Modeling cognitive deficits and enhancements in adversity-exposed youth using Drift Diffusion Modeling
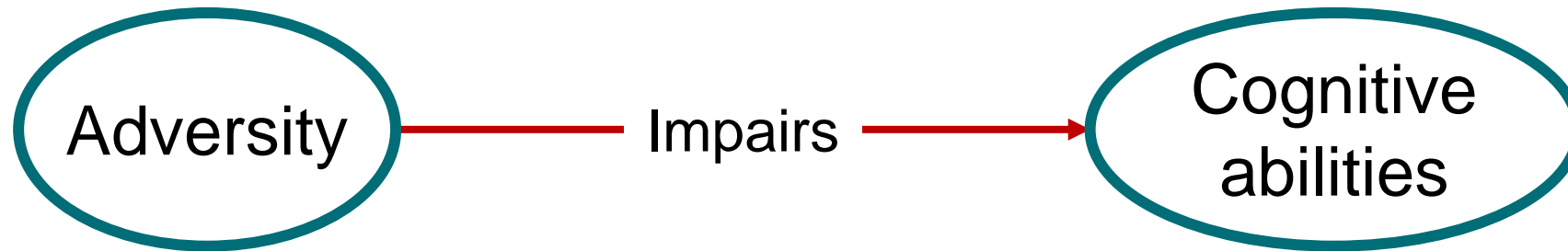
Stefan Vermeent

Cognitive deficits and enhancements in youth from adverse conditions: An integrative assessment using Drift Diffusion Modeling in the ABCD study
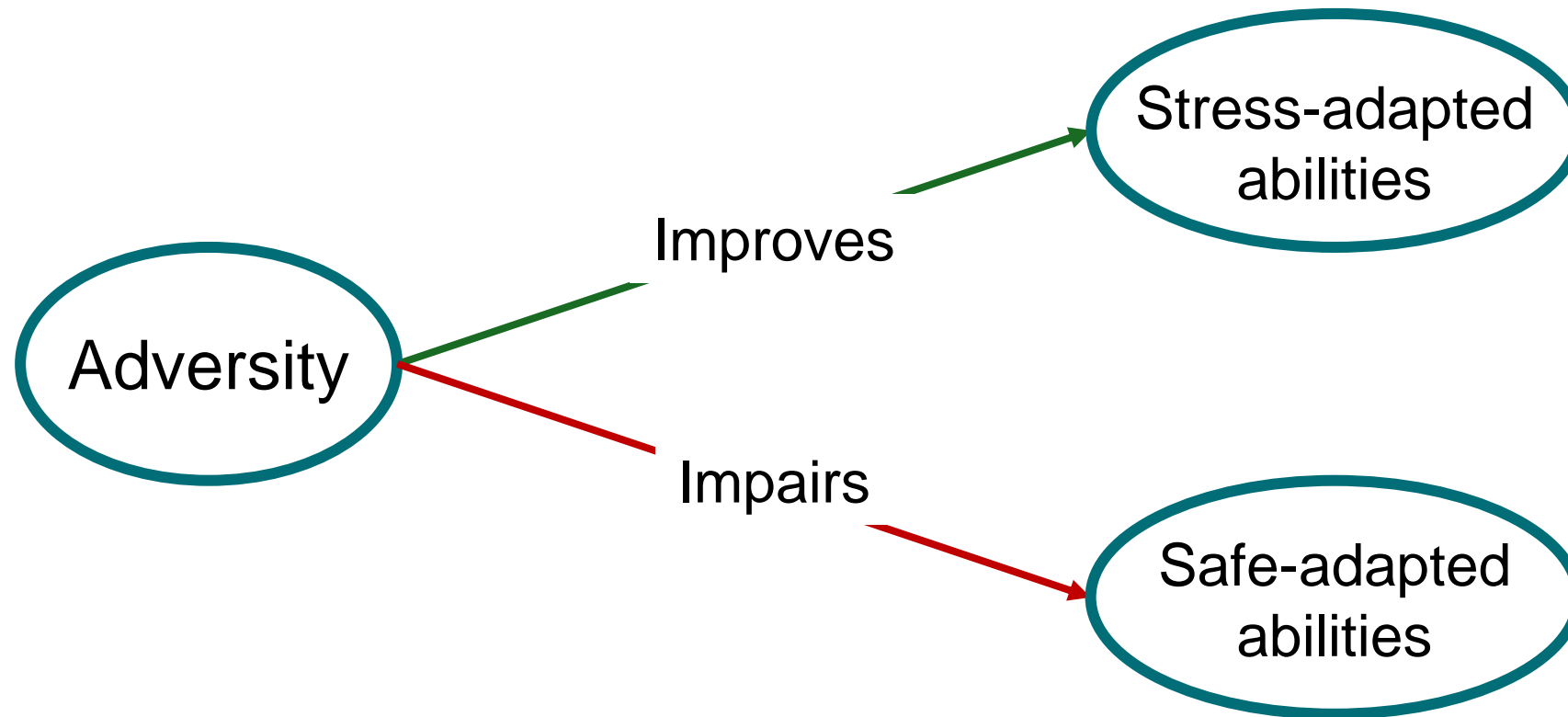
Stefan Vermeent ✉, Ethan S. Young, Meriah L. DeJoseph, Anna-Lena Schubert, Willem E. Frankenhuis

Cognitive deficits

Adversity —— Impairs ——▶ Cognitive abilities

Cognitive adaptations

Performance-ability gap

Response time / Accuracy

Cognitive ability
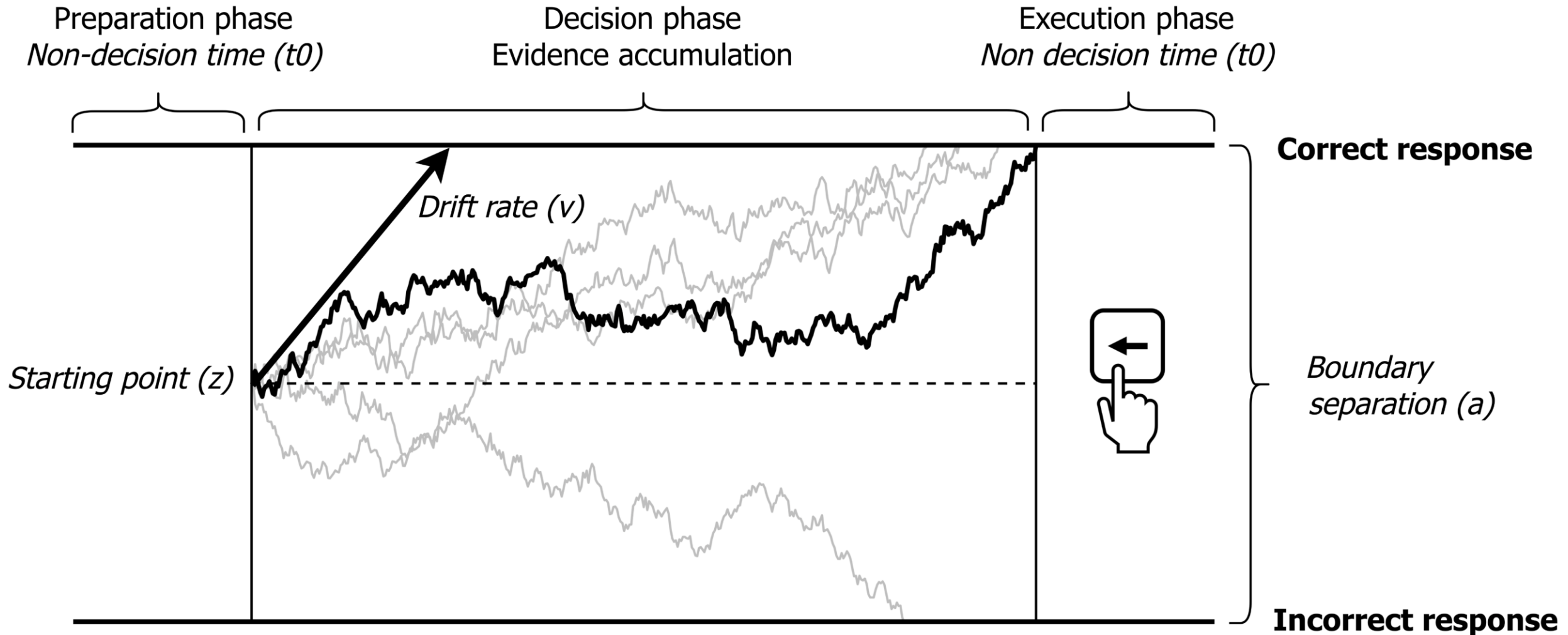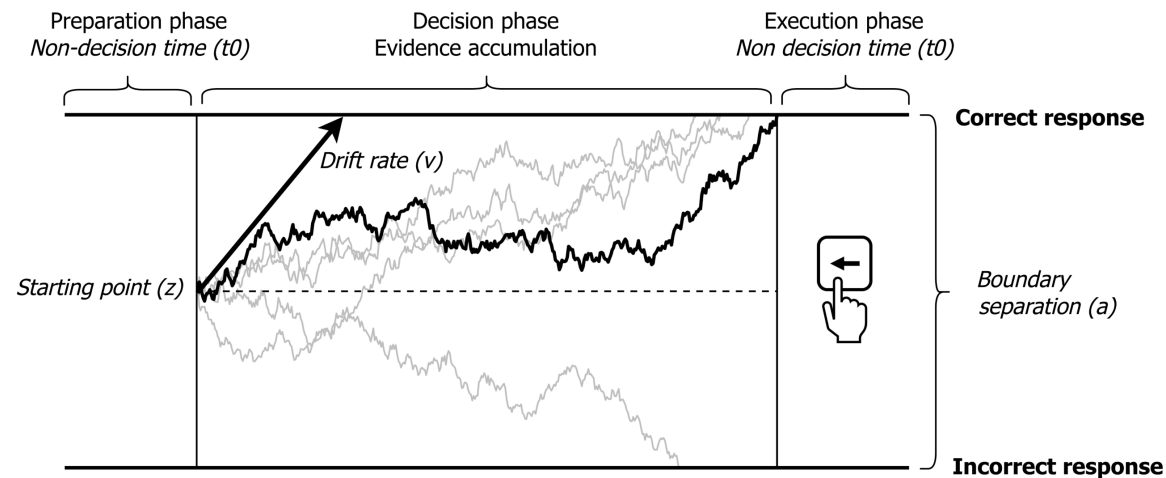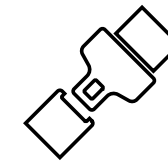
Why is this important?

Theory development
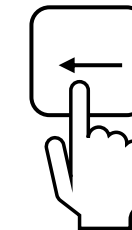

Interventions

Drift Diffusion Model

Drift Diffusion Model

Implementation

More trials needed / Less susceptible to outliers ↓

Option 1. Fit to *individual participants*

Maximum likelihood

Kolmogorov-Smirnov

Chi-square

Option 2. Account for *group-level* effects

Hierarchical Bayesian

Software/packages

Fast-dm

Software/packages

HDDM (python module)
hBayesDM (R package)
runjags (R package; with wiener module)
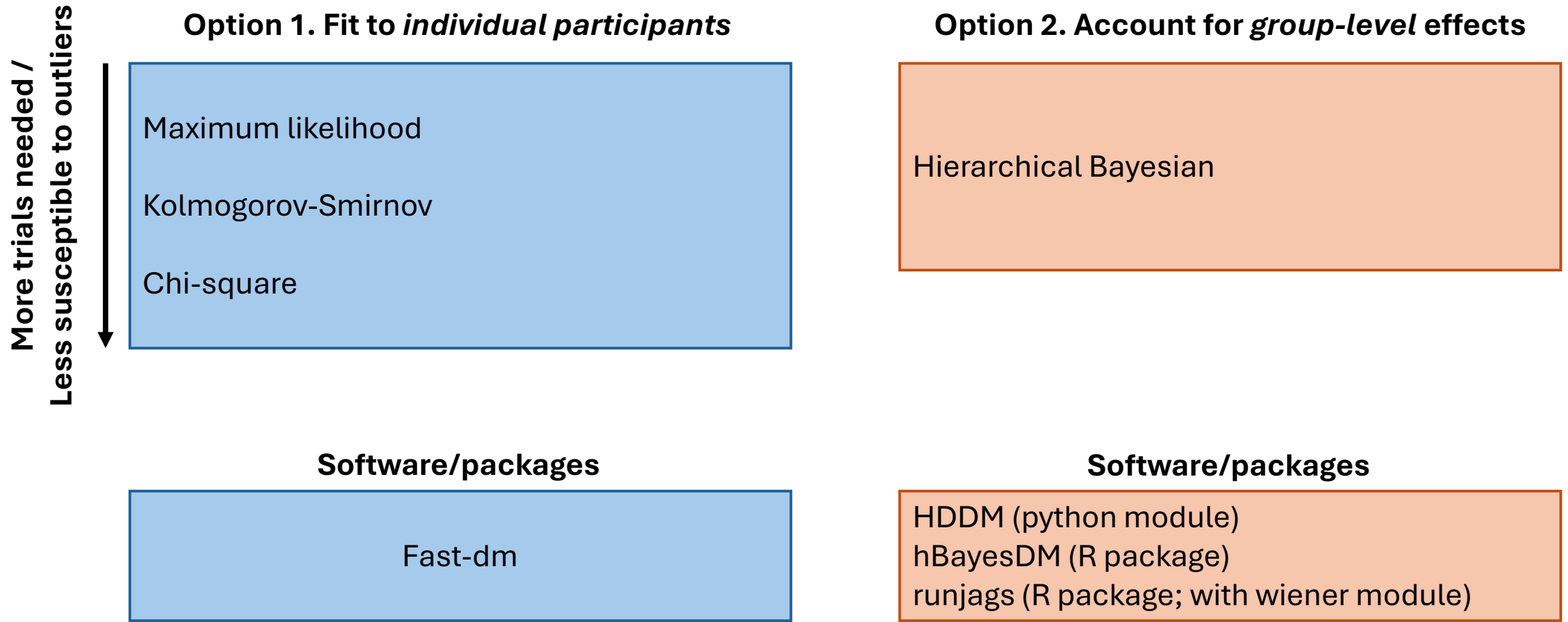
Lower rate of evidence accumulation

Drift rate: _2_
Boundary separation: 1
Non-decision time: 0.3
Bias: 0.5

More correct RTs in the tail

More errors
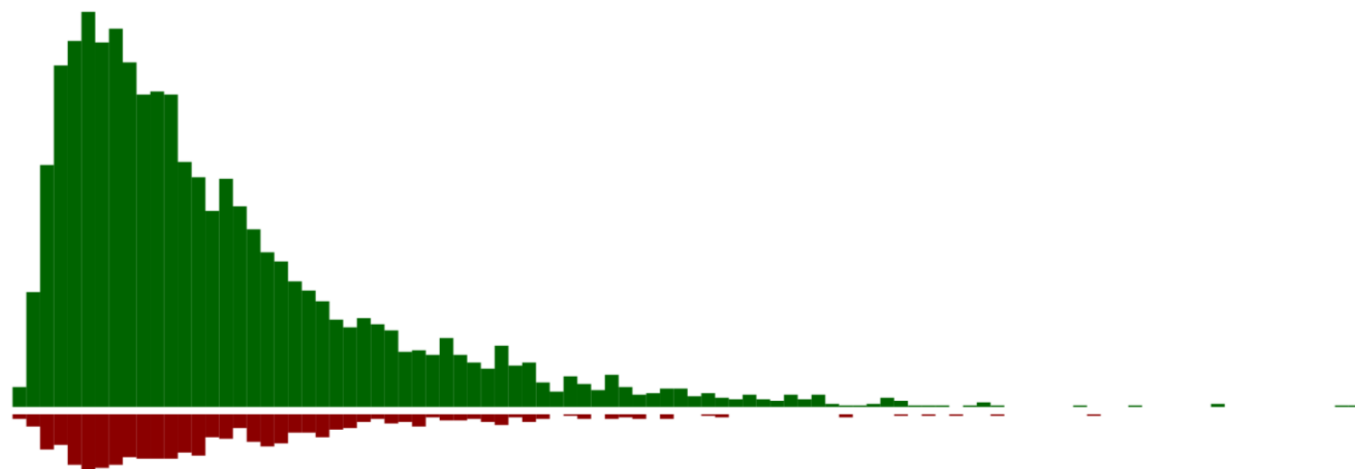
Drift rate: _1_
Boundary separation: 1
Non-decision time: 0.3
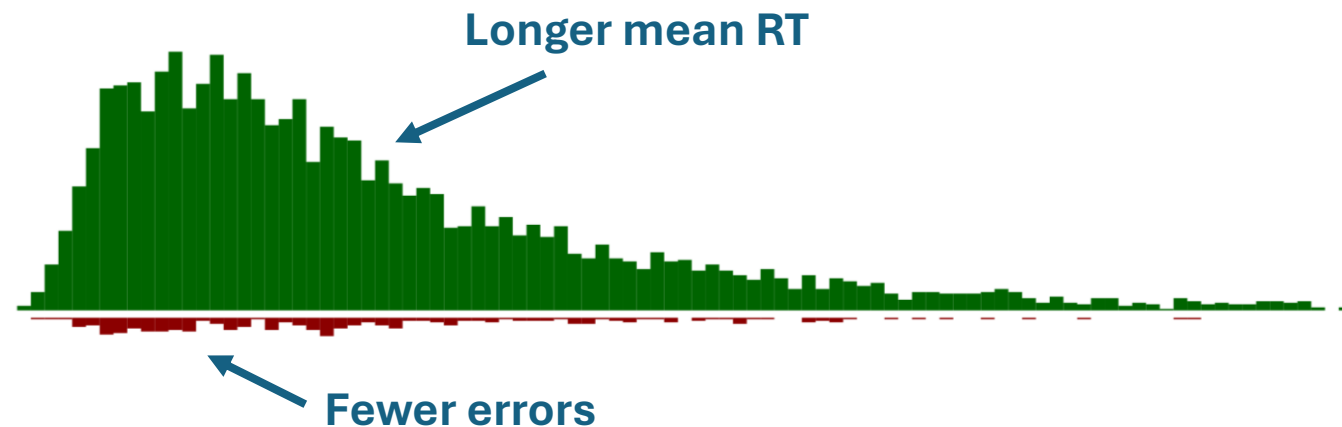**Bias:** 0.5

Increased response caution
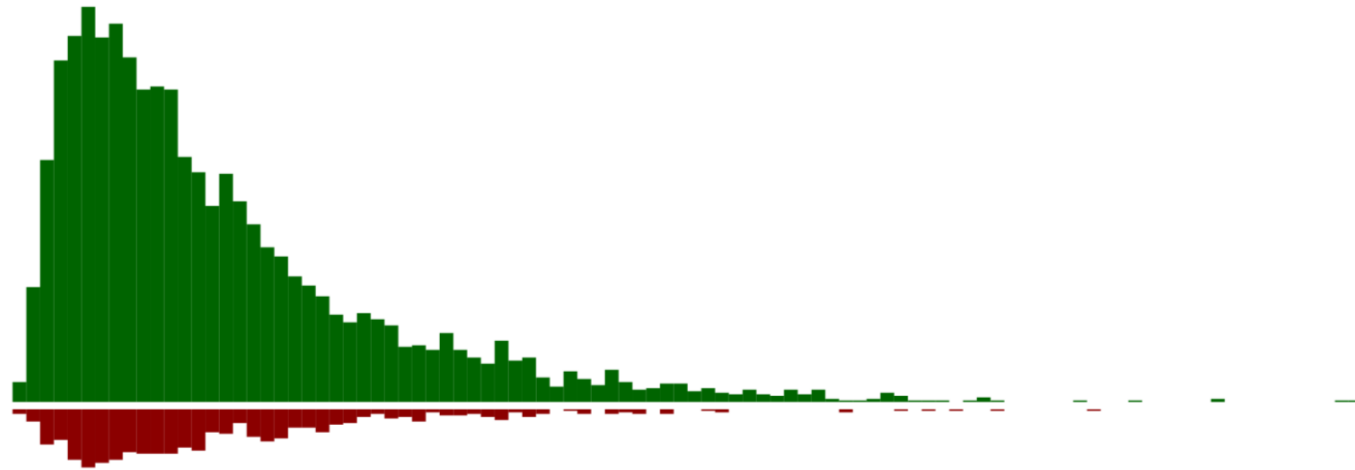
Drift rate: 2
Boundary separation: *1*
Non-decision time: 0.3
Bias: 0.5

Longer mean RT

Drift rate: 2
Boundary separation: *1.5*
Non-decision time: 0.3
Bias: 0.5

Fewer errors

Cognitive adaptations
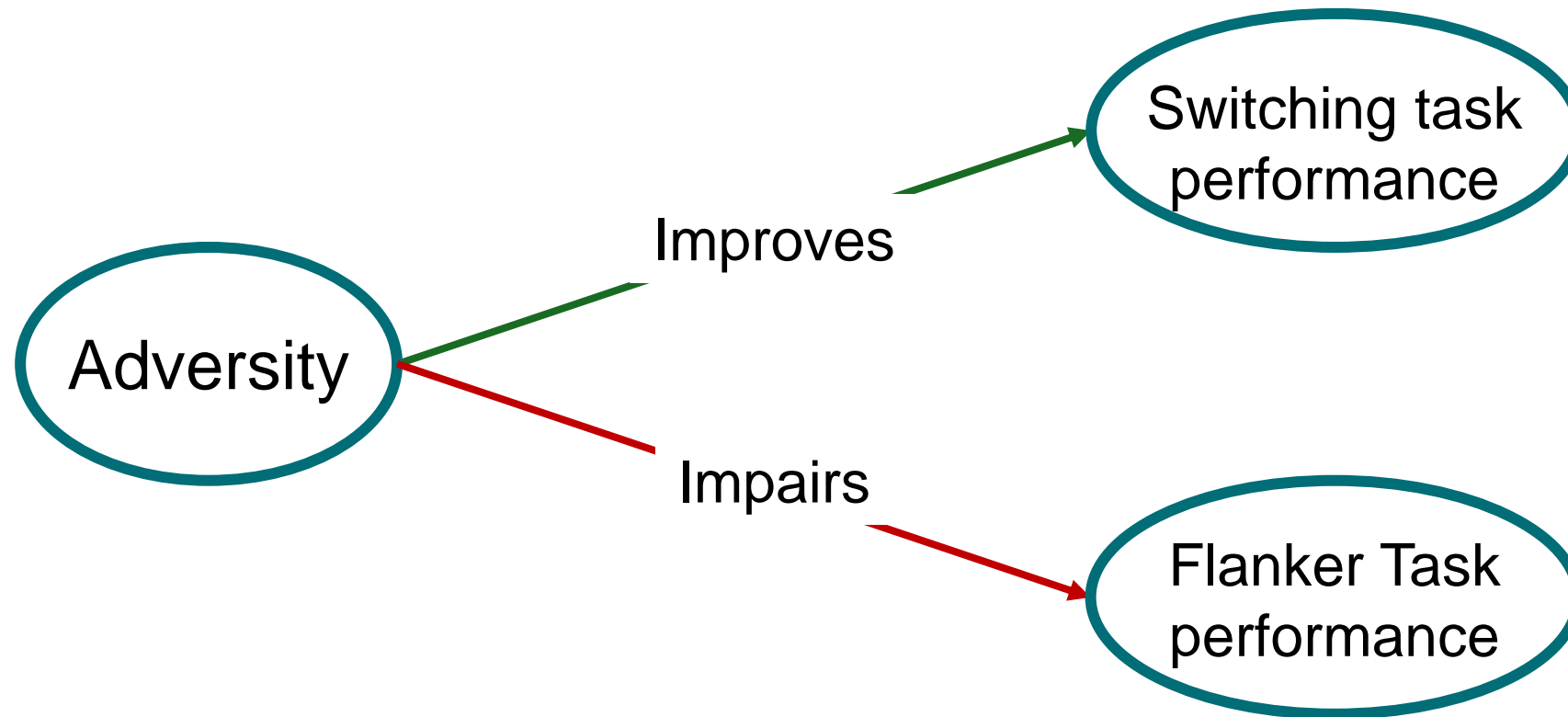
Task-general factors

Task-general factors

Common EF Drift rate

Basic processing speed Drift rate
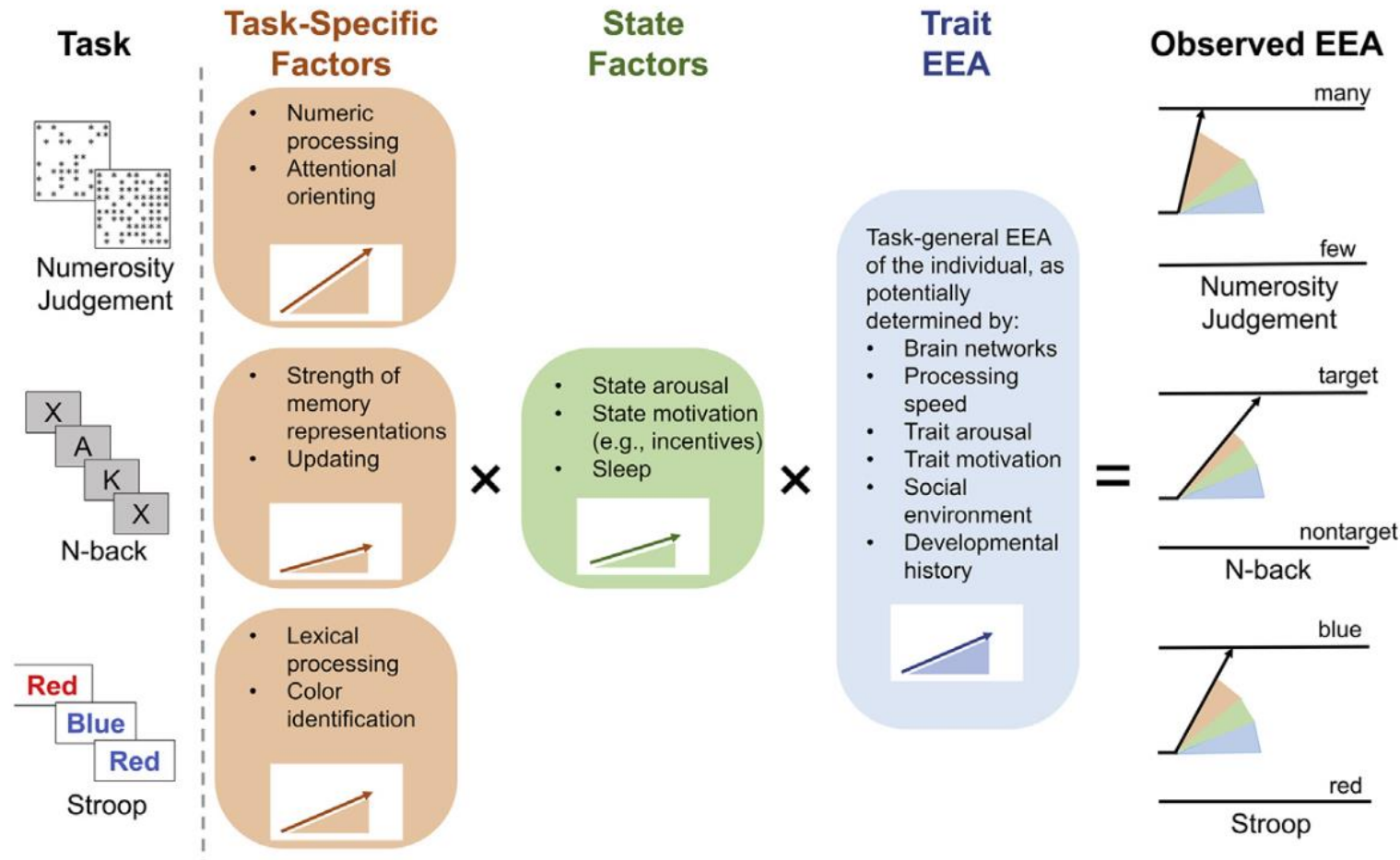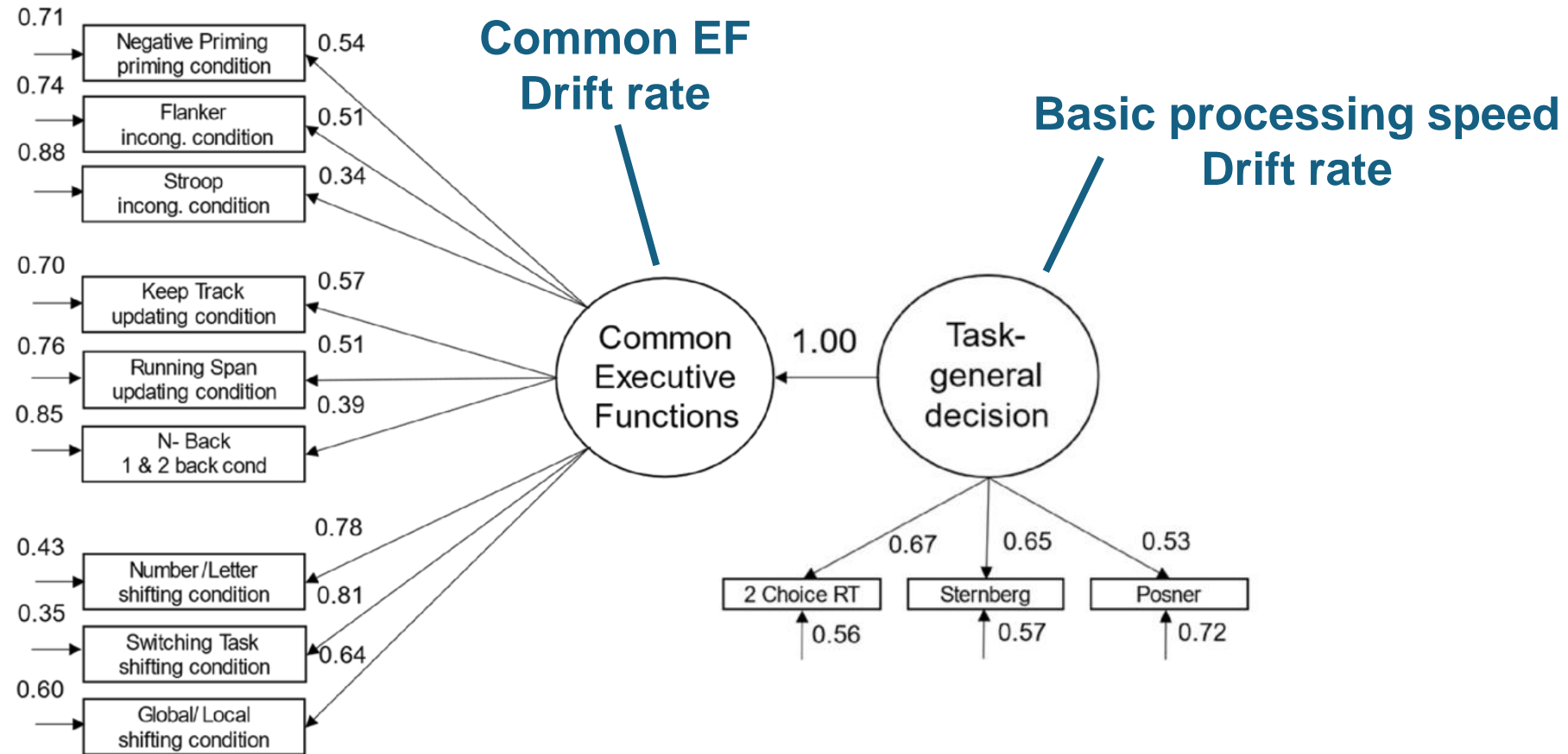
ABCD data

N = 10,563 US children aged 9-10

Household Threat (9 items)
"We fight a lot in our family"

Material deprivation (7 items)
"Needed food but couldn't afford to buy it or couldn't afford to go out to get it"

Processing Speed Task
Visual processing

Flanker Task
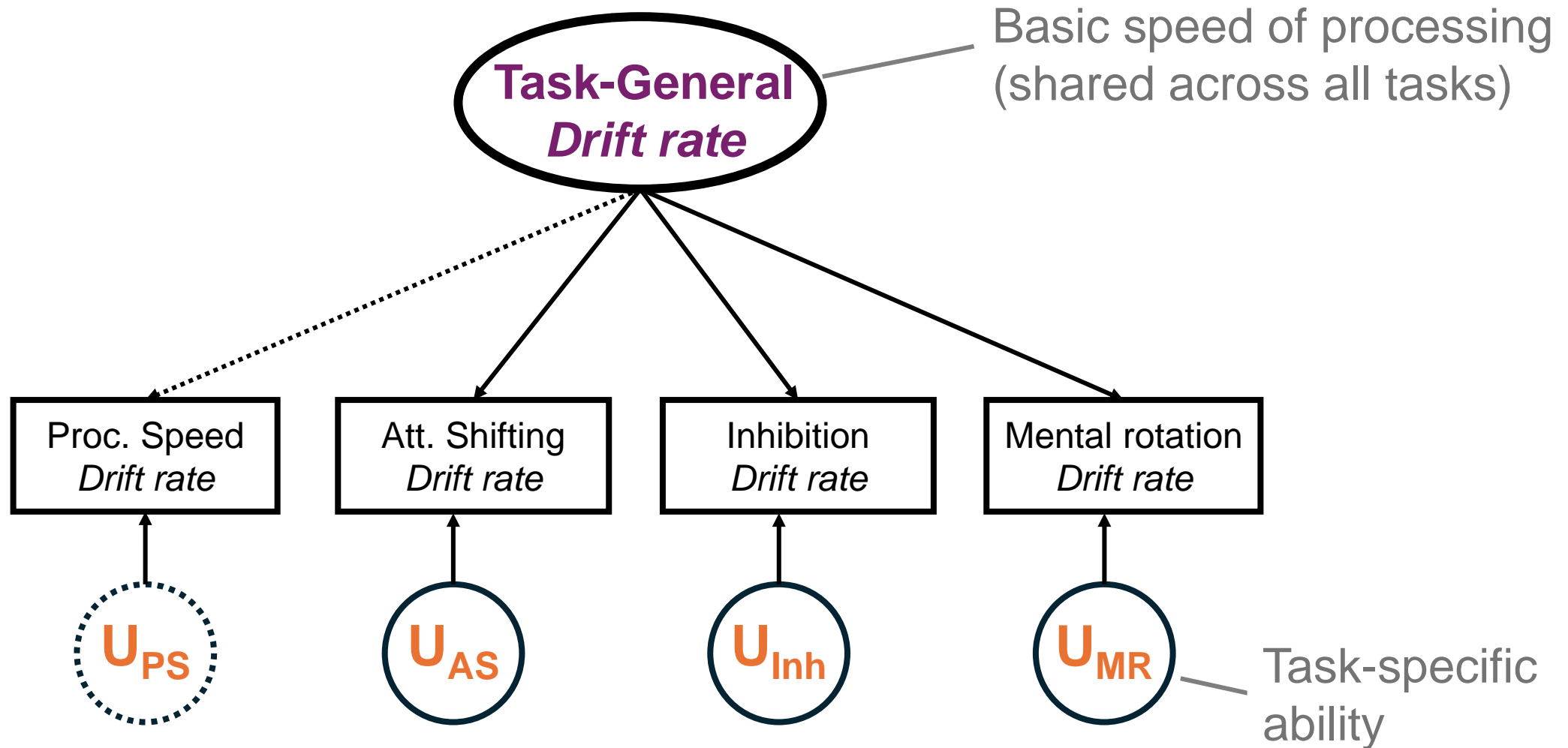Inhibition / cognitive control

Dimensional Change Card Sort Task
Attention Shifting

Mental Rotation Task
Visual-spatial processing

Structural Equation Modeling

Structural Equation Modeling
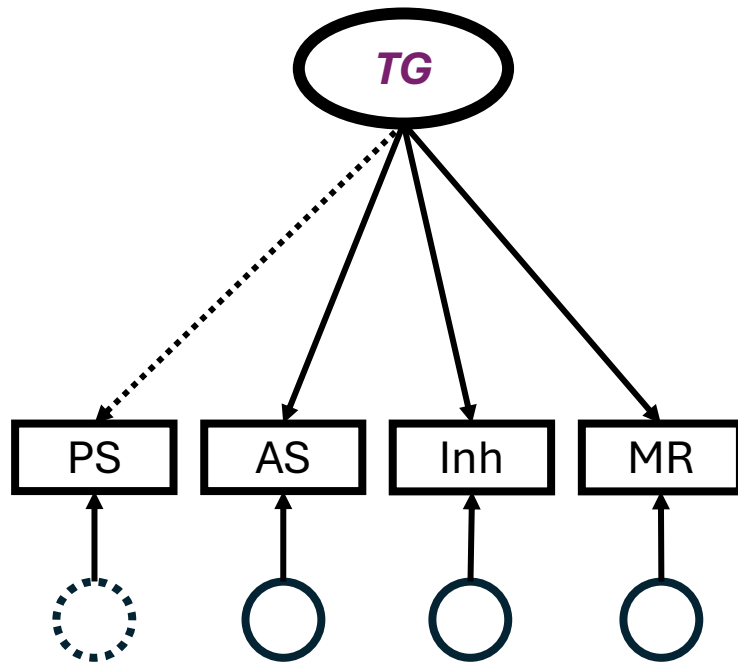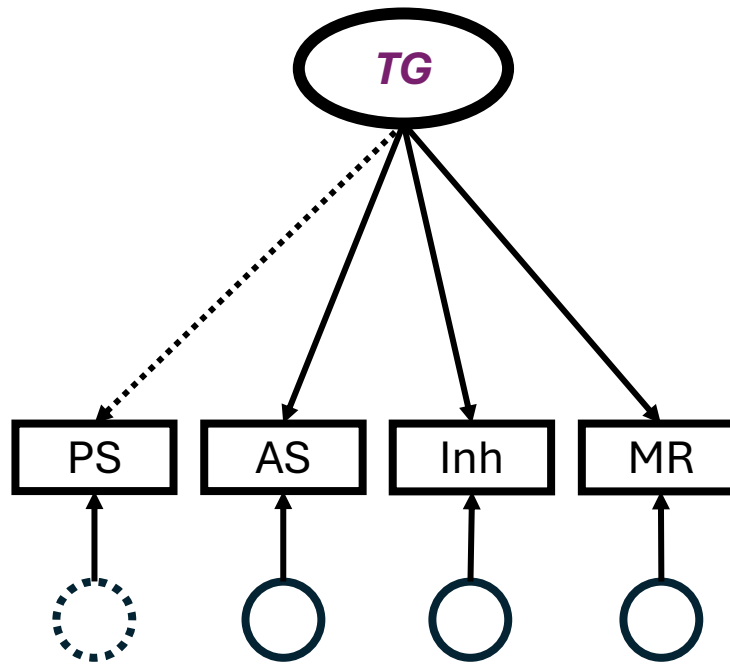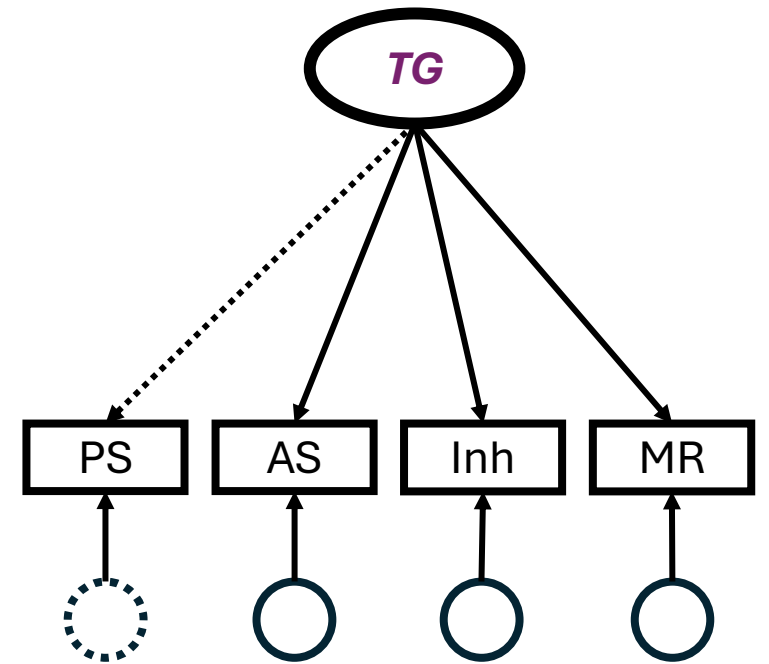
* Not shown: covariances between task-general factors and task-specific factors within tasks

Household threat   **Material deprivation**
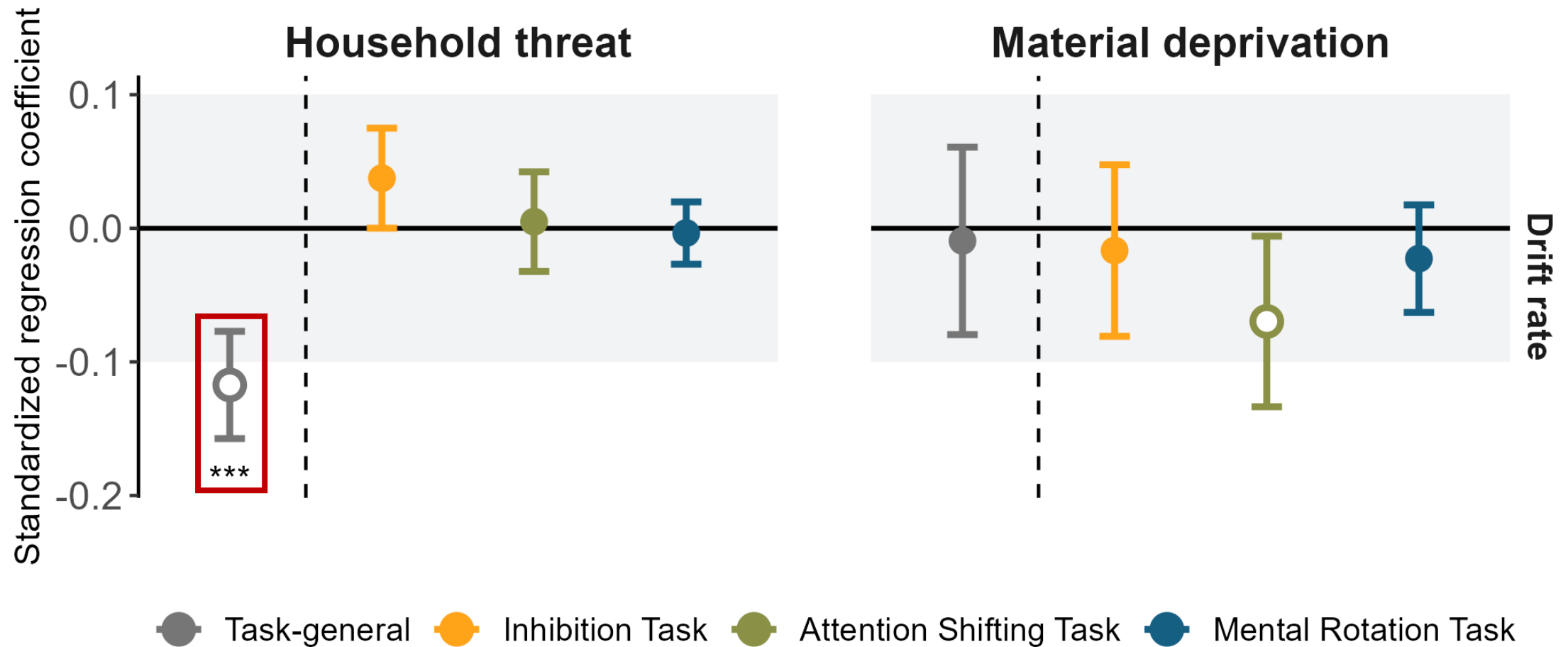
Lowered performance due to task-general speed of processing

Legend: Task-general, Inhibition Task, Attention Shifting Task, Mental Rotation Task
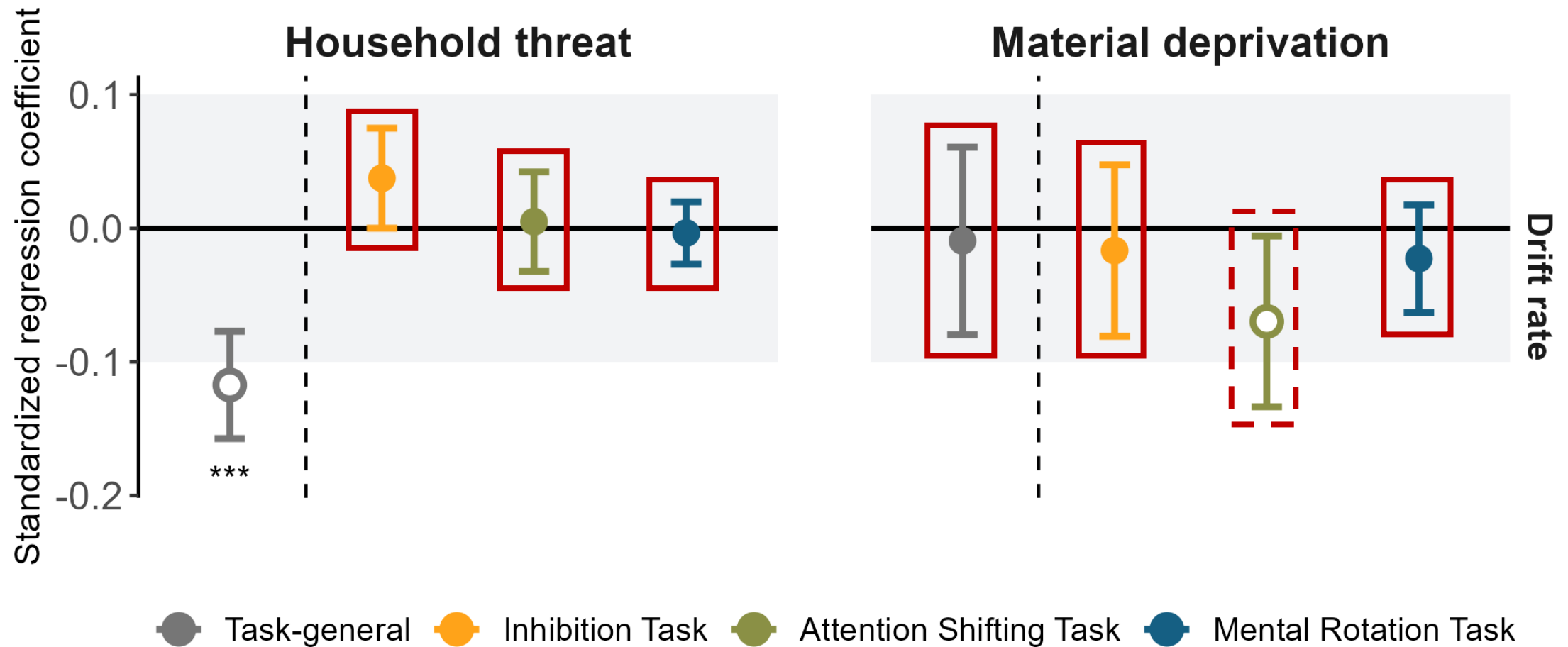
**Many instances of practical equivalence
for task-specific effects**
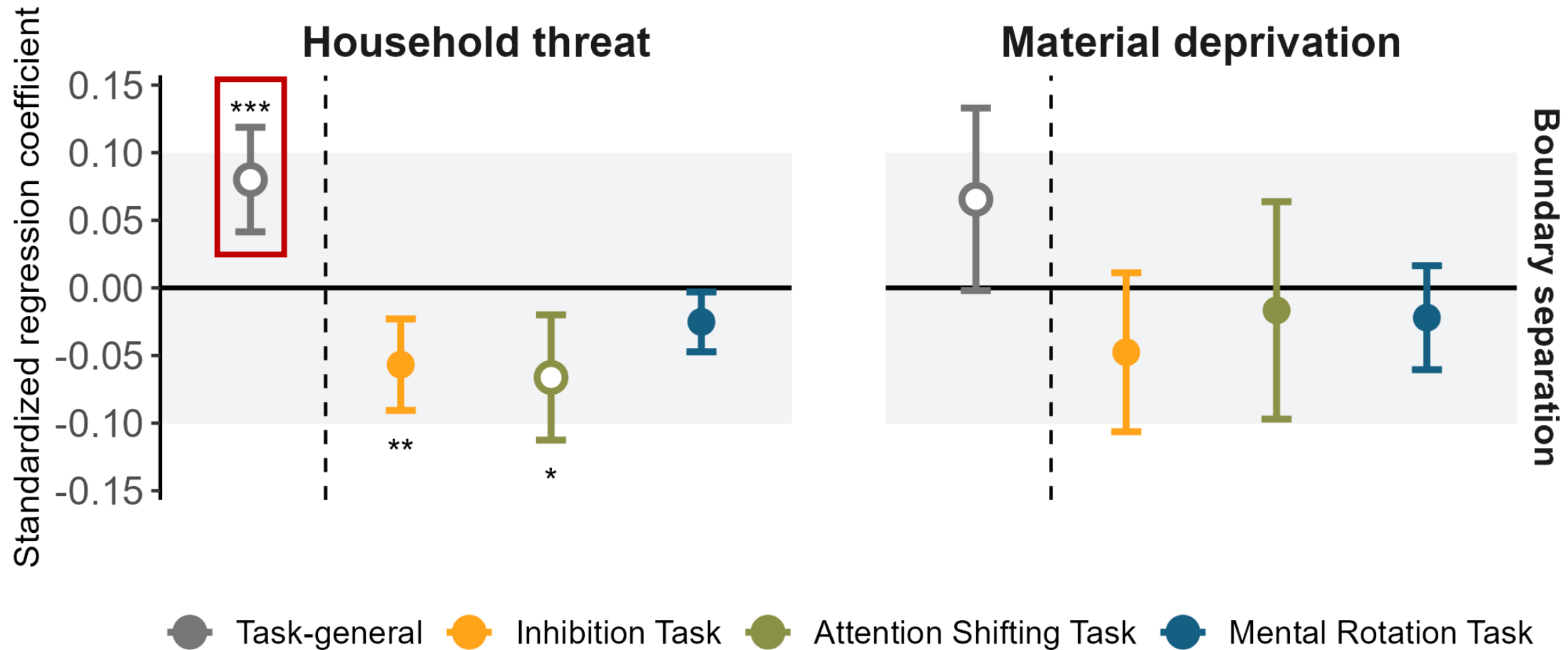
HIGHER task-general response caution,
But LOWER response caution for the shifting task

Conclusions

Mostly task-general, not task-specific effects

Support for deficit framework, but also strategy differences

Open question: what does the task-general drift rate factor represent, and why is it lowered in children from adverse conditions?

References

Ellis, B. J., Abrams, L., Masten, A., Sternberg, R., Tottenham, N., & Frankenhuis, W. (2022). Hidden talents in harsh environments. *Development and Psychopathology*, 95–113. https://doi.org/10.1017/S0954579420000887

Frankenhuis, W. E., Young, E. S., & Ellis, B. J. (2020). The Hidden Talents approach: Theoretical and methodological challenges. *Trends in Cognitive Sciences, 24*(7), 569–581. https://doi.org/10.1016/j.tics.2020.03.007

Lerche, V., Voss, A., & Nagler, M. (2017). How many trials are required for parameter estimation in diffusion modeling? A comparison of different optimization criteria. *Behavior Research Methods, 49*(2), 513–537. https://doi.org/10.3758/s13428-016-0740-2

Löffler, C., Frischkorn, G. T., Hagemann, D., Sadus, K., & Schubert, A.-L. (2024). The common factor of executive functions measures nothing but speed of information uptake. Psychological Research. https://doi.org/10.1007/s00426-023-01924-7

Ratcliff, R., & Childers, R. (2015). Individual Differences and Fitting Methods for the Two-Choice Diffusion Model of Decision Making. *Decision, 2*(4), 237-279. https://doi.org/10.1037/dec0000030

Ratcliff, R., & McKoon, G. (2008). The diffusion decision model: Theory and data for two-choice decision tasks. *Neural Computation, 20*(4), 873–922. https://doi.org/10.1162/neco.2008.12-06-420

Vermeent, S., Young E.S., DeJoseph, M.L., Schubert, A.-L., & Frankenhuis, W.E. (2024). Cognitive deficits and enhancements in youth from adverse conditions: An integrative assessment using Drift Diffusion Modeling in the ABCD study. *Developmental Science, 27*(4), e13478.

Weigard, A., & Sripada, C. (2021). Task-General Efficiency of Evidence Accumulation as a Computationally Defined Neurocognitive Trait: Implications for Clinical Neuroscience. *Biological Psychiatry Global Open Science, 1*(1), 5–15. https://doi.org/10.1016/j.bpsgos.2021.02.001

Thank you!

Collaborators:

Ethan Young   Meriah DeJoseph   Anna-Lena Schubert   Willem Frankenhuis