

Origins of the concepts cause, cost, and goal in prereaching infants

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Before their first birthdays, infants become sensitive to other people's:



Motor experience plays a causal role in acquiring this knowledge [5-7], but **what role?**

Hypothesis: Infants learn about the **causal structure** of specific actions (e.g. grasping an object can cause it to lift) from motor experience

Empirical Prediction: If this is true, then we should be able to give them this information **visually**, without intervening on their motor experience

Methods: 5 experiments, N=152 3-month-old infants (range 91-122 days)

Exp	N	Goal	Hand	Action over barrier	Action on contact	Stimuli
1	20	pick up	glove	yes	yes	H1, T1
2	20		bare	yes	yes	H2, T2
3	20	state change	glove	yes	yes	H3, T3
4	20		glove	no	yes	H4, T3
5*	26		glove	yes	no	H5, T4
	26		glove	yes	yes	H3, T3
			glove	yes	no	H5, T4

*pre-registered direct replication

Analysis: Linear mixed effects models, random intercepts for participants and experiments

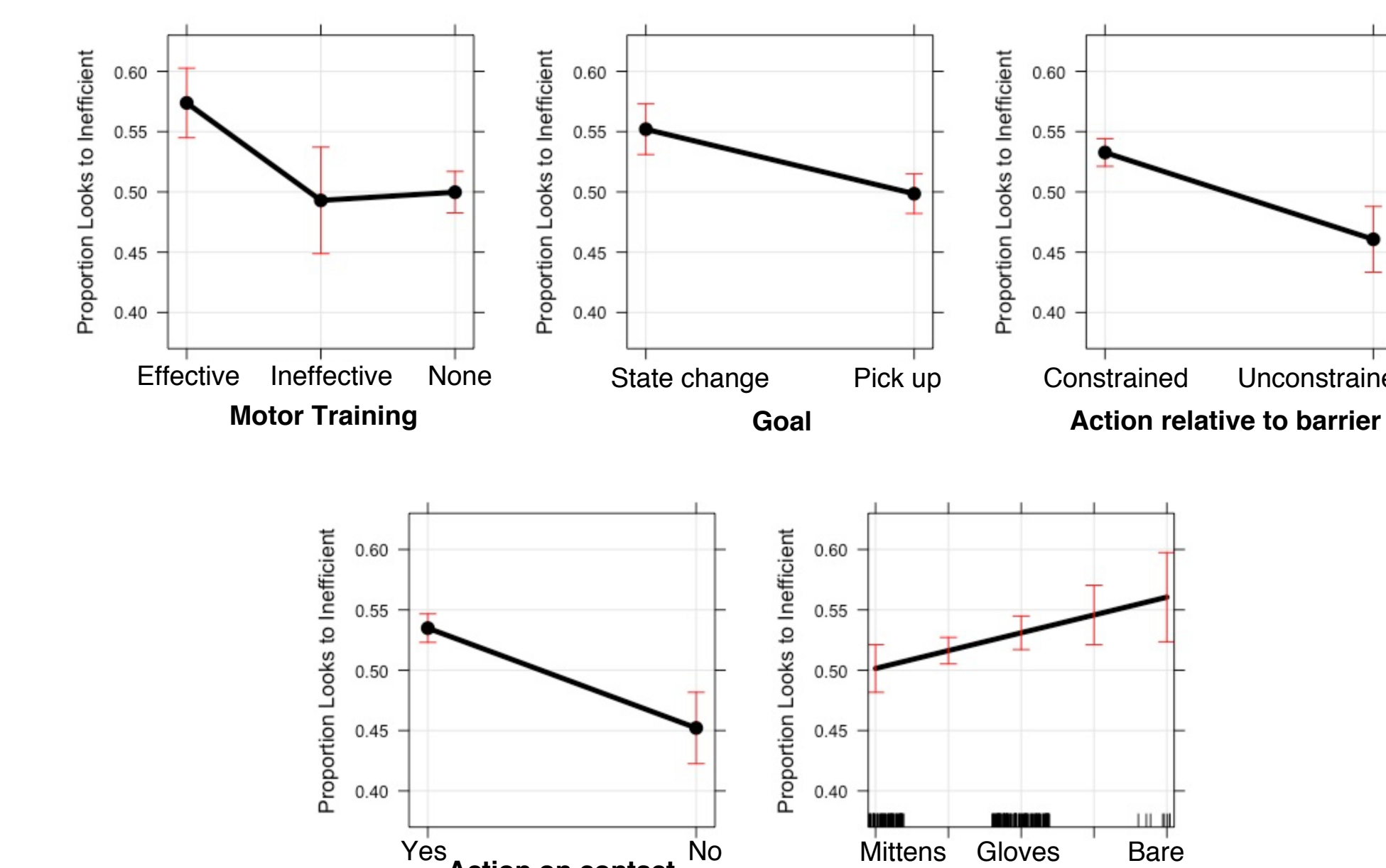
DV: Average looking time in log seconds towards the inefficient and efficient test event

Three-month-old infants appreciate that other people make things happen.

This ability helps them see reaching actions as physically constrained.

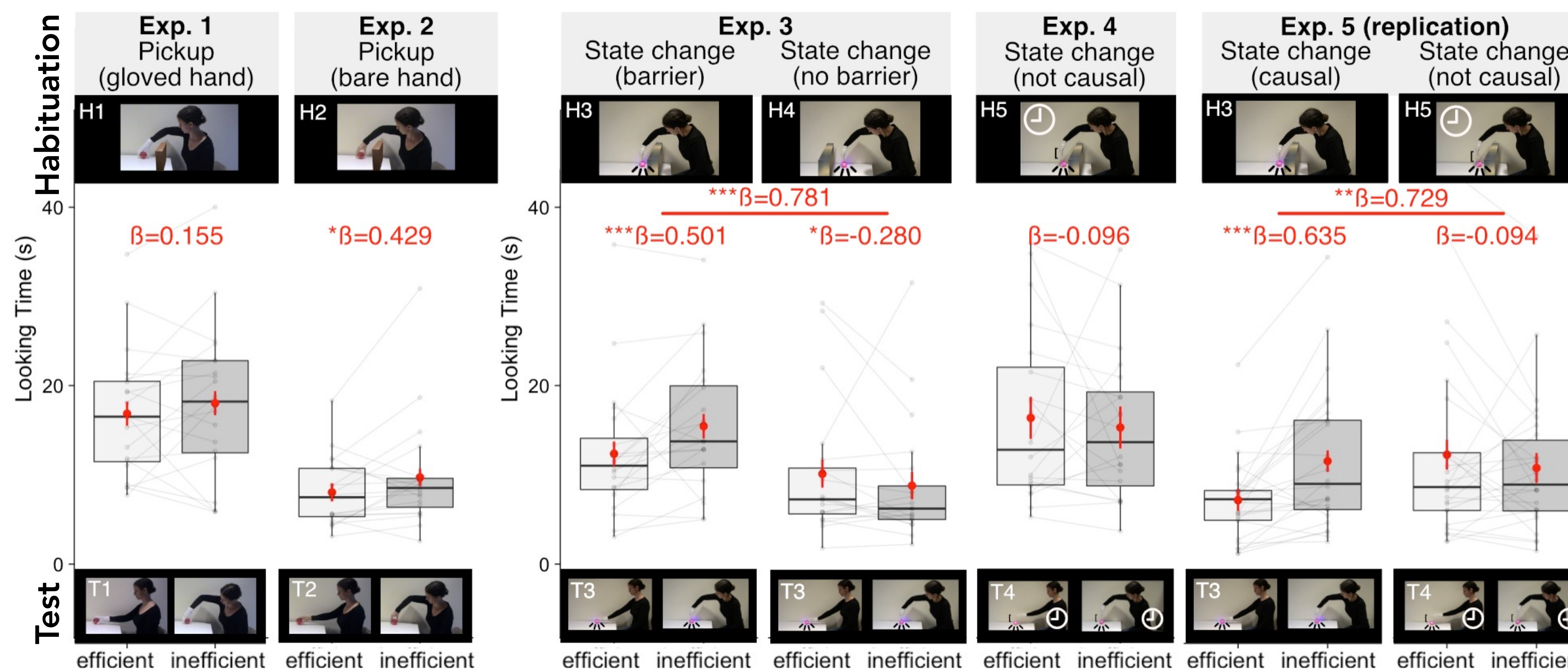


Meta-analytic results over the current research and Skerry et al. (2013) [7]:



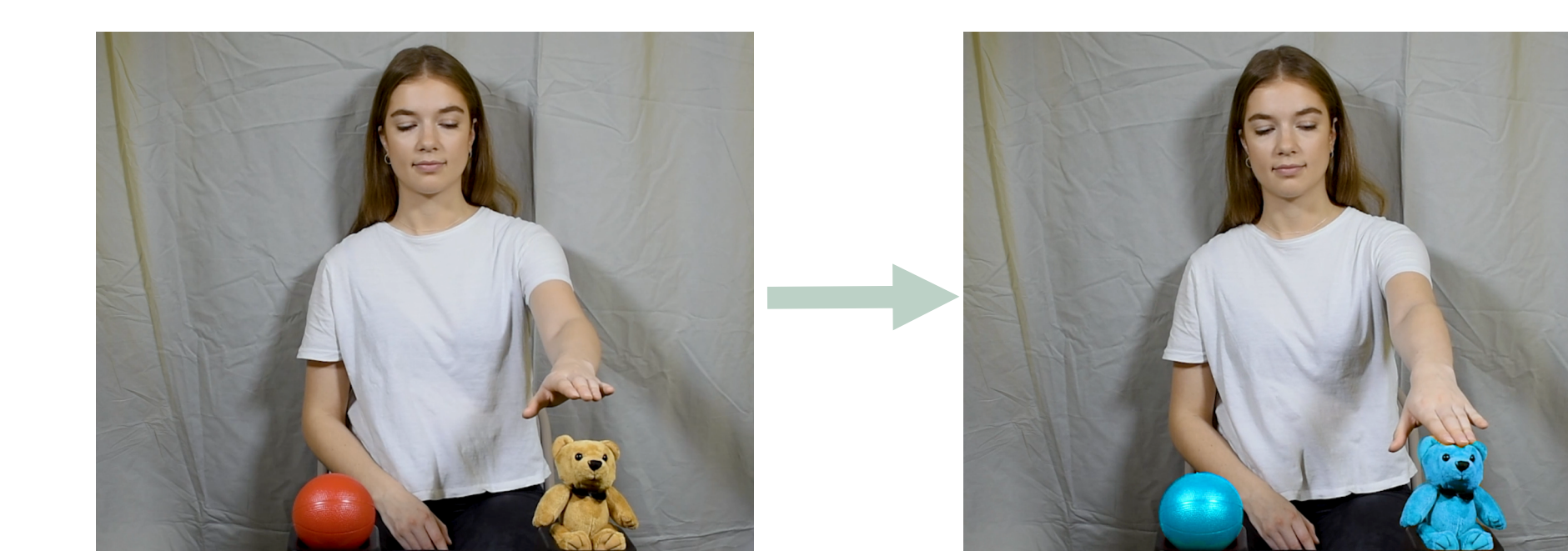
Take-Home Messages:

1. Infants see actions they cannot yet perform as *goal-directed*, *causal*, and *physically constrained*
2. Motor experience is not the only path to this knowledge
3. Over development, infants face the hard learning problem of figuring out which objects are goals, which actions are hard and easy, and how acting causes people to achieve their goals



Clock indicates 0.5 delay, and bracket indicates 50-pixel gap. β indicates effect sizes in standard deviations. Pairs of connected points indicate data from a single participant. Means and within-participant 95% CIs. $P^* < .05$, $** < .01$, $*** < .001$, two-tailed, except for the causal condition in Experiment 5, which was pre-registered as a one-tailed test.

Main Finding: Untrained prereaching infants looked longer at **inefficient** than **efficient** reaching actions when these actions caused a simple, **spatiotemporally continuous state change** in an object.



Current and Future Directions:

- Investigating early concepts of
- *goal*: object identity vs location [8]?
 - *cost*: continuous [9]?
 - *cause*: agentic vs physical [10]?

Open data, code, and materials:



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