Dealing with uncertainty in developmental psychology: the multiverse approach

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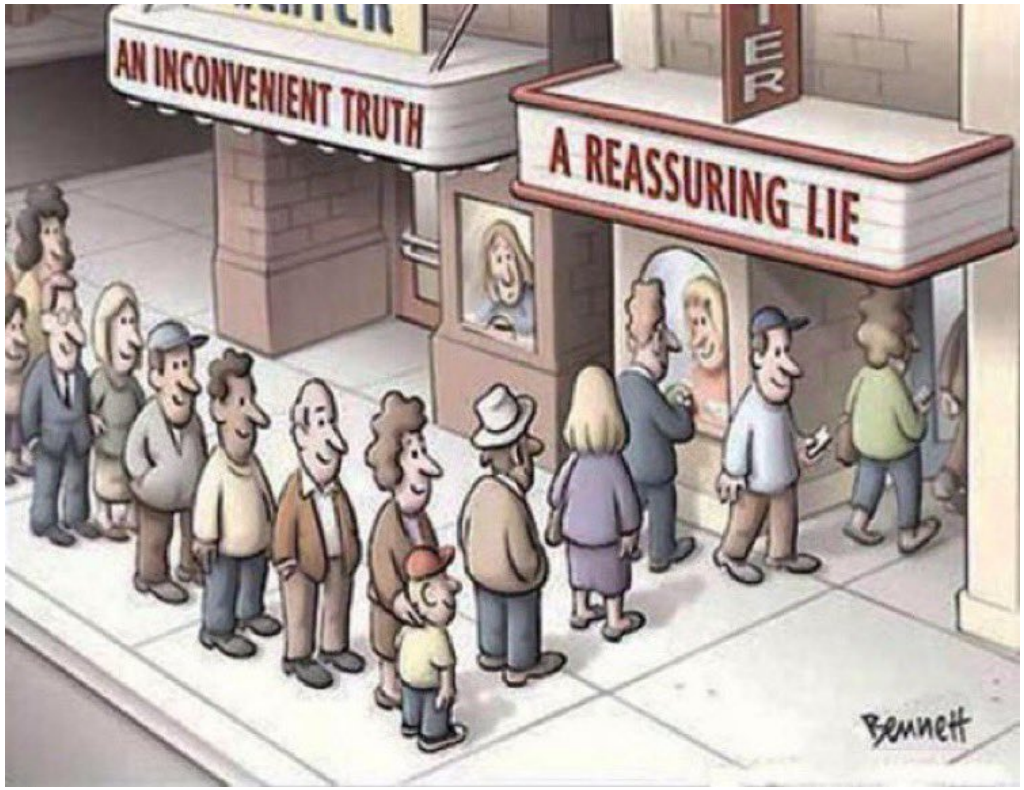
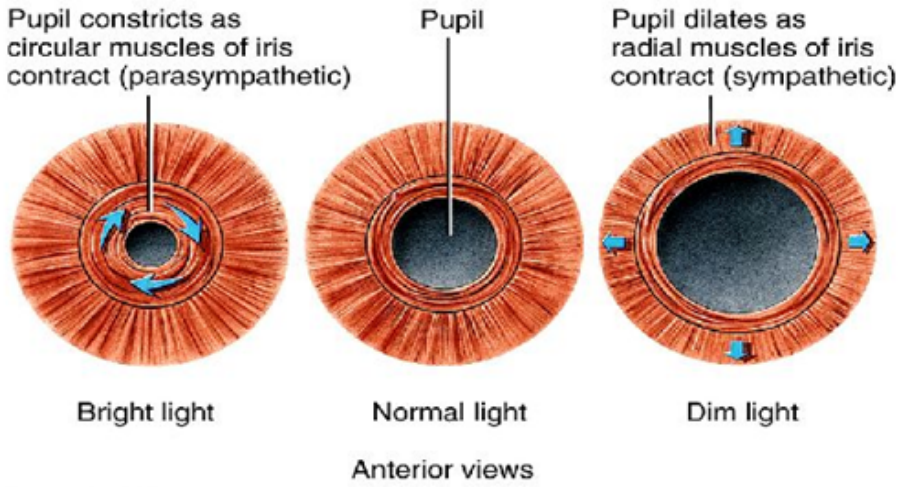
We rarely find data, we actively construct datasets



- A single data collection = a multiverse of possible datasets

(Steegen et al., 2016)

Psychophysiology of pupil dilation in infancy

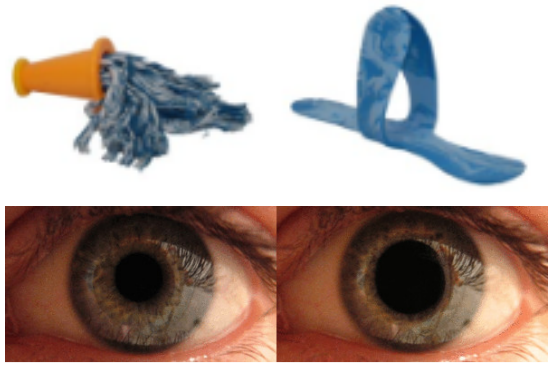


- The dilator muscle is under adrenergic control (sympathetic system) from the superior sympathetic ganglion
- The sphincter pupillae innervated by cholinergic fibers of the parasympathetic system
- **Dilation = activation of the sympathetic system + a parallel inhibitory parasympathetic mechanism**

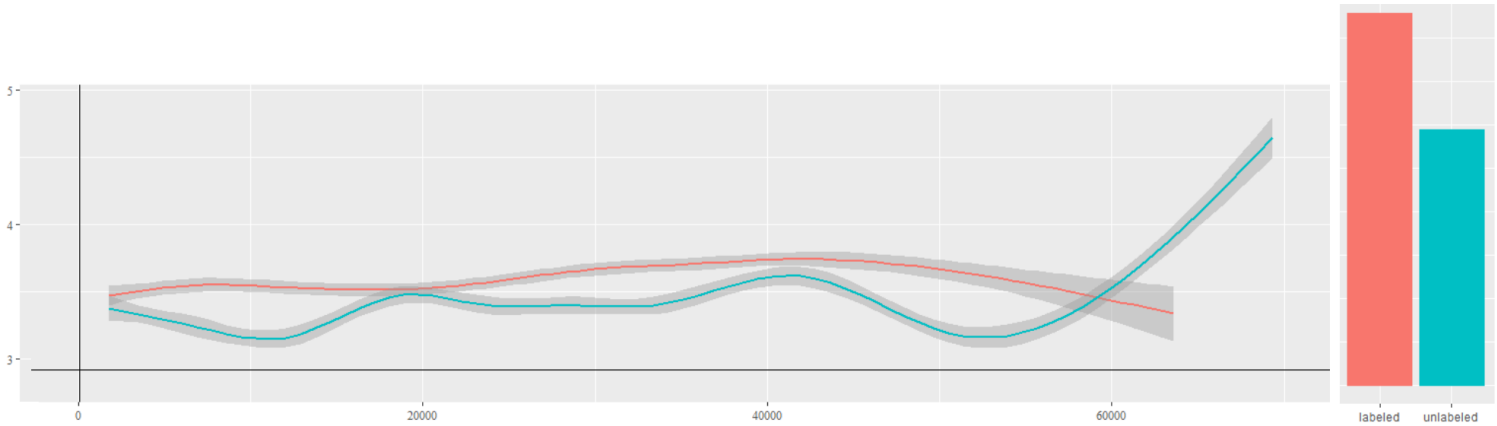
(Beatty & Lucero-Wagoner 2000)

Degrees of freedom in pupil analysis

- Luminance variation VS. attentional resources



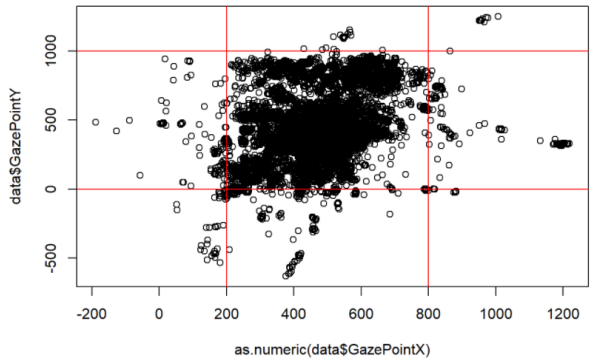
- Pupil variation across time :) vs average barplot ?! :(



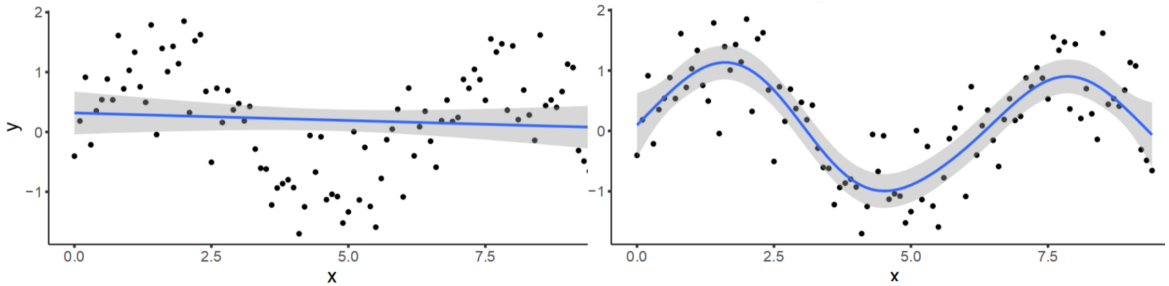
(Calignano, Valenza, Vespignani, Russo & Sulpizio, 2021)

Degrees of freedom in pupil analysis

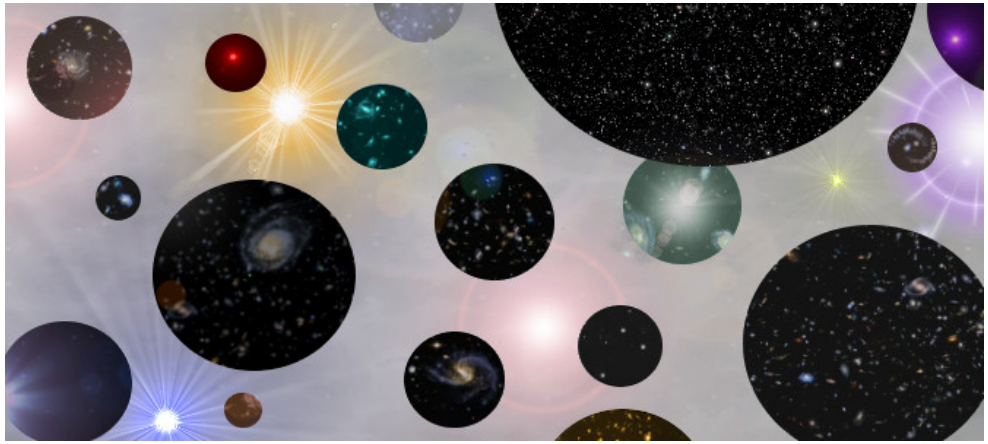
- Area of Interest (AOI) and implausible values e.g. outliers



- Baseline correction **!big issue in psychophysiology!**
- Statistical modeling **do not forget individual variability!**



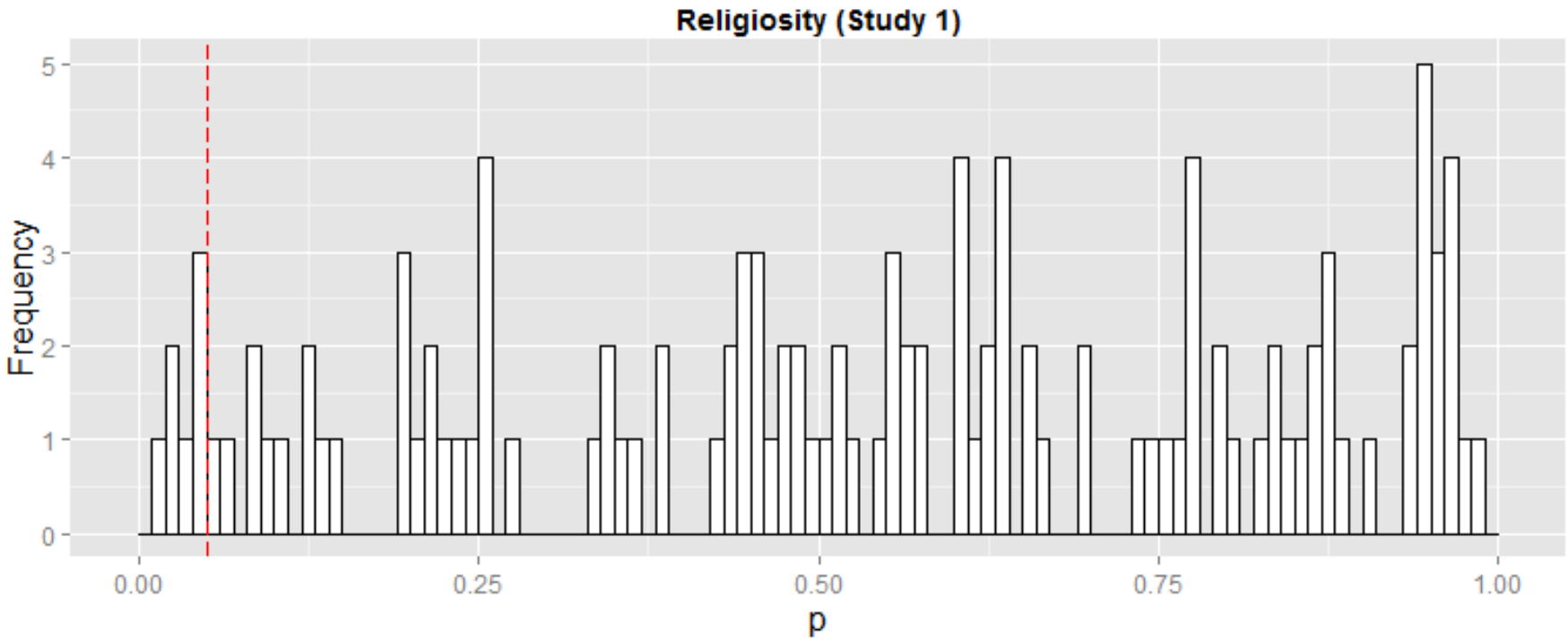
A Multiverse approach



- **a philosophy of statistical reporting** in the manuscript (not in the supllementary materials) the outcomes of many different statistical analyses showing how robust findings are (Dragicevic, et al.,2019)
- **robustness of a finding** across different options for all steps in data processing (Steegen et al., 2016).

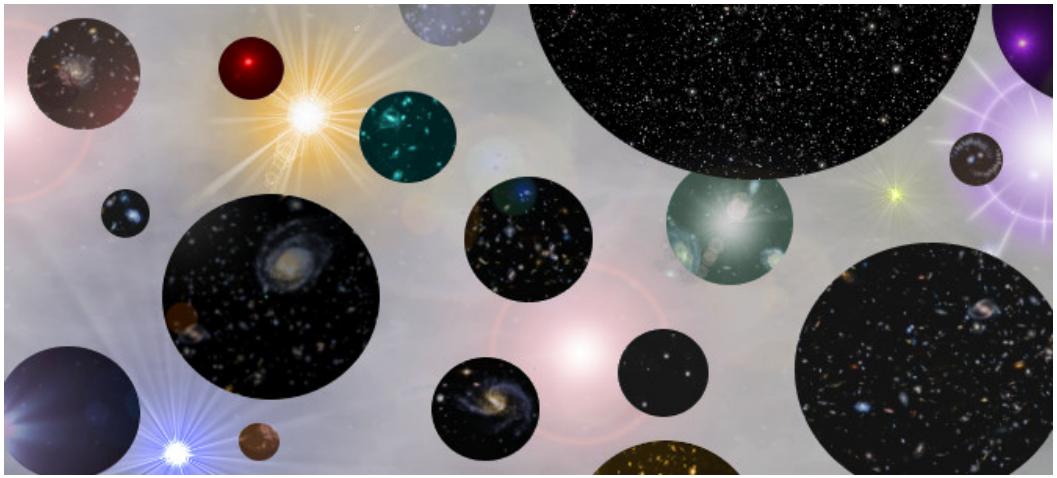
A Multiverse approach

- is the effect **robust** or is it driven by data processing choices?
- there is a multiverse of statistical results



(Steegen et al., 2016)

Building a reliable Psychophysiology and Cognitive Neuroscience

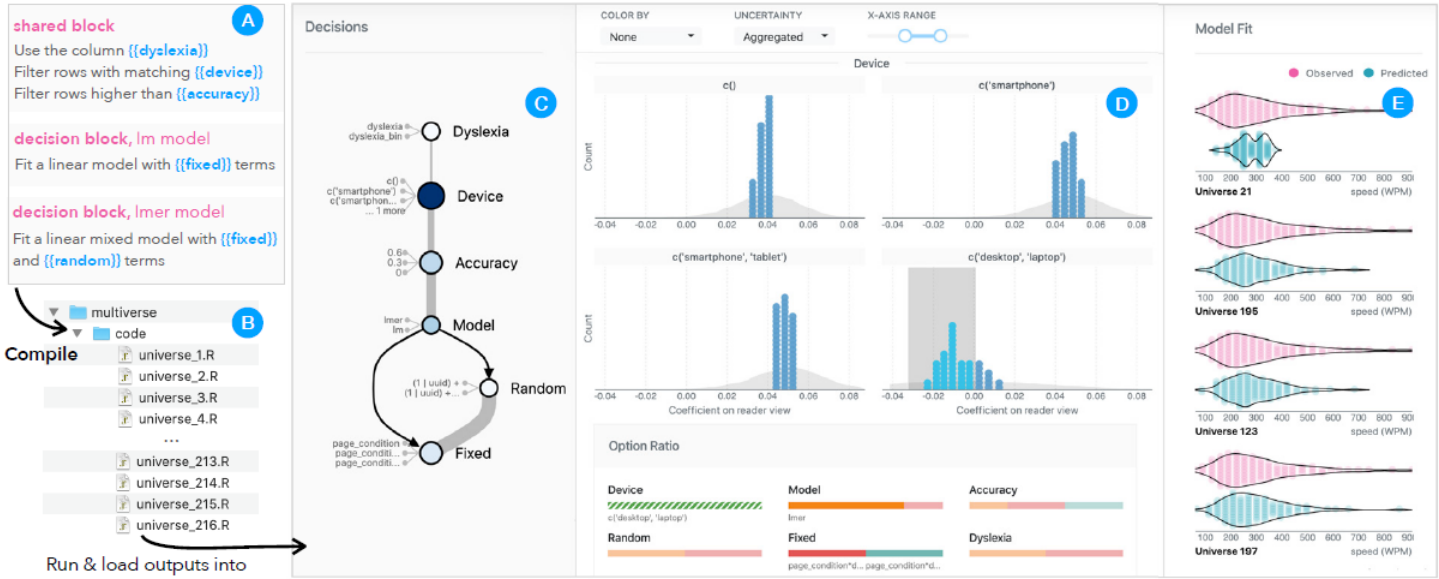


- **Importance of embracing (rather than be afraid of) the uncertainty in data**
- Data sharing and caring contribute to a full-multiverse approach

Open Tools

Boba: Authoring and Visualizing Multiverse Analyses

Yang Liu, Alex Kale, Tim Althoff, and Jeffrey Heer



Open tools and resources

- R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/
- **coming soon**
  A multiverse approach for better developmental science: The case of pupil size variation as index of attention deployment

  Calignano, G., Girardi, P., Altoè, G., (in prep.)

Resources

- Beatty, J., Lucero-Wagoner, B. (2000). The pupillary system. Handbook of psychophysiology, 2(142-162).
- Calignano, G., Valenza, E., Vespignani, F., Russo, S., Sulpizio, S. (2021). The unique role of novel linguistic labels on the disengagement of visual attention. *Quarterly Journal of Experimental Psychology*, 17470218211014147.
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- Donnelly, S., Brooks, P. J., Homer, B. D. (2019). Is there a bilingual advantage on interference-control tasks? A multiverse meta-analysis of global reaction time and interference cost. *Psychonomic bulletin review*, 26(4), 1122-1147.

Resources

- Jackson, I., Sirois, S. (2009). Infant cognition: going full factorial with pupil dilation. *Developmental science*, 12(4), 670-679.
- Oakes, L. M., DeBolt, M. C., Beckner, A. G., Voss, A. T., Cantrell, L. M. (2021). Infant Eye Gaze While Viewing Dynamic Faces. *Brain Sciences*, 11(2), 231.
- Parsons, S. (2020). Exploring reliability heterogeneity with multiverse analyses: Data processing decisions unpredictably influence measurement reliability.
- Steegen, S., Tuerlinckx, F., Gelman, A., Vanpaemel, W. (2016). Increasing transparency through a multiverse analysis. *Perspectives on Psychological Science*, 11(5), 702-712. https://doi.org/10.1177/1745691616658637

Thank you

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https://psicostat.dpss.psy.unipd.it/

https://lilia.dpss.psy.unipd.it/babylab/