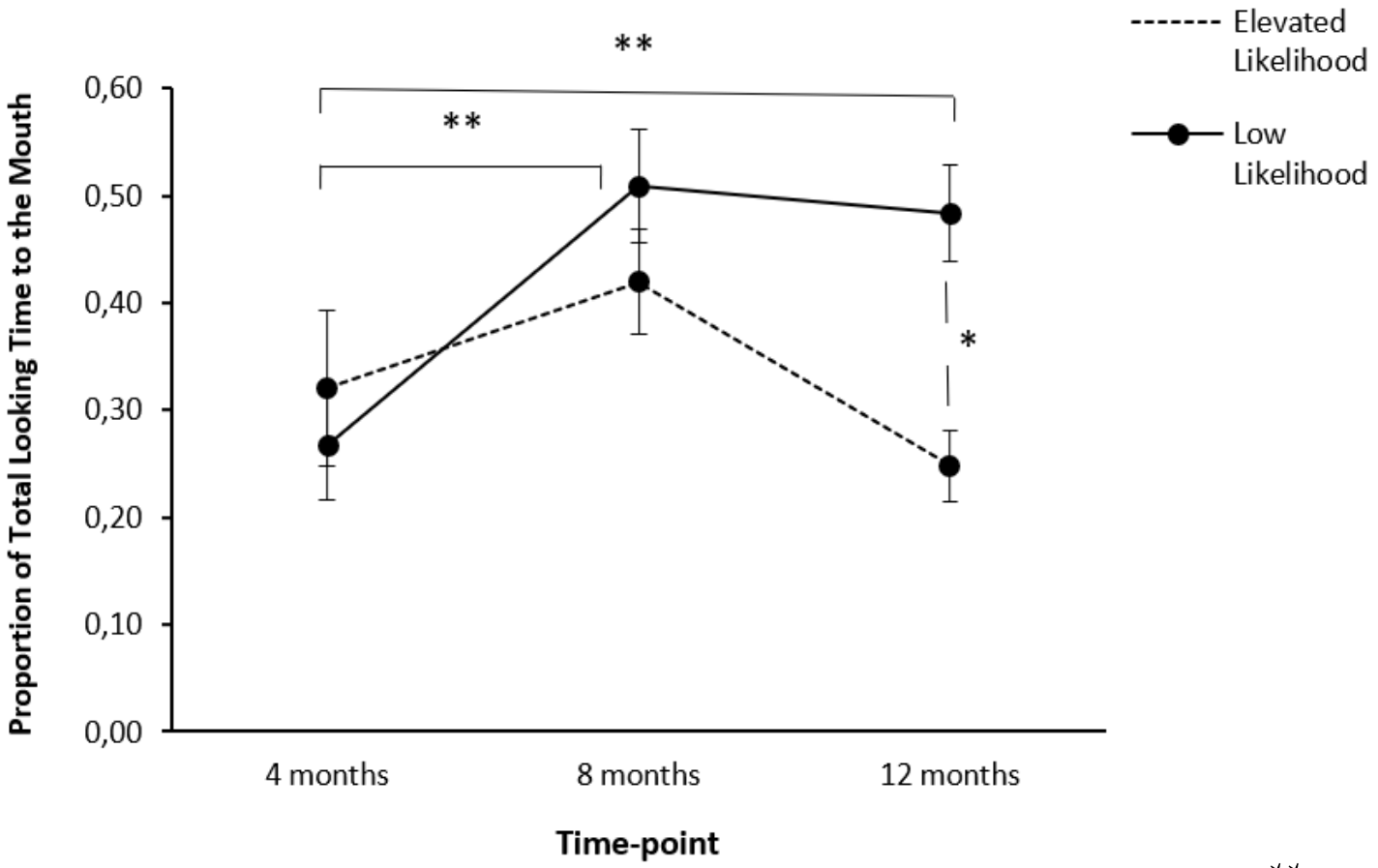
Follow-up; one sample *t*-tests & Bayesian t-tests; PTLT Synchronous vs. chance (50%)



Results – Selective Attention to Facial Features

LMMs; Group × Timepoint, $F(2, 97.09) = 4.00$, $p = .02$, $r = 0.25$

PTLT Mouth

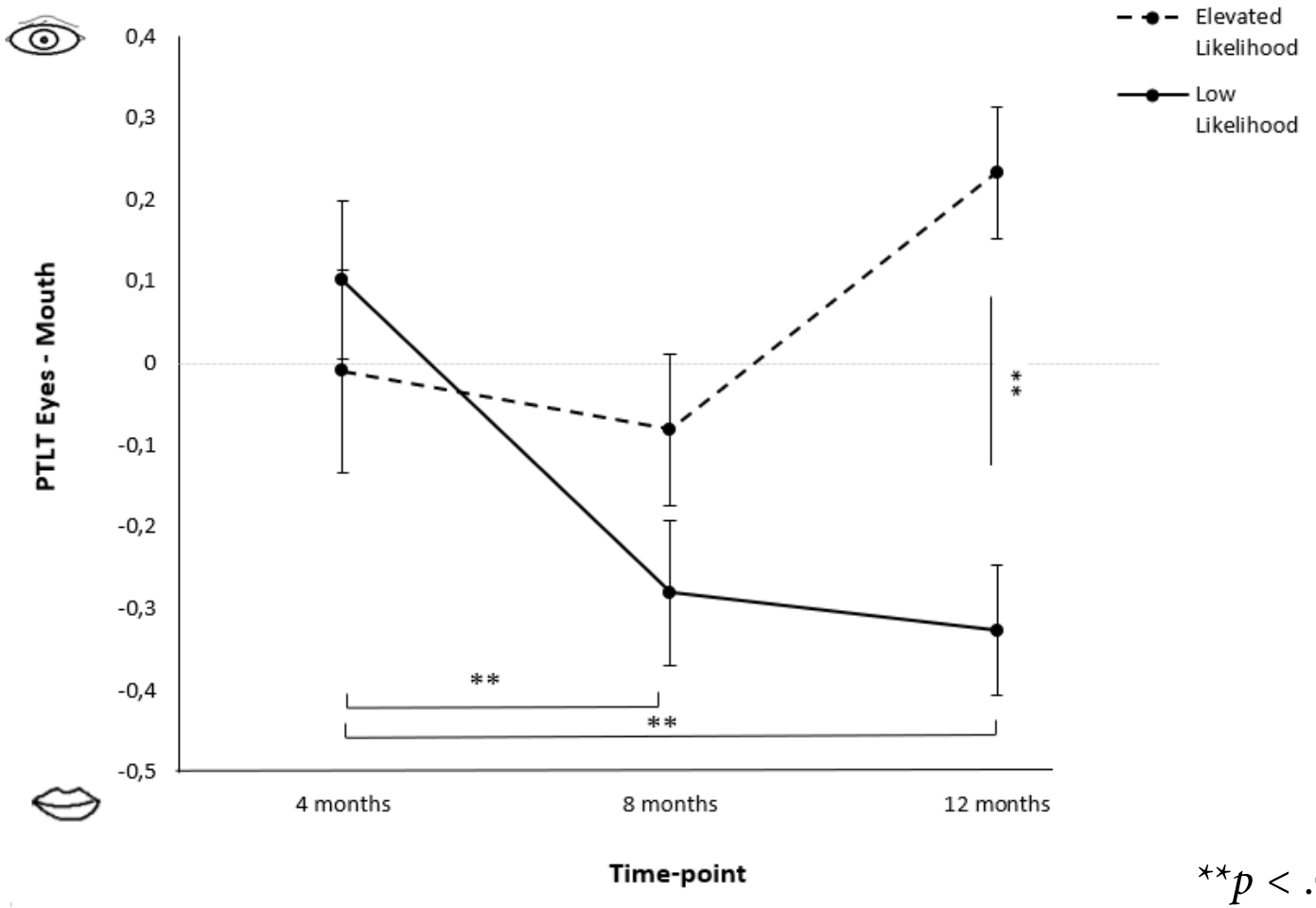


$^{**}p < .01$

Results – Selective Attention to Facial Features

LMMs; Group × Timepoint, $F(2, 101.27) = 5.83$, $p = < .01$, $r = 0.29$

PTLT Eyes-Mouth



$^{**}p < .01$

Discussion: No Evidence for Reduced STS in AV speech in EL-infants

- Regardless of group of likelihood, infants detected **temporal asynchronies** in talking faces at 12 months
- Unlike predicted, **no evidence for reduced temporal asynchrony detection** in AV *fluent* speech in EL-infants over the first year, nor for **group differences** (unlike Guiraud et al., 2012; Suri et al., 2022; AV syllables; Cross-sectional)
- Thus, **no evidence in support of the prediction by the *IIH*** (Bahrick, 2010; Bahrick & Todd, 2012) positing a difference in this perceptual ability in infant siblings
- However, we cannot rule out this possibility due to our small **sample size**, which may have reduced our chances of detecting group differences that could still occur; thus, our results are **preliminary**
- Ours is the 1st longitudinal study in LL-infants: inconclusive at 8 months (transition?) but STS at 12 months (later than Pons & Lewkowicz, 2014; 8 months); trajectory likely linked to perceptual narrowing of *AV fluent* speech

Discussion: Preliminary Evidence for Reduced SA to the Mouth in EL-infants

- Like predicted, relative to LL-infants, EL-infants showed **reduced selective attention to the mouth** of a talking face at the **end** of the 1st year; and **no evidence for trajectory of changes** in their interest to the mouth over time

- Thus, preliminary evidence on a **potentially different trajectory** of **reduced mouth-looking** in AV speech in EL-infants **during** the 1st year**;** unlike LL-infants, EL-infants may not find visual speech cues **as beneficial** for language (Shic et al., 2014) - An **adaptation** of redundancy being overly complex? Reduced AV speech experience?

- 'Widespread' domain-general difference, potentially supporting the *IIH* (Bahrick, 2010; Bahrick & Todd, 2012) and domain-general accounts of emerging autism (Campos et al., 2019; Elsabbagh & Johnson, 2016); but need for replication in larger samples; further, which are the underlying *developmental processes*? *Perceptual narrowing*?

- Early **differences** in the mechanism of **selective attention to facial features** in infant siblings may potentially cascade into **later differences in language skills** (e.g., lack of functional link as a candidate: Chawarska et al., 2022)

Limitations

- Small sample size (small to medium effects sizes; achieved power ~35%). Need for better-powered studies
- We used asynchronies of 500 and 666 ms instead of the planned 666 ms (yet control analyses showed no impact in the main results)
- Future research should measure selective attention to the eyes and mouth **separately** from detecting temporal asynchrony (in a *free-viewing* paradigm) to provide more reliable measures

‘Early sex differences in attention to the articulating mouth as a female protective candidate mechanism in autism’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MEDEA BABYLAB

IRCCS EUGENIO MEDEA

DIVE Development and Neurodiversity Lab

Uppsala Universitet

Karolinska Institutet

National Science Centre Poland

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Thank you!

My supervisors

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Dr. M. Belinchón

TRABERITEA Team

Infants & their families!

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- NCN - Sonatina 7- Project no. 2023/48/C/HS6/00264

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