

The Multiverse Approach in Multi-Lab Projects: Robustness Might Matter More Than Statistical Significance in Infancy Research

Giulia Calignano

AIP Sperimentale - Noto, September 24, 2024

Outline

- 1 ManyBabies 2 : Theory of Mind in Infancy
- 2 MB2 Pupillometry Spin Off
- 3 The MB2P Preregistration and the Multiverse approach
- 4 Robustness in Infancy Research
- 5 Resources

ManyBabies 2 : Theory of Mind in Infancy

MB2 - ToM



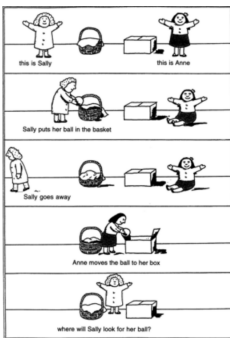
MB2

Theory of Mind in Infancy

Stage 1 Registered Report

Schuwert, T.*, Kampis, D.*, Baillargeon, R., Biro, S., Bohn, M., Byers-Heinlein, K., Dörrenberg, S., Fisher, C., Franchin, L., Fulcher, T., Garbisch, I., Geraci, A., Grosse Wiesmann, C., Hamlin, K., Haun, D. B. M., Hepach, R., Hunnius, S., Hyde, D. C., Karman, P., ... Rakoczy, H. (accepted pending data collection). **Action anticipation based on an agent's epistemic state in toddlers and adults.** *Child Development*. PsyArXiv. <https://doi.org/10.31234/osf.io/x4jbm> (*co-first authors)

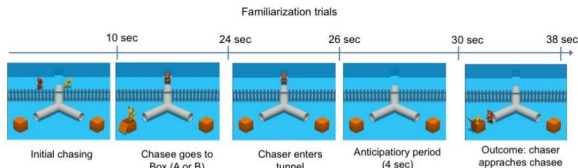
MB2 - Do toddlers and adults engage in spontaneous Theory of Mind (ToM)?



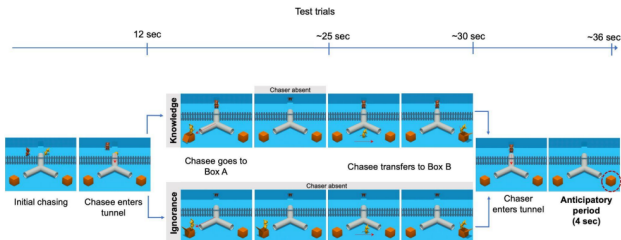
- Evidence from **anticipatory looking (AL)** studies
- But a growing body of **failed replication studies** raised **the need to test the robustness**
- Question: 18- to 27-month olds' and adults' anticipatory looks between **two forms of epistemic states**: knowledge and ignorance.

MB2 - ToM - Paradigm

Timeline of the familiarization trials.

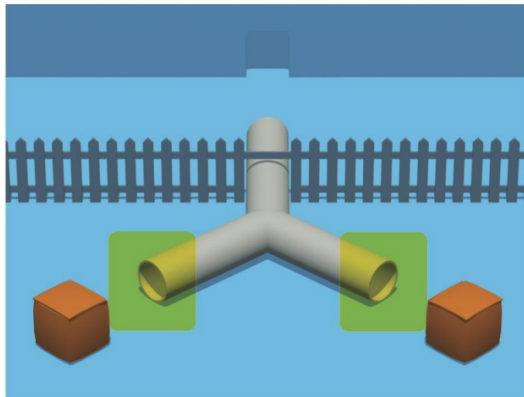


Schematic overview of stimuli and conditions of the test trials.



MB2 - ToM

Areas of Interest (AOIs)



MB2 - ToM

OSFHOME Search Support

ManyBabies 2: Infant Theory of Mind Metadata Files Wiki Analytics Registrations

ManyBabies /

ManyBabies 2: Infant Theory of Mind

Contributors: Michael C. Frank, Tobias Schuerk, Dora Kampis, Grace Zhou, Heidi A. Baumgartner, Yanwei Wang

Date created: 2017-03-29 02:08 AM | Last Updated: 2023-11-13 05:47 AM

Category: Project

Wiki

ManyBabies 2: Infant Theory Of Mind

This is a placeholder the project page for the second study of the ManyBabies collaborative research project.

For contributors

You can join the manybabies2 listserv (manybabies2@lists.stanford.edu).

You can get in touch with Michael Frank

[Read More](#)

Citation

Components

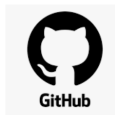
Registered Report: Knowledge vs. Ignorance

Schuerk, Frank, Tammes & 9 more

Documents and Material

Schuerk, Frank, Tammes & 6 more

Eye-tracking data



ManyBabies

10 followers <http://manybabies.github.io>

Overview Repositories 19 Projects Packages People

Popular repositories

[mb2-analysis](#) Public

Analysis scripts for MB2

TeX 7 7 10

[mb1-analysis-public](#) Public

ManyBabies1 analysis code for public sharing

TeX 6 6 15

MB2 Pupillometry Spin Off

MB2P - Secondary Data Analysis



MB2P

Measuring Pupil Dilatation in Response to Expected and Unexpected Events

MB2P - Secondary Data Analysis

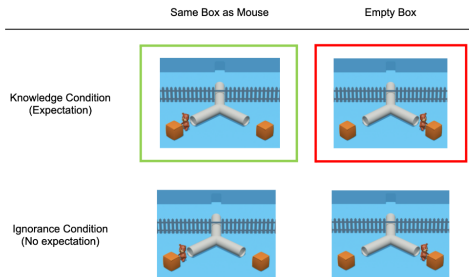


Table 1. Illustrations of the outcomes within the VOE-design. In this example, the mouse is hiding in the left box. The green box marks the congruent outcome while the red box marks the incongruent outcome.

- MB2P is interested in responses to seeing a **goal-congruent vs. a goal-incongruent outcome**
- MB2P asks whether children are **surprised** if the protagonist (the bear) responds in a way that is incongruent with the goal (to follow the mouse)
- Measures: **pupil dilation** and **looking time** in response to the congruent and incongruent events

The MB2P Preregistration and the Multiverse approach

The MB2P Preregistration and the Multiverse approach

OSFHOME ▾ My Projects Search Support Donate Giulia Calignano

MB2P - Knowledge vs. Ignorance-based... Metadata Files Wiki Analytics Registrations Contributors Add-ons Settings

0.0B Private P 0 ...

MB2P - Knowledge vs. Ignorance-based Violation of Expectation in Children and Adults: A combined eye tracking and pupillometry study

Contributors: [Giulia Calignano](#), Marlena Mayer, Melanie S. Schreiner, Robert Hepach
 Date created: 2024-07-16 09:58 AM | Last Updated: 2024-08-20 04:44 PM
 Category: Project
 Description: Empirical evidence in support of conceptual replication of action with two dependent variables:

The proposed study is a spin-off time. In this scene, the second

Wiki

MB2P Measurement Expected and

A violation-of-expectation p...

- MB2P
 - MB2P-Preregistration
 - MB2P_MULTIVERSE_PREREGIS...**
 - mb2p_multiverse.Rmd
 - prerec_mb2p_multiverse.Rmd
 - MB2P-specific-checks.qmd
 - README_MB2P.rtf

manybabies / mb2-analysis

Type to search

<> Code Issues 17 Pull requests Actions Projects Wiki Security Insights

mb2-analysis / MB2P / MB2P-Preregistration / MB2P_MULTIVERSE_PREREGISTRATION.md

thepach Aligned text with online preregistration and added comments. 95bb2f1

Preview Code Blame 122 lines (71 loc) · 8.01 KB Raw

MB2P - Multiverse Approach to Data analysis - Preregistration

Authors:
Giulia Calignano, Marlena Mayer, Robert Hepach

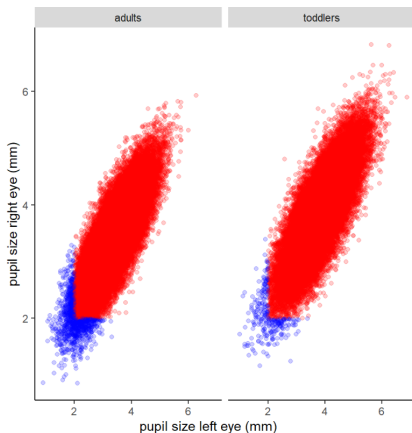
The MB2P Preregistration and Data simulation

- **Data Collection** by MB2 completed in 2023. MB2 will provide the raw data for the present study **after** the Stage 1
- **The analyses** will be based on the second test trial of the main study.
- **Data Simulation** mirroring anticipated data characteristics, **to pre-register preprocessing and analysis strategies**
- The simulated data includes: **participant id**, two **age cohort**, **Timestamp or duration**, **x and y: Coordinates or measurements**, **pupil left and pupil right sizes**, **lab id**, **conditions and outcomes**

The MB2P - Preregistration and Multiverse Forking Paths

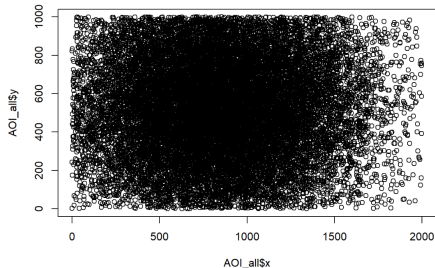
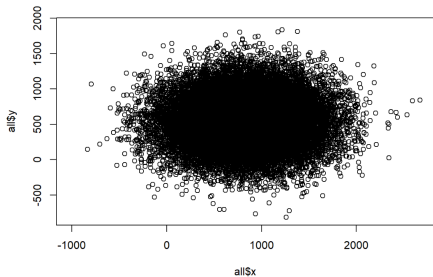
First Degree of Freedom: *Filtering Extreme Pupil Values*

- Step 1: Filter implausible pupil values (obtaining 2 datasets)



The MB2P - Preregistration and Multiverse Forking Paths

Second Degree of Freedom: *Spatial filtering*



The MB2P - Preregistration and Multiverse Forking Paths

Third Degree of Freedom: *Moving average filtering*

- A moving average is a method to smooth data by calculating the average of a set number of consecutive data points, which then shifts forward over time
- For example, in pupillometry, a 5-second moving average can be used to track pupil diameter changes by averaging measurements from each 5-second window, reducing the influence of short-term fluctuations like blinking or minor eye movements

The MB2P - Preregistration and Multiverse Forking Paths

Fourth Degree of Freedom: *Moving average filtering Baseline Correction*

- Method 1: 5 seconds before the bear resolution
- Method 2: 300 milliseconds after the bear resolution
- Method 3: 500 milliseconds after the bear resolution.

The MB2P - Preregistration and Multiverse Forking Paths

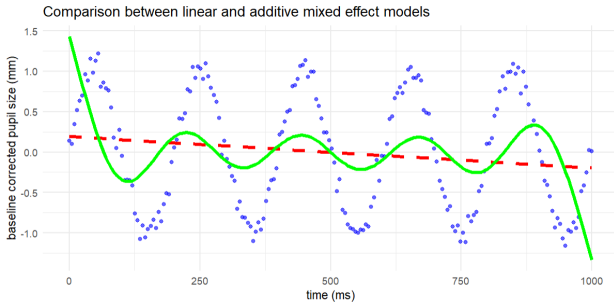
Fifth Degree of Freedom: *Participant Exclusion*

- including only those subjects with two valid test trials
- with one valid test trial (as defined by the main MB2-inclusion criteria),
- with no trial exclusion criteria applied.

The MB2P - Preregistration and Multiverse Forking Paths

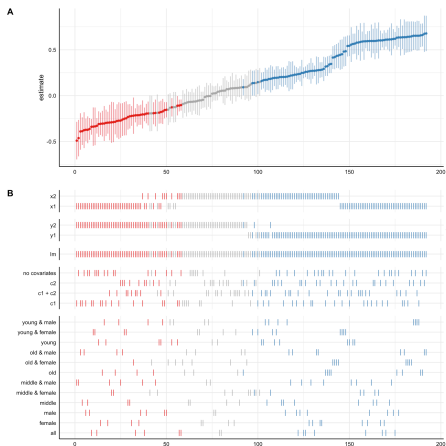
Statistical Modeling

- Model 1: Linear mixed-effect model with condition, outcome, and age
- Model 2: Linear mixed-effect model with condition, outcome, and age over time
- Model 3: Generalized Additive mixed-effect with condition, outcome, age, time, and participant-specific effects



The MB2P - Preregistration and Multiverse Forking Paths

- Model selection with Bayesian Information Criterion (Parsimony and Plausibility)
- Robustness visualization via Specification Curve (Simonsohn, et al., 2020)

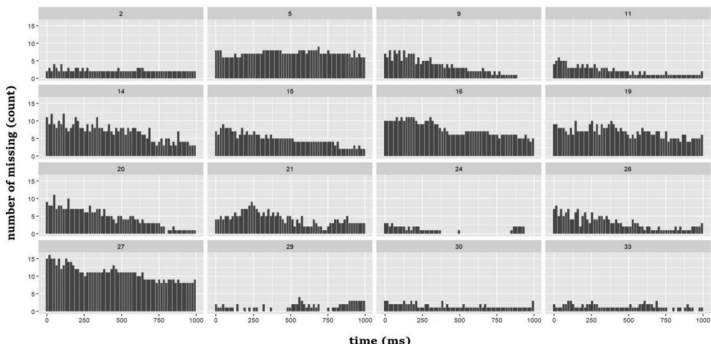


Robustness in Infancy Research

Robustness may matter more than statistical significance... at least in Infancy research

data

is the plural form of the Latin word *datum*,
which means the 'thing given'



adapted by Calignano et al., 2023

Robustness in Infancy Research

The multiverse approach increases the robustness of the present collaborative and pupillometry study (Sirois et al., 2023).

By exploring multiple preprocessing paths and statistical models, **we aim to provide robust results and informative interpretations in developmental pupillometry** (Calignano et al., 2023; Steegen et al., 2016)

Robustness in Infancy Research

- **No practice leads to perfectly clean data**, yet it is fundamental to show the impact of preprocessing on statistical results (Stegen et al., 2016; Dragicevic et al., 2019)
- Pupillometry is a useful indirect measure of **the time course** of attention since infancy (Hepach, 2024; Blaser et al., 2014; Brisson et al., 2013; Sirois Jackson, 2012; Tamasi et al. 2016)
- Statistical models that allow to evaluate *how* and *when* an effect emerge is fundamental in cognitive development (more than p-value)
- Statistical significance **is not useful at all when taken alone**
- multiverse analysis address **robustness** and avoid p-hacking
- Embracing (rather than being afraid of) the inherent uncertainty of infant data **increase our understanding of individual differences in developmental pathways of attention, learning processes, and beyond.**

Resources

Resources

- GitHub ManyBabies
- MB2P
- Calignano, Girardi, Altoè, 2024
- Sirois, S., Brisson, J., Blaser, E., Calignano, G., Donenfeld, J., Hepach, R., Hochmann, J.-R., Kaldy, Z., Liszkowski, U., Mayer, M., Ross-Sheehy, S., Russo, S., Valenza, E. (2023).

Thank you

Big Thanks to the MB2P Great Team

Big Thanks to the MB2P Leaders

Robert Hepach, University of Oxford, United Kingdom

Hannes Rakoczy, University of Göttingen, Germany

Thank you for the attention

giulia.calignano@unipd.it



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

