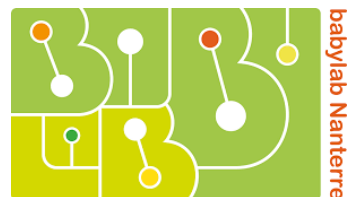




Unraveling the Impact of Surprise in Humor-Enhanced Learning in infants



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Under the supervision of
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June 7, 2024



Introduction

Intro



Hoicka 2014; Suls, 1972; Hurley et al. 2011; Schopenhauer, 1969

- ◆ Humor is based on **incongruity**
(violation of expectancy)

Esseily et al. 2015; Martin 2007; Hurley et al. 2011

- ◆ **Surprise** $\xrightarrow{+}$ **learning in infant!**

Kidd et al., 2012, 2014; Mather & Plunkett, 2012;
Stahl & Feigenson, 2015; Twomey & Westermann, 2018

Humor \longrightarrow **Surprise** $\xrightarrow{+}$ **Learning?**



Understand the role of surprise on the influence of humor on learning in infant.

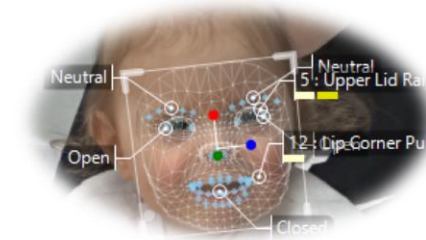
Implied two steps, thus two studies:

Study 1

Aim: identify the markers of surprise



Behavior



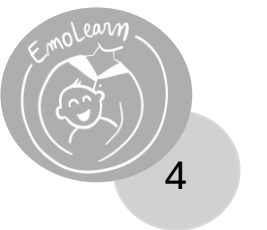
Physiology



Study 2

Aim: assess the role of surprise on learning

What are the indicators of the emotion of surprise in our social context?



- ◆ Identify markers of surprise by using a multidimensional approach.

Four principal markers of surprise:

→ Fixation Time **LIMITED**

In infant: Baillargeon, 1993; Baillargeon et al., 1985; Baillargeon & Graber, 1987; Horstmann, 2015; Ramsay & Campos, 1975; Spelke et al., 1992

→ Pupil dilation **LIMITED**

In adult: Antony et al., 2021; Nassar et al., 2012; Preuschoff et al., 2011

→ Freezing behavior **ATTENTION**

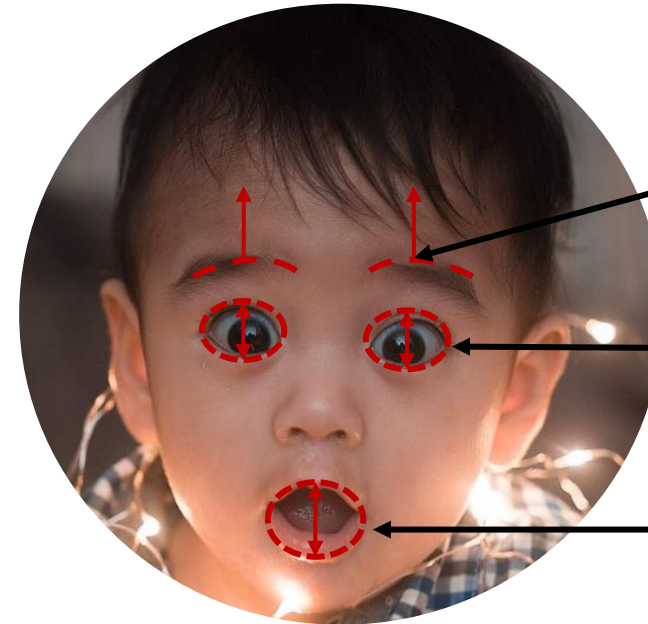
In infant: Camras et al. 2002; Scherer et al. 2004

→ Facial Expression → Perspective Dynamical Theory **ATTENTION**

In adult: Reisenzein, 2000; Reisenzein et al., 2006

In infant: Camras et al. 2002; Scherer et al. 2004

Camras et al. 1996



AU 1 & 2

AU 5

AU 26 & 27

Facial expression of Surprise

Do as I do Task

Intro

Study 1

Method

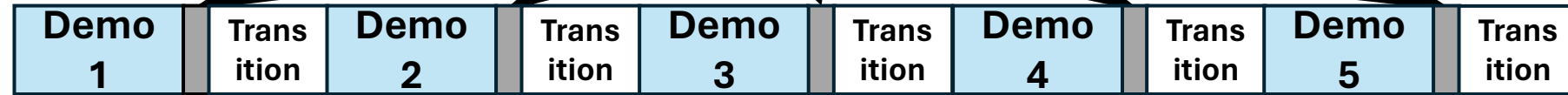
100 infants from 14- to 22-month-old included

Neutral demonstration

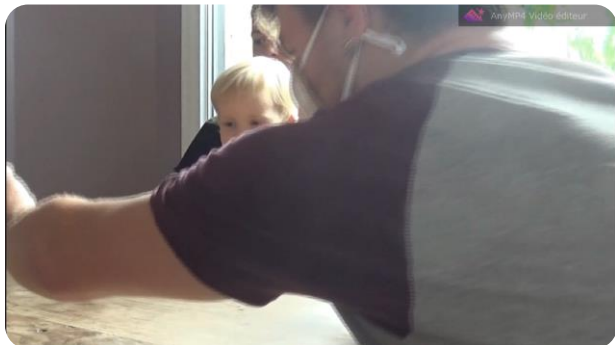


Neutral

Five neutral stimuli



Humorous demonstration

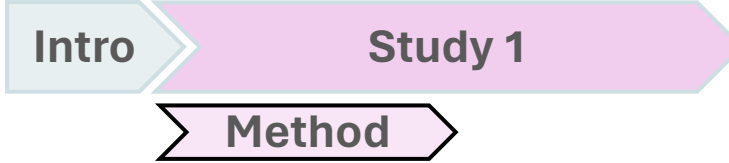


incongruous

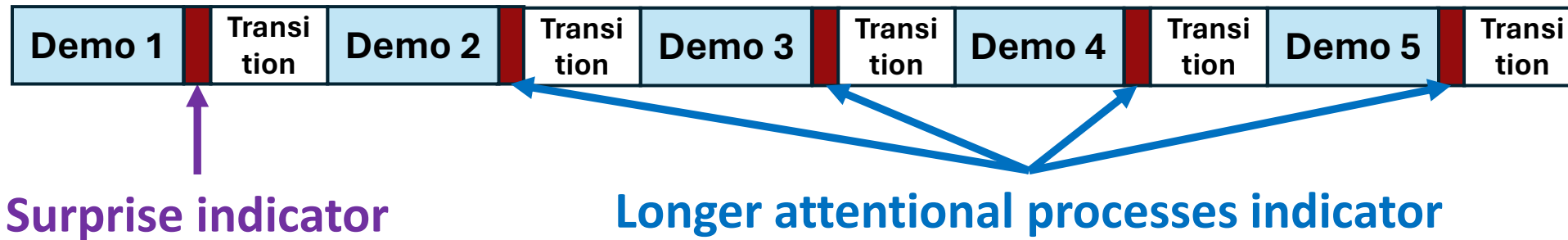
Five incongruous stimuli



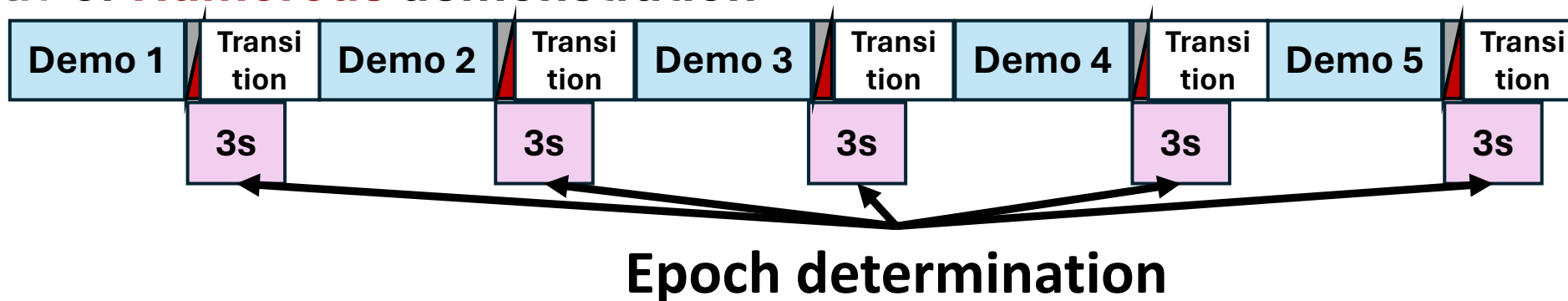
Demonstrations



Humorous demonstration



Neutral or Humorous demonstration



Behavioral Analyses

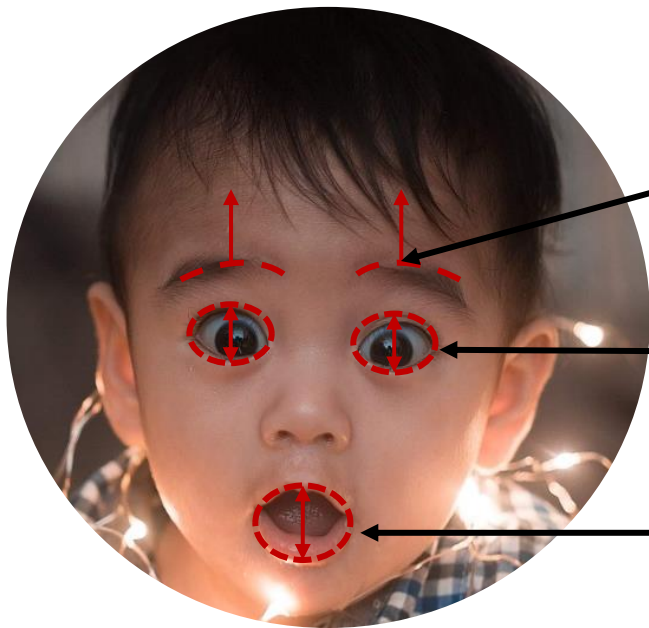
Intro

Study 1

Method

Hand coded

- Social gazes
- Positive emotional reaction (e.g., smile, laugh)



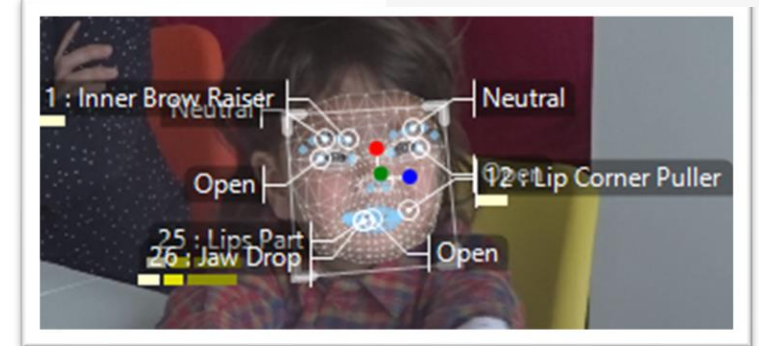
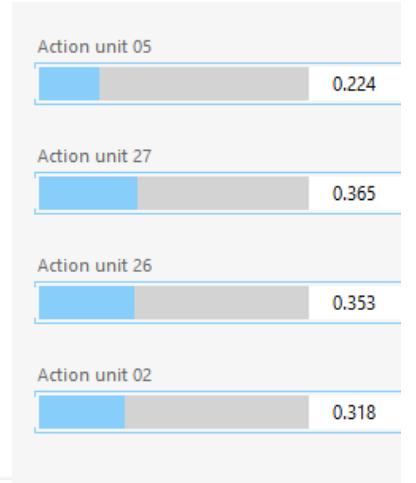
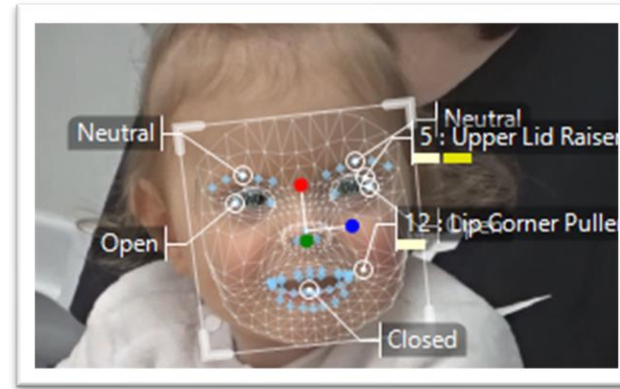
AU 1 & 2

AU 5

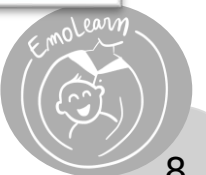
AU 26 & 27



Automatized



Izard Surprise Score Algorithm

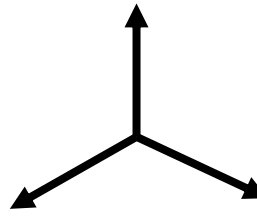



Physiological data

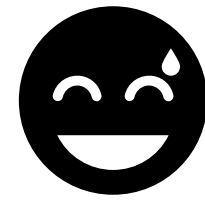
Intro

Study 1

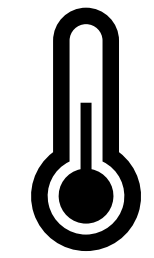
Method


Accelerometry


Heart Rate


**Electrodermal
Conductance**




Skin temperature



Gaze at experimenter

Intro

Study 1

Method

Results

After each demonstration

Frequency  > in **Humor**

Duration  > in **Humor**

Analyze inter-demonstration

Duration 

D1 > D3 in Humor

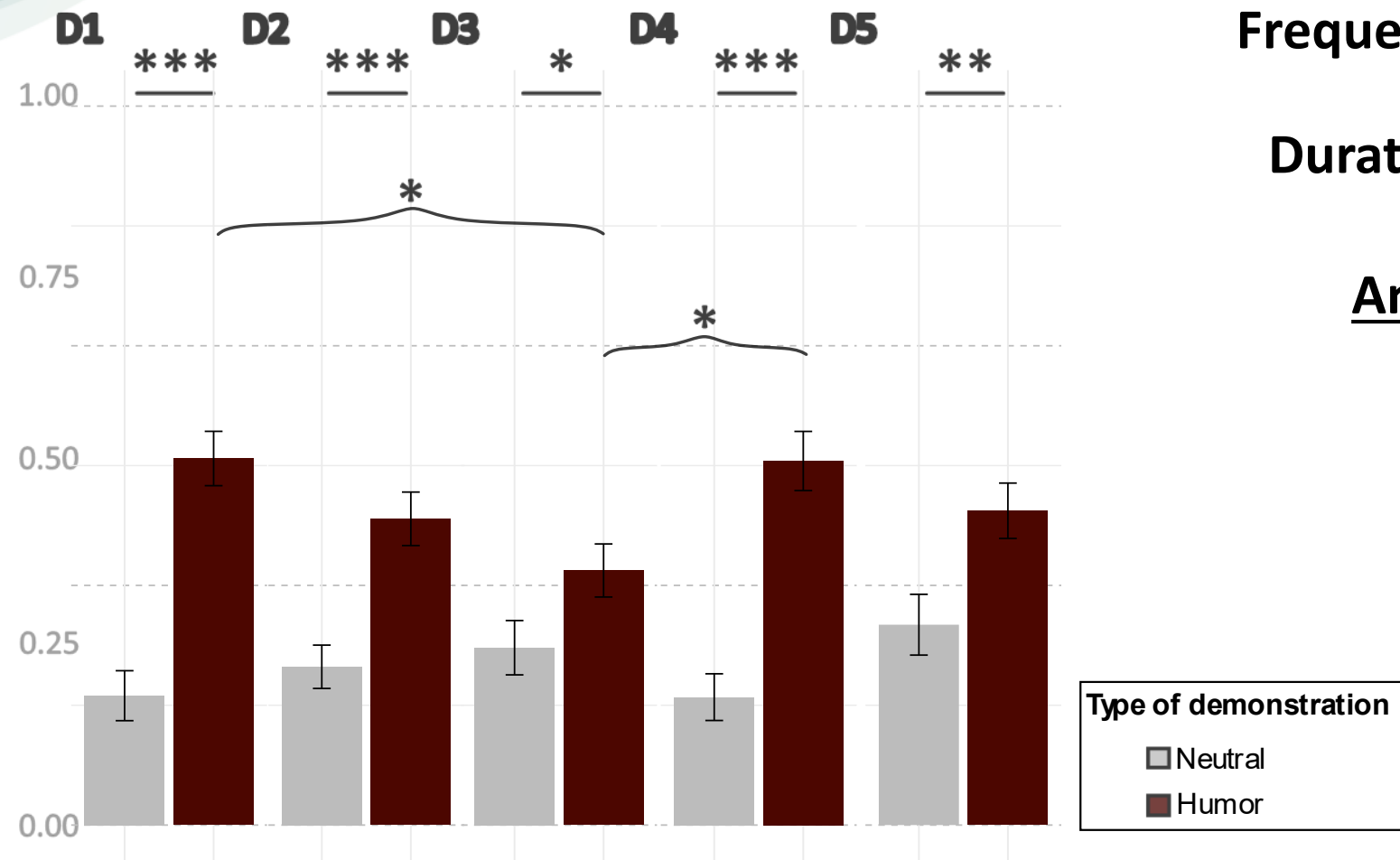
SURPRISE

D4 > D3 in Humor

INTERACTION



Duration of Gaze Toward experimenter

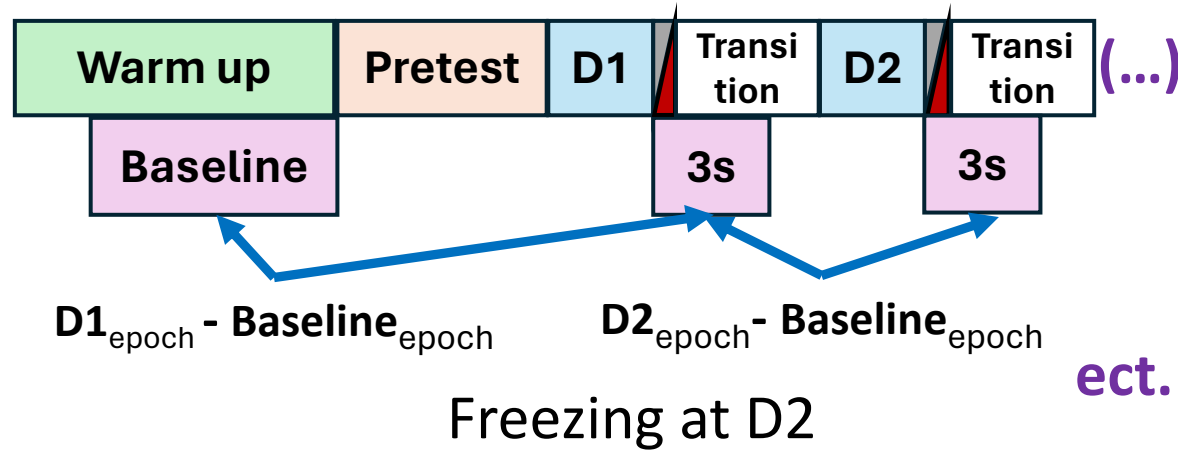
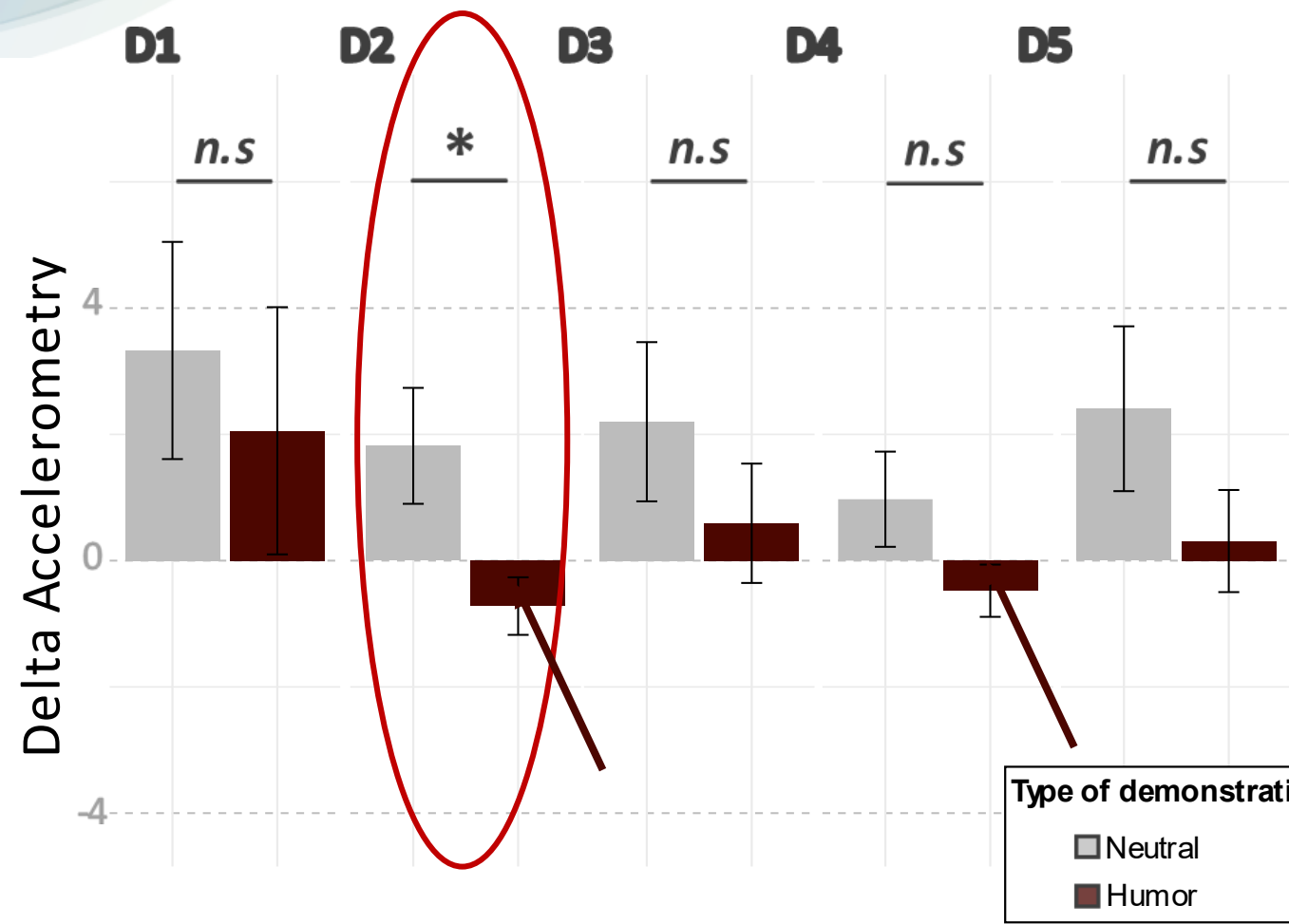
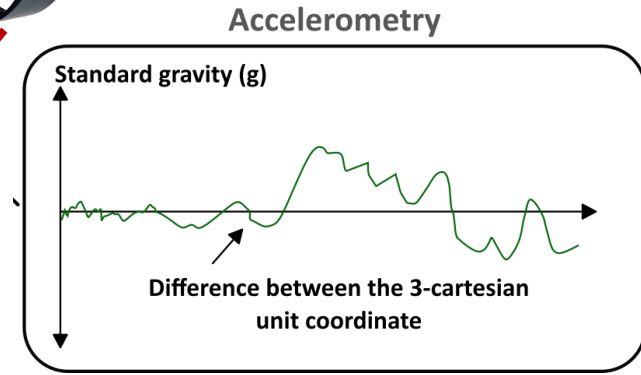


*Results based on Permutation Test with a Monte Carlo sampling of 1000 permutations - PermTest function of the package 'pgirmess' Giraudoux, 2024

Δ Accelerometry



Motions recording

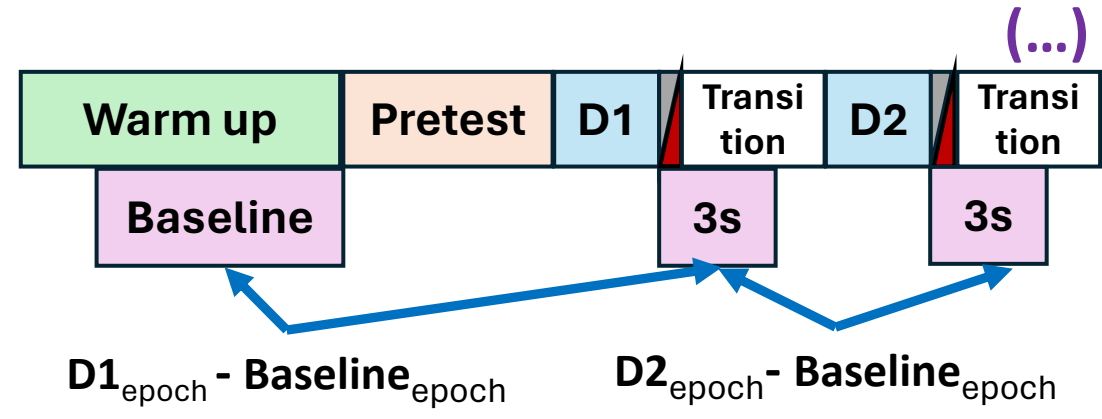
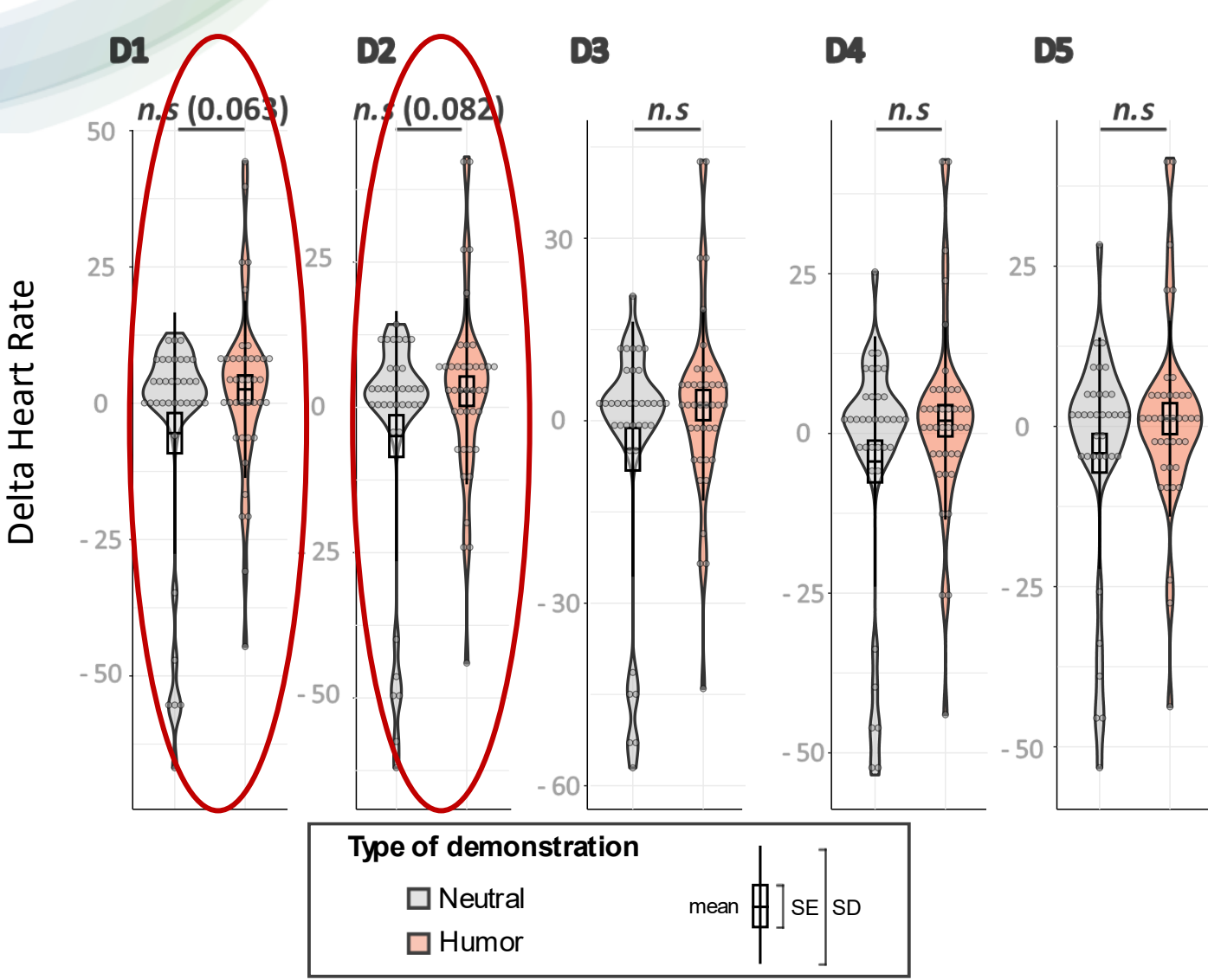
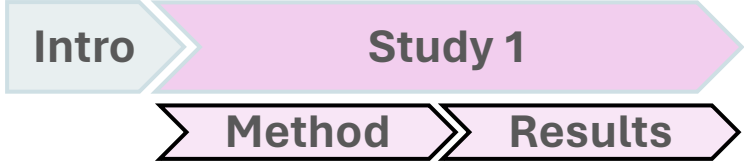


ANTICIPATION



*Results based on Permutation Test with a Monte Carlo sampling of 1000 permutations - PermTest function of the package 'pgirmess' Giraudoux, 2024

Δ mean Heart rate



Mean of Heart Rate (HR)

Not significant but a trend

♥ > D1 & D2 Humor

→ Heart Rate Variation (HRV) analyses?



*Results based on Permutation Test with a Monte Carlo sampling of 1000 permutations - PermTest function of the package 'pgirmess' Giraudoux, 2024

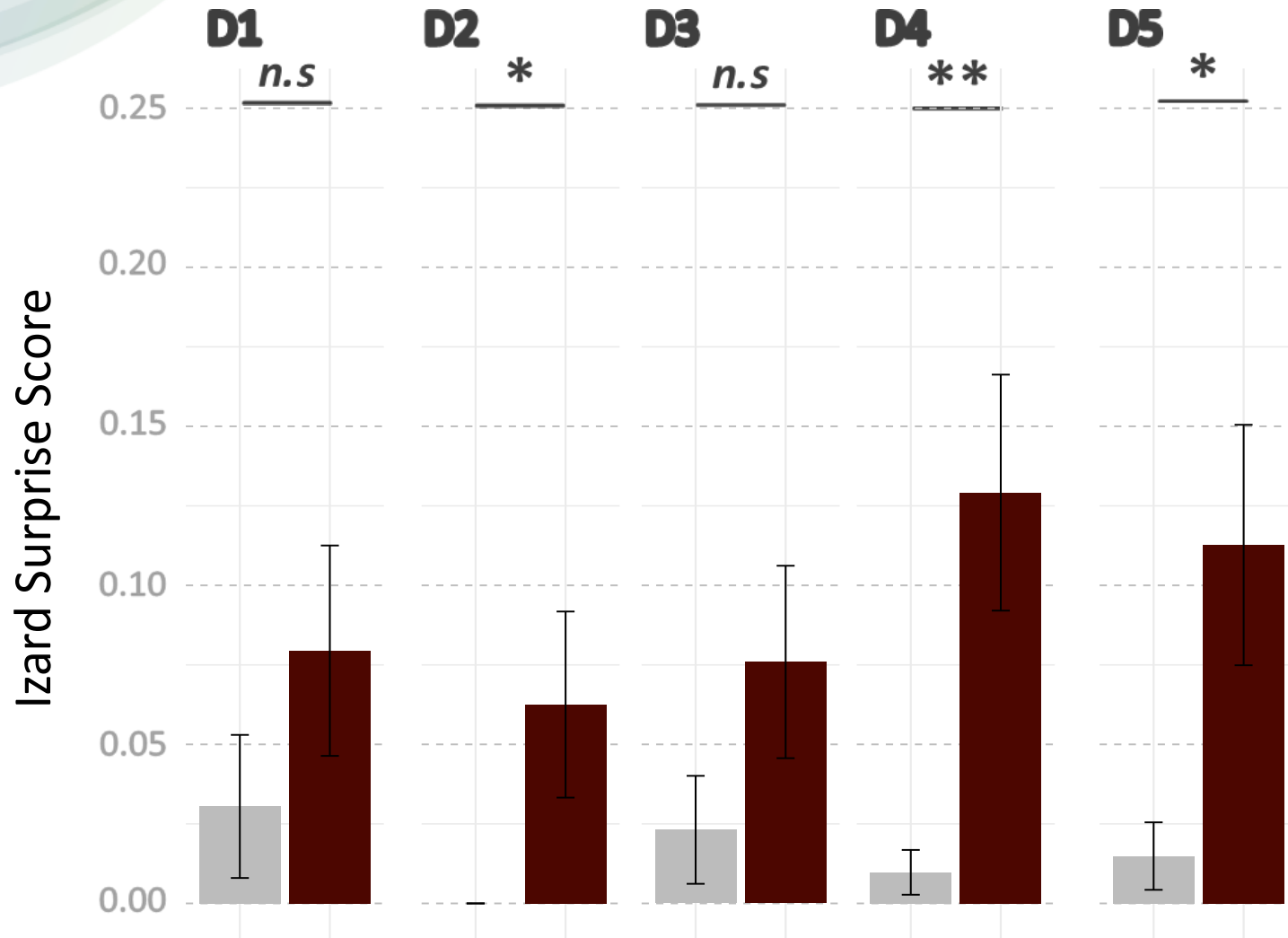
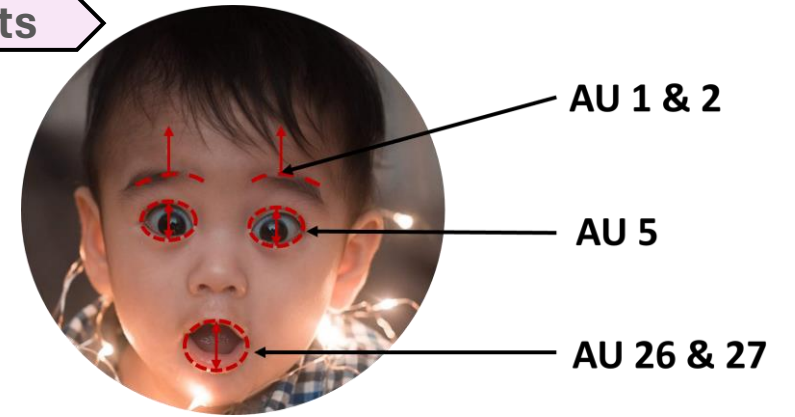
Facial Expression

Intro

Study 1

Method

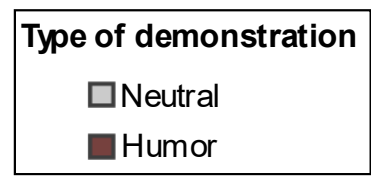
Results



No clear pattern

But consistent across demonstration

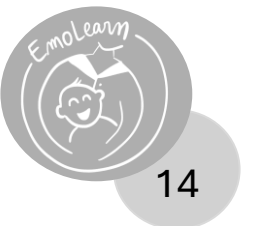
ATTENTION?



*Results based on Permutation Test with a Monte Carlo sampling of 1000 permutations - PermTest function of the package 'pgirmess' Giraudoux, 2024

What are the indicators of the emotion of surprise in our social context?

- ◆ Duration of social gazes → good surprise indicator (not frequency)
- ◆ Surprise facial expressions → attentional processes indicator (not surprise)
- ◆ Motor interruption/freezing behavior → Anticipation indicator (not surprise)
- ◆ Heart Rate (HR) could be interesting as Surprise Indicator
 - ↳ Other physiological signals need time → 3s epoch is too short (not interesting for surprise)

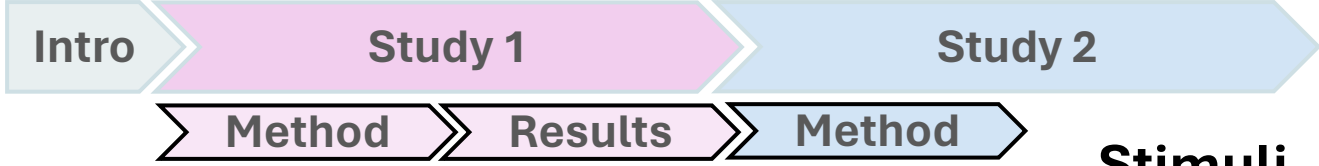


Research question

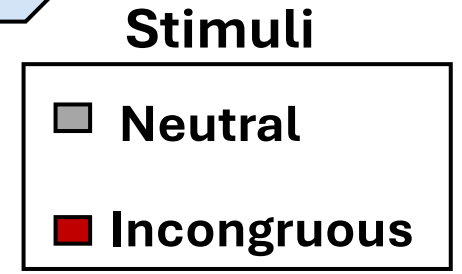


Can surprise alone explain the positive influence of humor on learning?

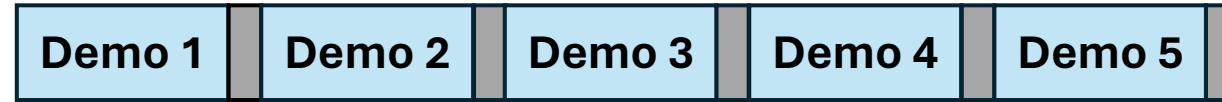
Demonstration



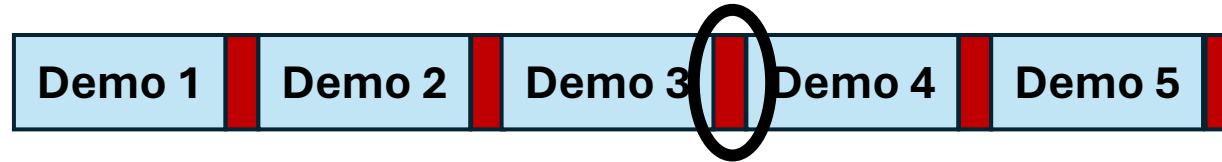
60 infants from 17- to 22-month-old included



Neutral Demonstration

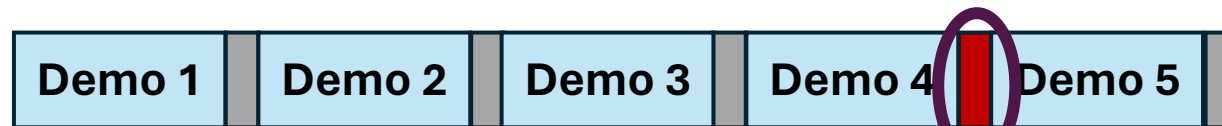


Humorous Demonstration



First Laughters

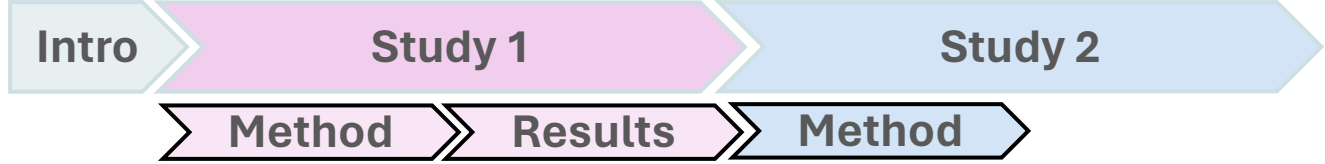
Surprising Demonstration



One Incongruous event

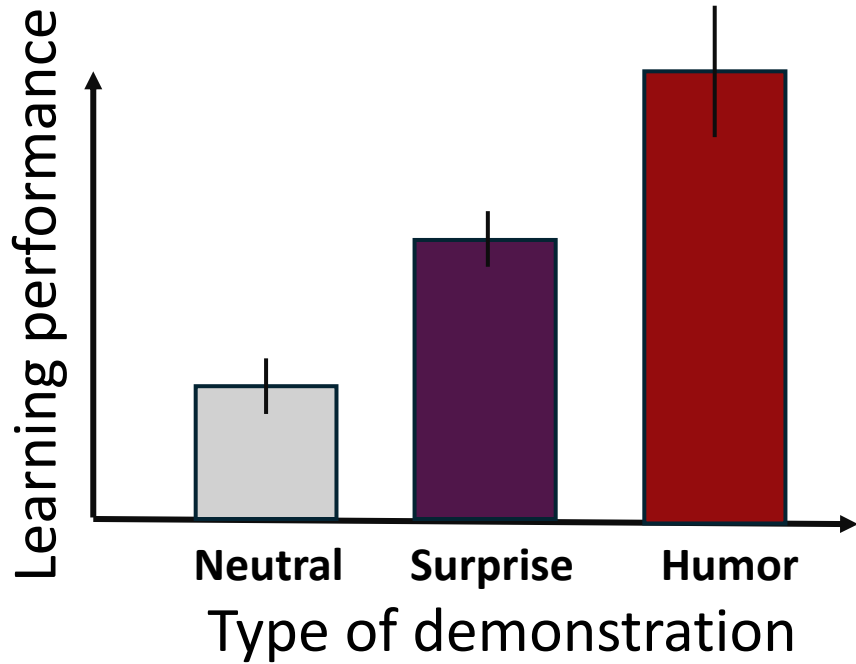


Prediction



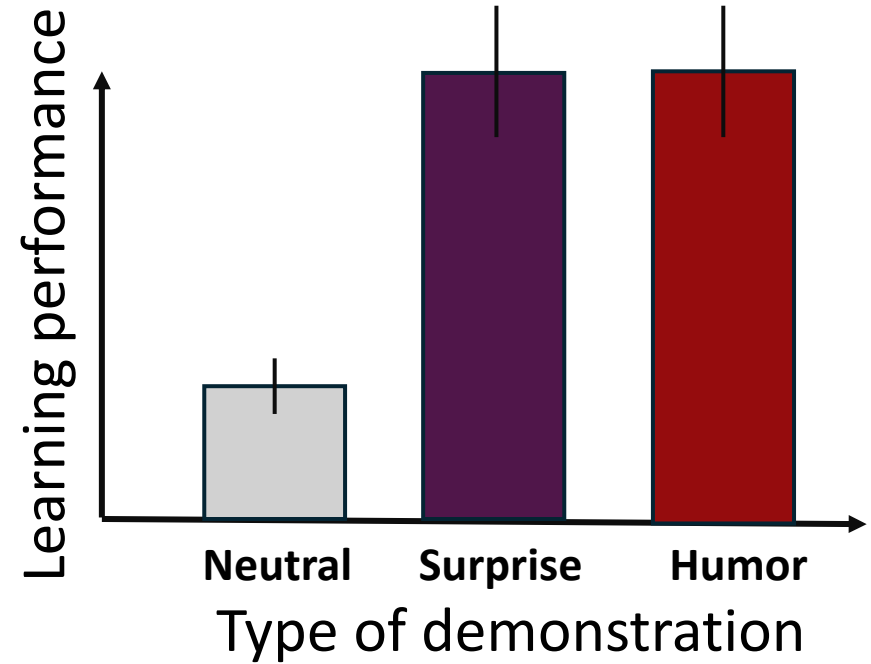
What do we expect?

A cumulative effect (synergy)

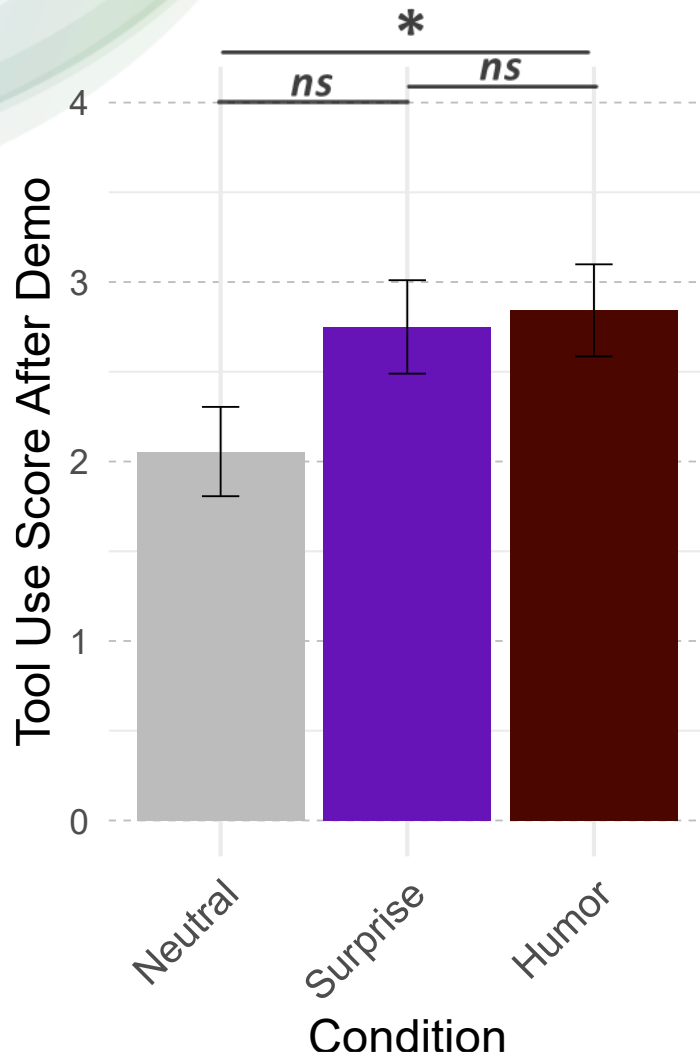
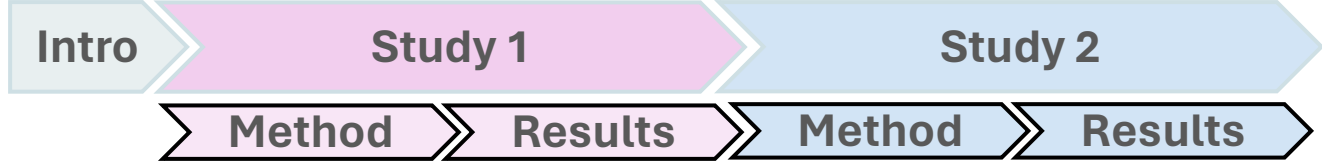


OR

An effect of surprise alone



Tool Use Score



◆ No effect of infant's smiles or laughs on learning

*Results based on cumulative link model (clm) of the package 'ordinal' (Christensen 2023)
Checked with bayesian model function (brm) of the package 'brms' (Burkner 2017; 2018; 2021)
Post-hoc realized with emmeans function of the package 'emmeans' (Lenth 2024)

Gaze at experimenter

Intro

Study 1

Study 2

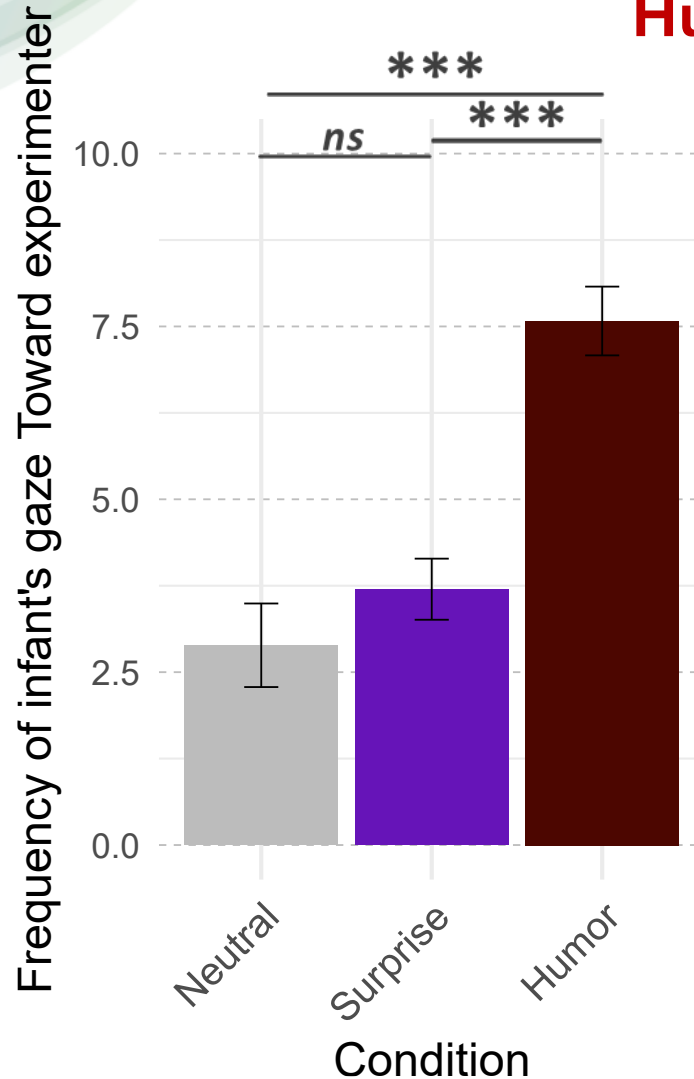
Method

Results

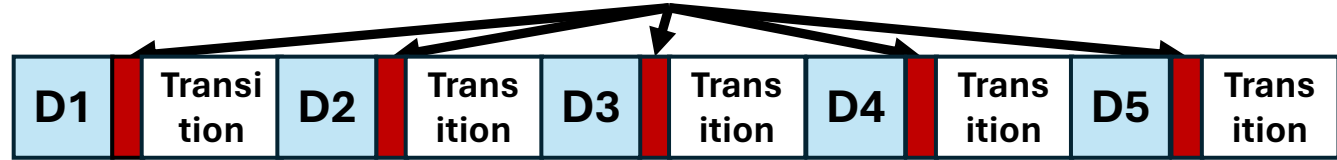
Method

Results

Humorous demonstration



Five incongruous stimuli



That is why:

Frequency  > in Humor

◆ Social gazes (+) opportunity for infant to learn.

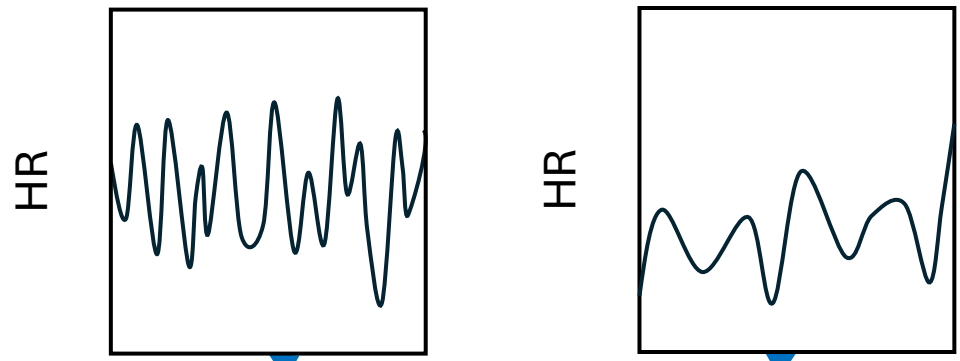
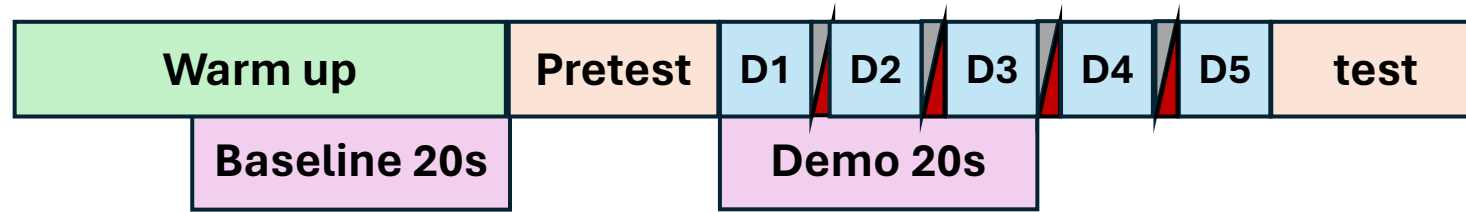
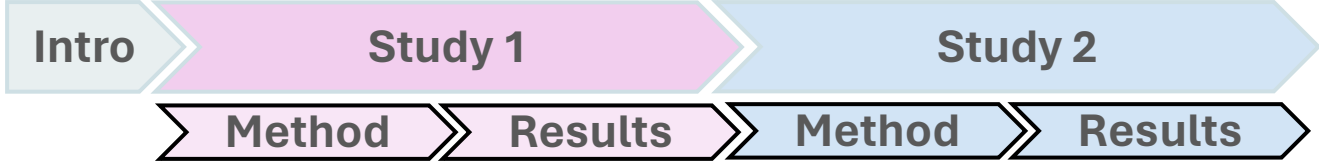
ATTENTION



↗ infants' learning



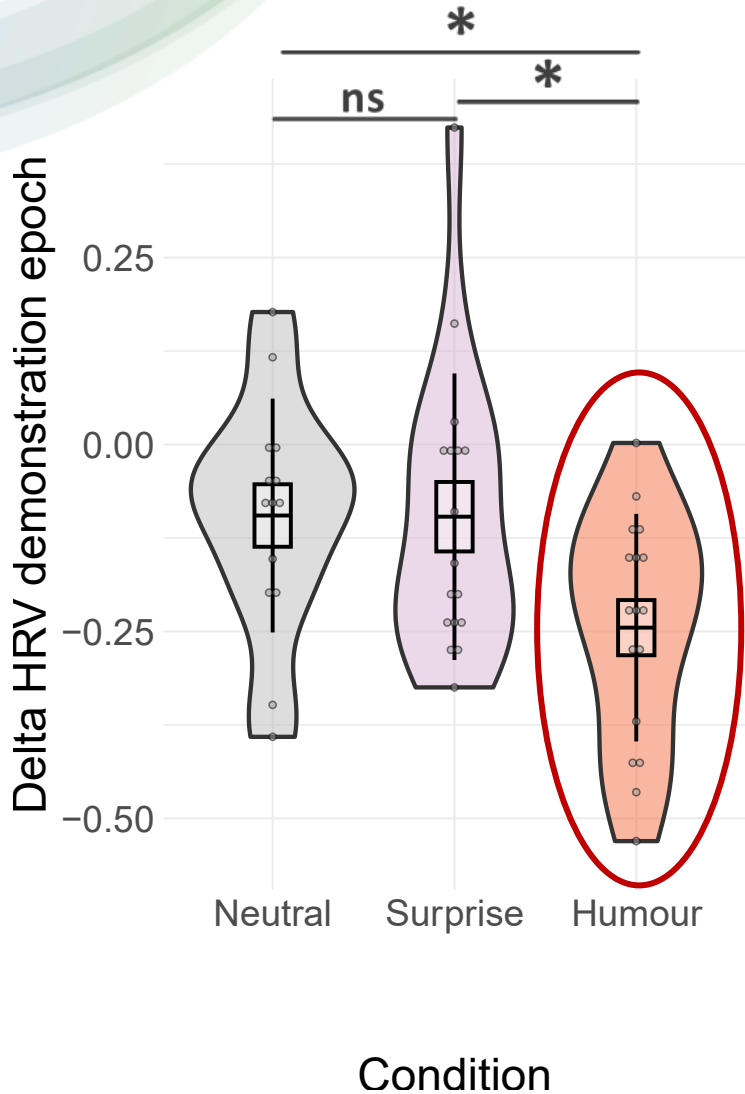
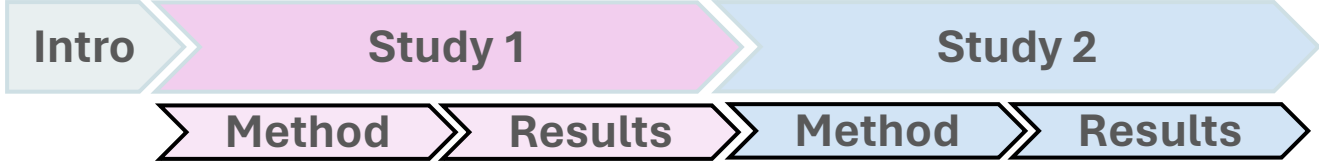
Heart rate variation



Heart Rate Variability (HRV)
 $\Delta < 0 \rightarrow \searrow$ HRV
 $\Delta > 0 \rightarrow \nearrow$ HRV

$\text{Demo}_{\text{epoch}} - \text{Baseline}_{\text{epoch}}$

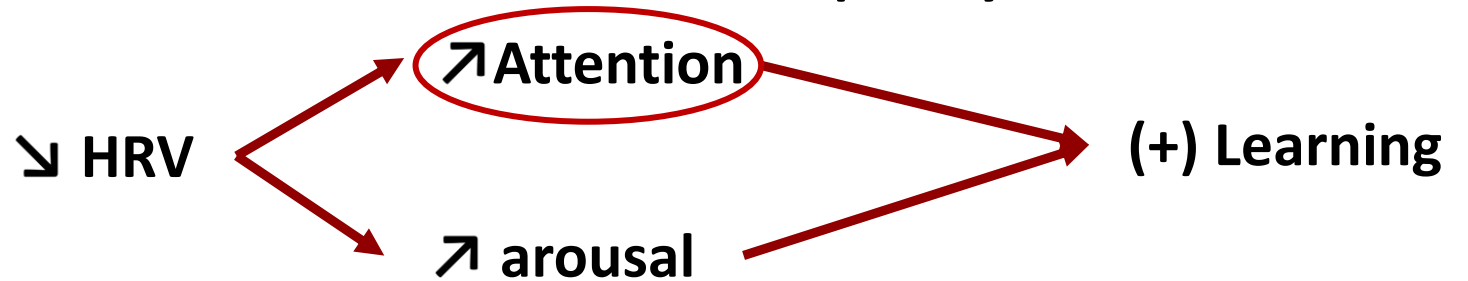
Heart rate variation



(+) \searrow of their Heart Rate Variation (HRV) **Humor**

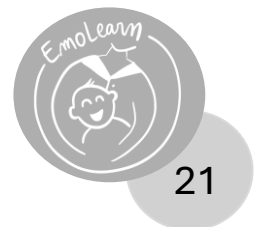
Hypothesis!

Since Frequency  $>$ in **Humor**

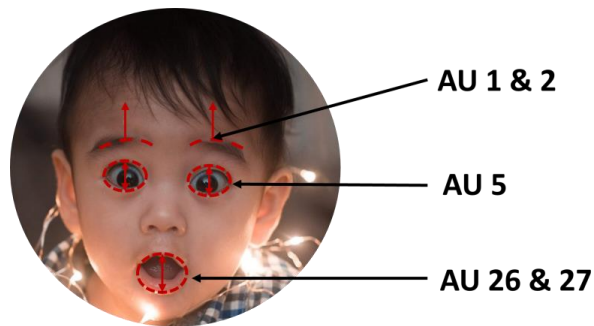


*Results based on Permutation Test with a Monte Carlo sampling of 1000 permutations - PermTest function of the package 'pgirmess'

(Giraudoux, 2024)



- ◆ An effect of the **humorous demonstration on learning**
But is it linked to humor understanding ?
 - **Attentional effect** (\nearrow gazes at experimenter; \searrow HRV)
 - **Arousal effect** (\searrow HRV) → **Emotional processes?**
 - ↳ \nearrow infants' learning performances
- ◆ Surprise is **not sufficient to explain the association between Humor and Learning in infant.**



≠ Surprise

&

Distinguish **Surprise** and **Attention** is not easy

Acknowledgements



Lauriane Rat-Fischer



Rana Esseily



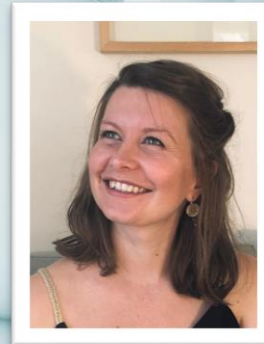
Fabien Cerrotti



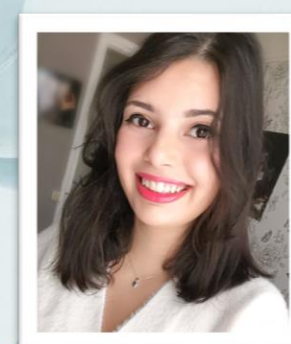
Ines Cathala



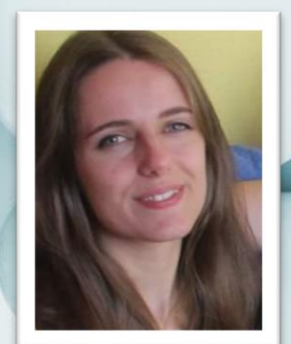
Chloé O'Neill



Justine Giraud



Sarah Commergnat



Jasmine Spenser

Fundings



institut
universitaire
de France



Thank you for your attention

For any further information,
please send me an e-mail at the
following address:
romain.di-stasi@outlook.com

Or scan the **QR code!**

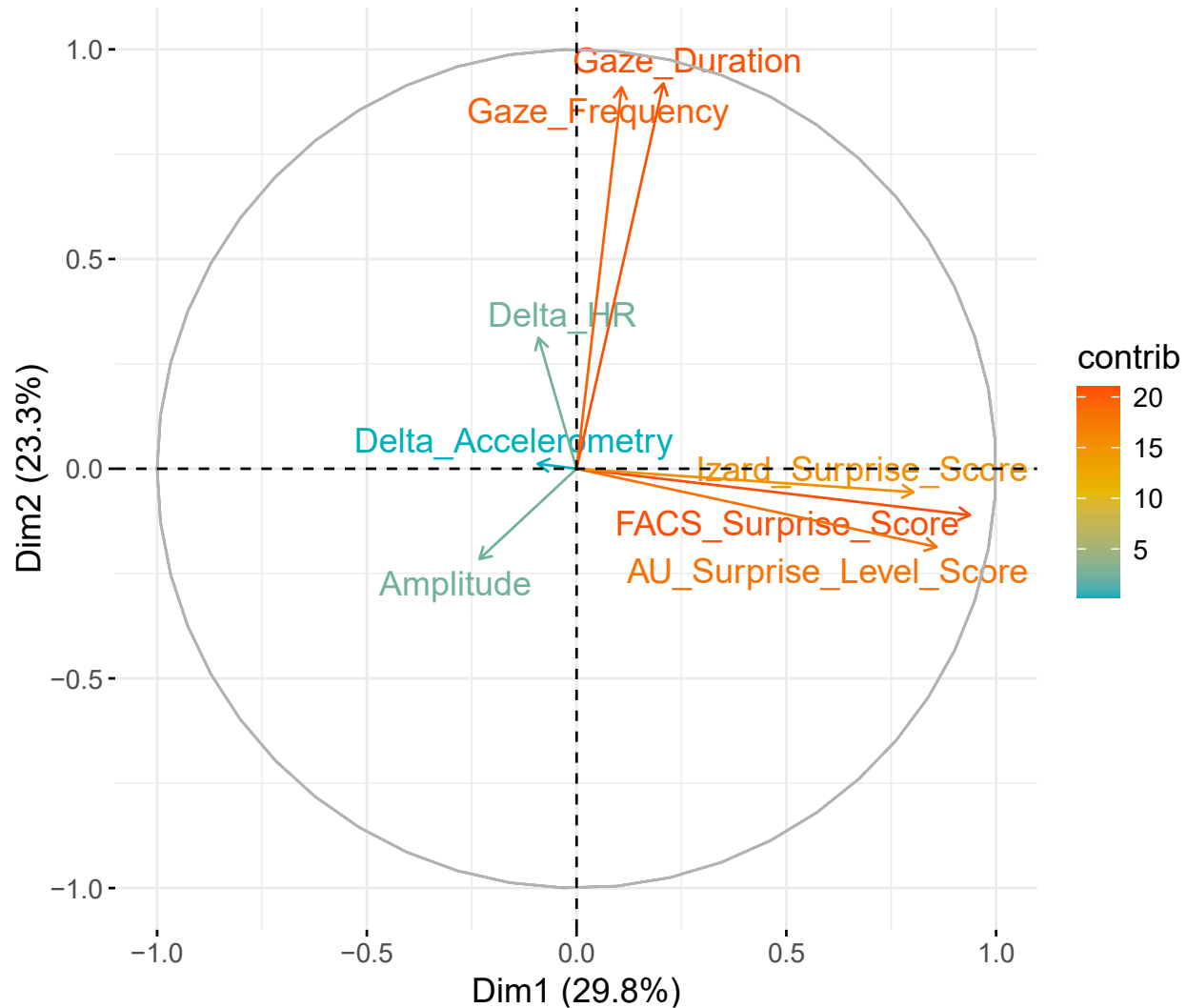


Study 1: Results and discussion

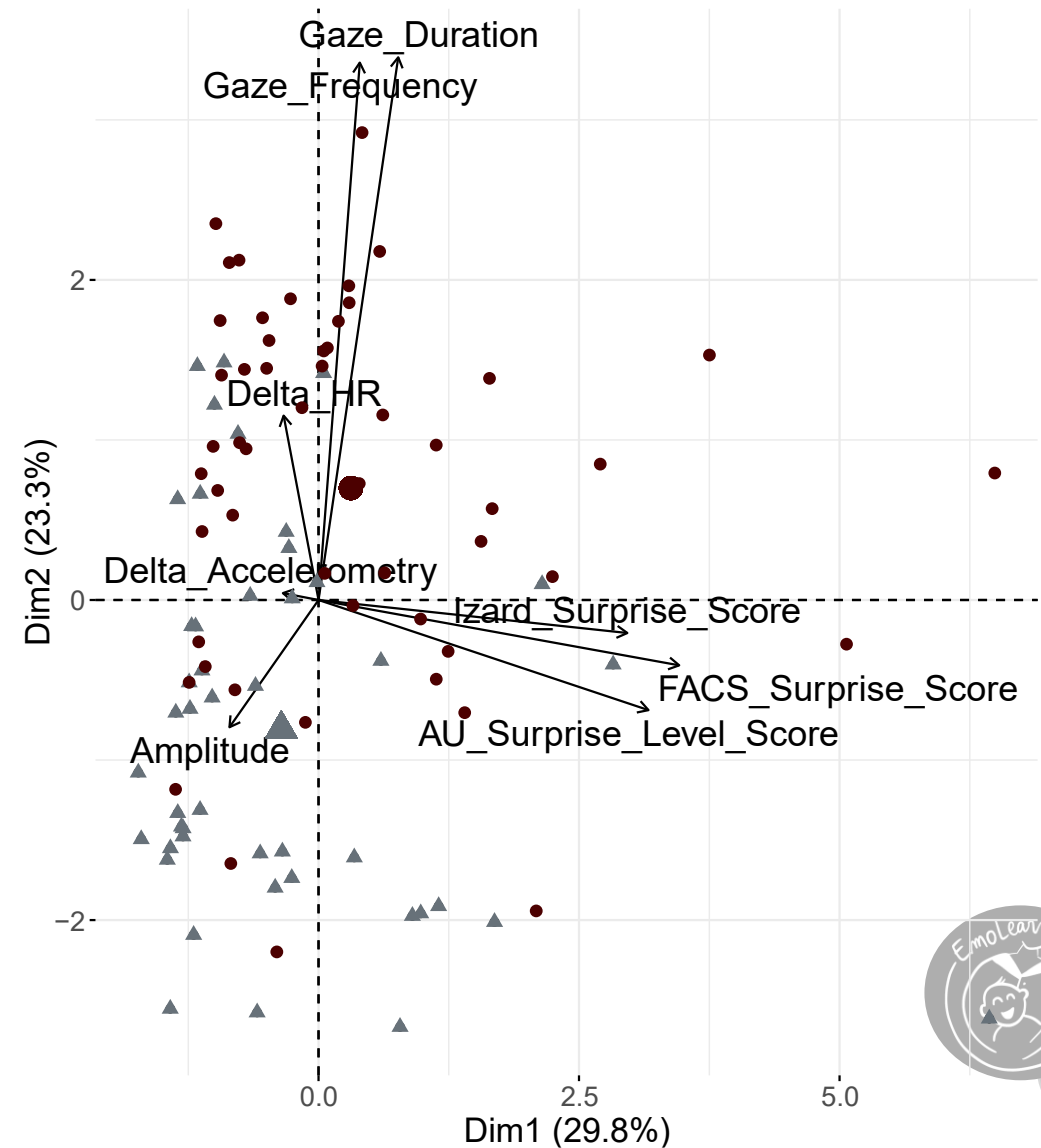
*ACP drawn with the package 'factoextra' (Kassambara 2016), NAN were imputed using the k-dimensions with the package 'missMDA' (Josse & Husson, 2016)

Demonstration 1, 3s

Variables – PCA



PCA – Biplot



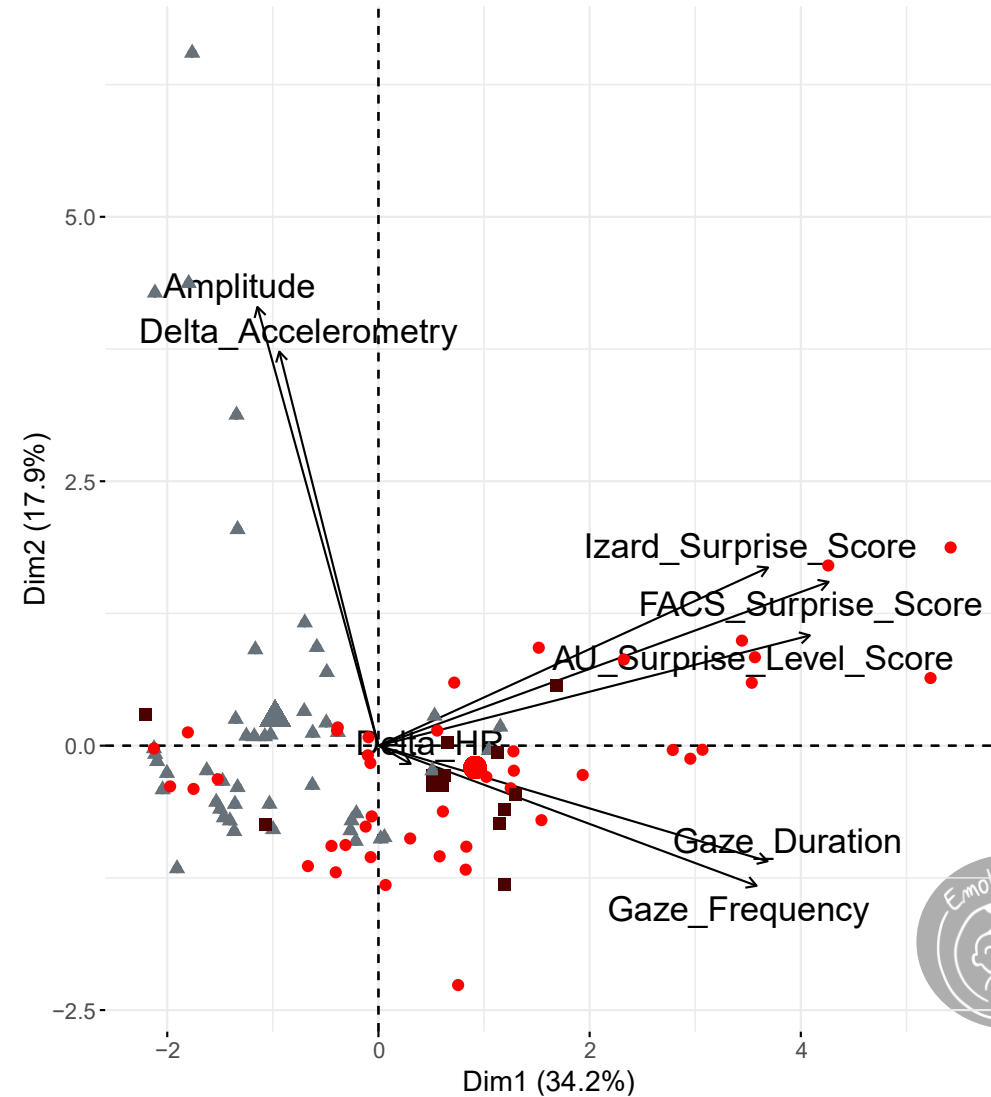
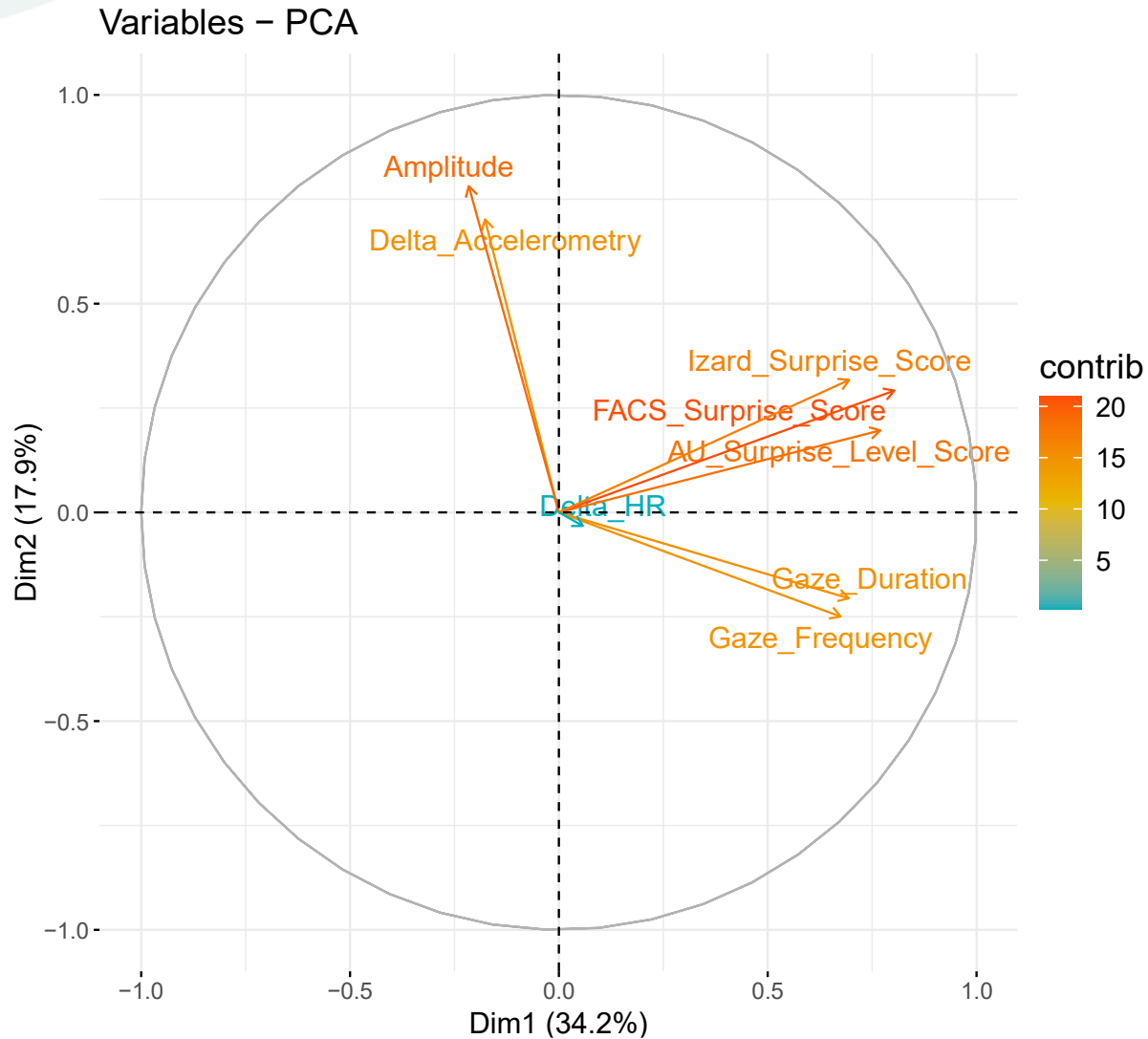
Study 1: Results and discussion

Demonstration 4, 3s

Type of demonstration and infant's emotional reaction

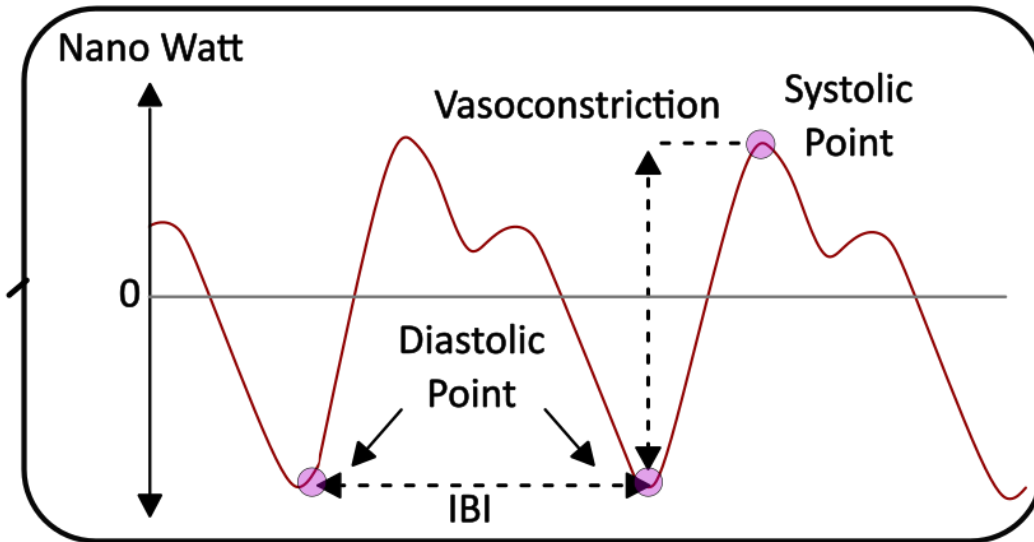
▲ Neutral ● Humor non-laughing ■ Humor laughing

PCA – Biplot



Physiological method HRV

Cardiac variability



Preprocessing



Then

$$RMSSD = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (RR_{i+1} - RR_i)^2}$$



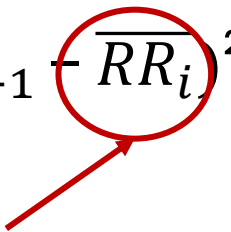
Physiological method HRV

Root Mean Sum of Squared Distance

$$RMSSD = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (RR_{i+1} - RR_i)^2}$$

- 1) A good indicator of the **parasympathetic nervous system**, not so good for the sympathetic one.
- 2) Minimum of **10 seconds epochs** are enough
- 3) Based on time T to T+1

Standard Deviation of RR-Intervals

$$SDNN = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (RR_{i+1} - \overline{RR_i})^2}$$


Mean of the interval RR

- 1) A good indicator of the **parasympathetic and sympathetic** (i.e., autonomic) nervous system.
- 2) Minimum of **60 seconds epochs** are enough
- 3) Based on RR mean



Physiological method HRV

