Two-year-olds can reason about the temporal structure of their performance

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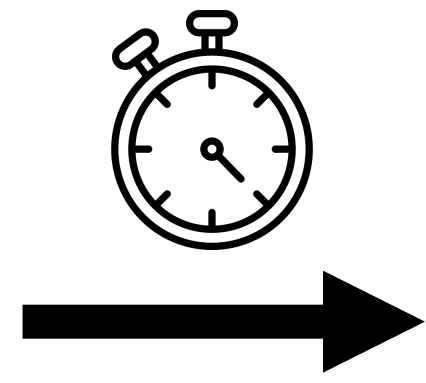Department of Psychology, Stanford University

Introduction

How do we know we are making progress at a task over time?

Improvement in skill or competence is not directly observable, but it is often reflected in *temporal changes* in performance outcomes!
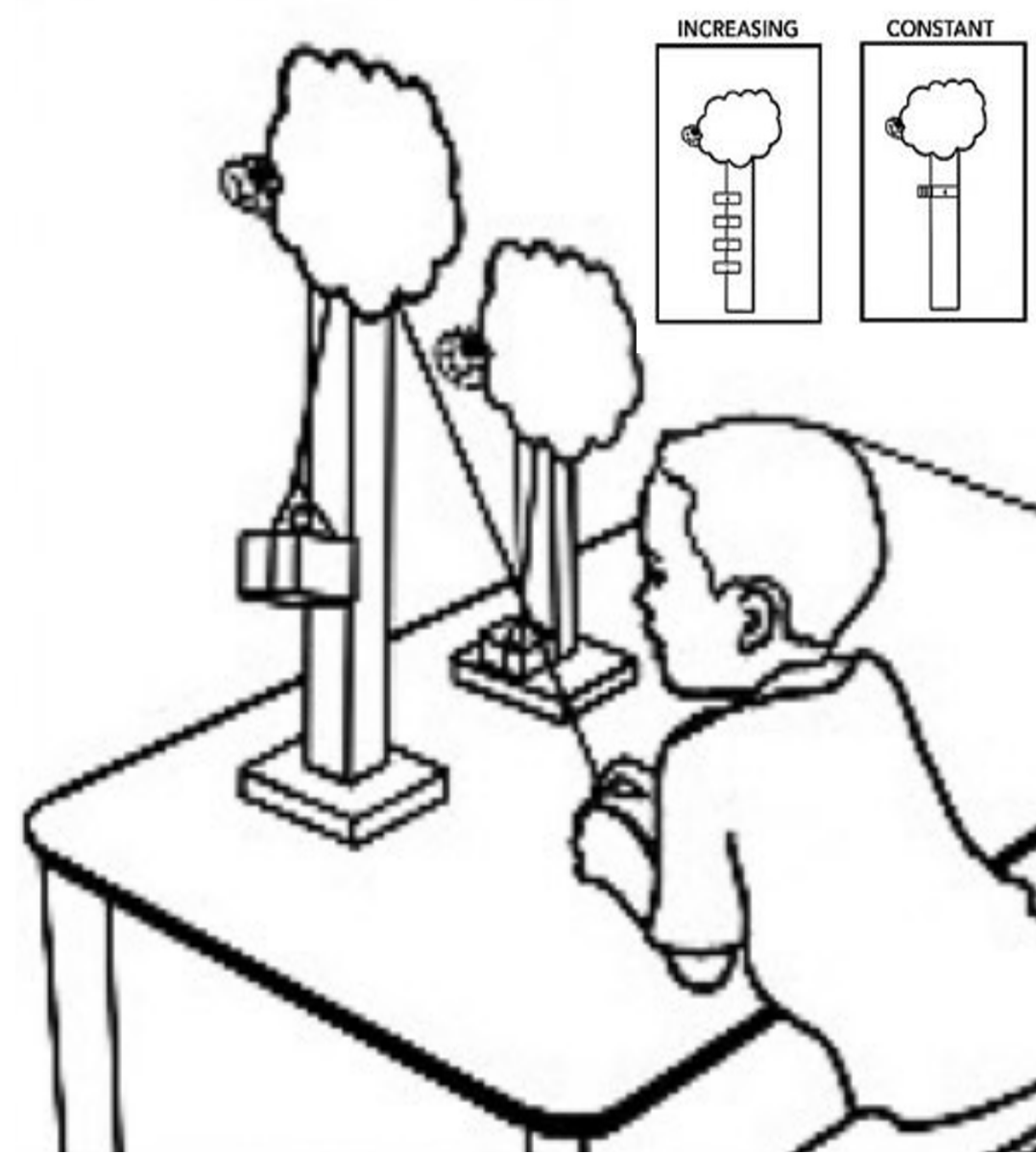
How does this ability develop early in life?

Figure from Leonard et al., (2023)

- Older kids (> 4 y/o) track[1] and predict[2] performance over time
- *Our hypothesis: ability to reason about improvement may emerge earlier!*
- Even toddlers represent performance outcomes like failure and success,[3,4,5] track statistical patterns in temporal signals,[6] and reason about the likely cause of failure given covariation data[7]

Can 2-year-old children reason about the temporal structure of their performance?

Methods

1. Control Toy Phase
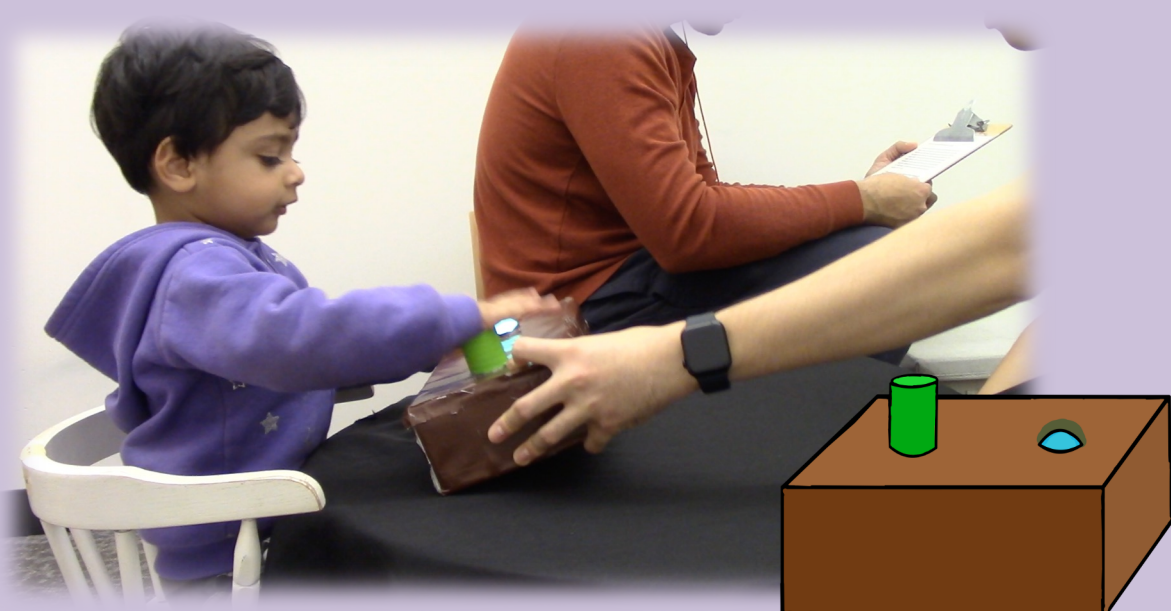
Child succeeds 3x on the *Control Toy*
(✔️ ✔️ ✔️)

2. Test Toy Phase

Child attempts *Test Toy* 6x;
✔️ & ❌ frequency is matched but temporal structure varies by condition

Improvement Condition:
❌ ❌ ❌ | ✔️ ✔️ ✔️
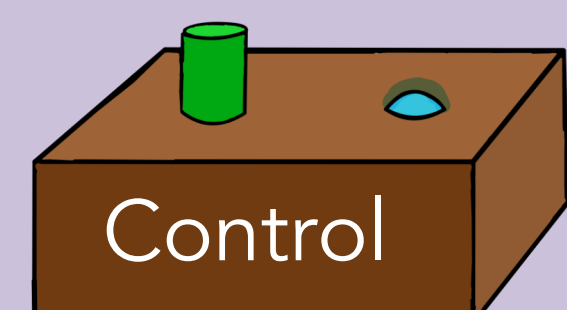
Stochastic Condition:
✔️ ✔️ ❌ | ❌ ✔️ ❌

* experimenter re-taught the toy after the child's 3rd attempt (denoted by "|")
** to show that the toys were not faulty, experimenter always succeeded during demonstration (2x on Control, 3x on Test)
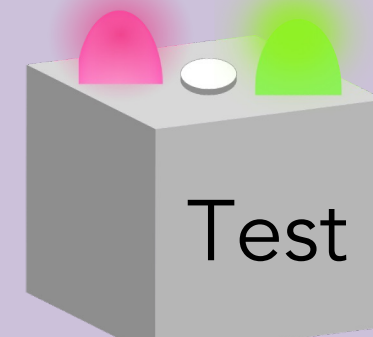
3. Confirmation + Decision Phases

Child succeeds 1x (✔️) on each toy, then selects one to show caregiver:

[Control] OR [Test]

**Key measure: which toy do children choose to show their caregiver?**

If children are motivated to choose a toy they *think* they can activate, more children will choose the Test Toy over the Control Toy in the Improvement than Stochastic condition. Pilot testing (*n* = 16) provided initial evidence for this hypothesis.

Participants

n = 60 two-year-olds (M_{age} = 2.52 years, SD = .31)

Note: Participants were recruited according to a Bayesian sequential sampling procedure.[8] We stopped testing due to reaching our preregistered cutoff criteria (*BF* > 10).

Results

n = 20/30   *n* = 9/30
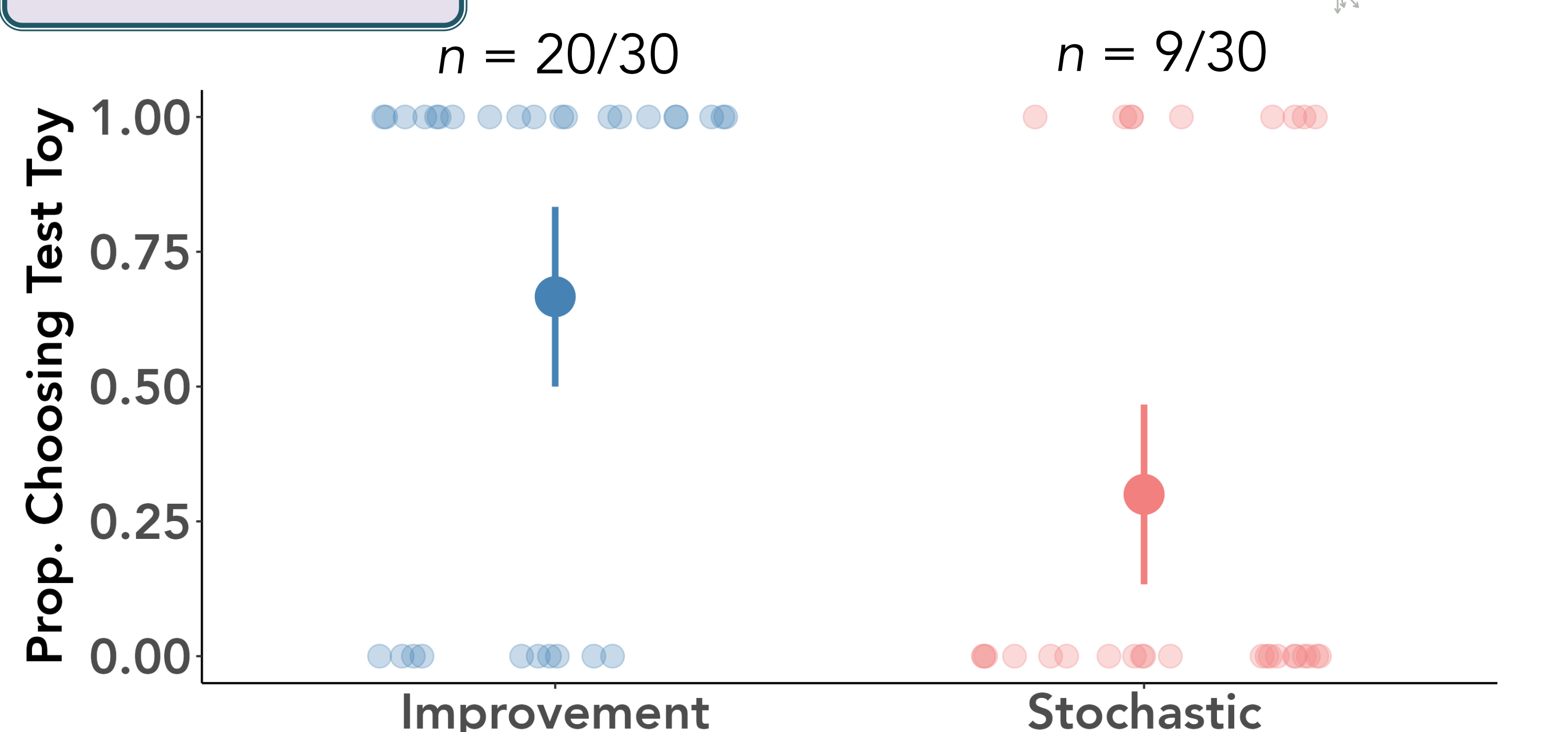
Children were more likely to choose the *Test Toy* in the Improvement condition (failing then succeeding) vs. the Stochastic condition (random performance; *BF* = 12.02, Fisher's Exact *p* = .009)

Ongoing Expt. 2

How do representations of progress influence subsequent response on novel tasks?

Children experience either Improvement or Stochastic performance on Toy 1...

...then persist on an inert, novel toy!
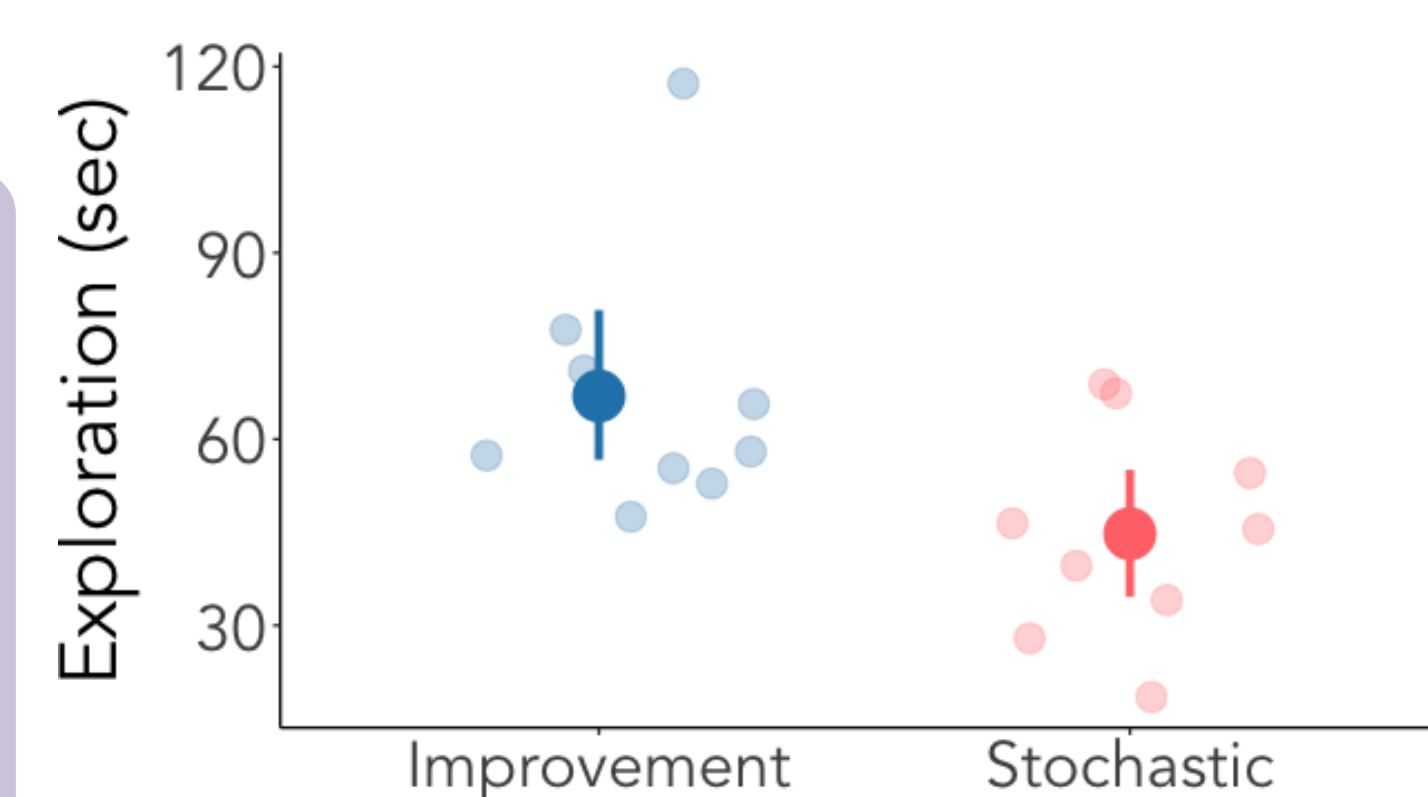
Preliminary findings (*n* = 18): past improvement promotes greater persistence, even on novel tasks!

Discussion

Key Takeaway: Toddlers are sensitive to the **temporal structure** of their past successes and failures!

This ability may serve as an important foundation for learning and improvement throughout childhood and beyond!

Ask me about these other future directions!

- How do these representations *generalize* to other tasks or learning signals (e.g., motor learning)?
- The current study motivated children with a presentational goal: would a learning goal *flip the pattern of performance* across conditions?
- How do children *conceptualize their experiences* as "success" or "failure", or even *create ad-hoc definitions of success* on a novel task?

References 1. Leonard et al. (2023), *Dev Psych*. 2. Zhang, Carrillo, & Leonard (2023), *CogSci Proceedings*. 3. Gopnik & Meltzoff (1986), *Child Development*. 4. Hamlin, Hallinan, & Woodward (2008), *Dev Sci*. 5. Brandone & Wellman (2009), *Psych Science*. 6. Saffran et al., (1997), *Science*. 7. Gweon & Schulz (2011), *Science*. 8. Mani et al. (2020), *Dev Sci*.

Reach out!

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