# Model-Based Characterization of Forgetting in Children and Across the Lifespan

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Research Coordinator
CCDL, University of Washington

# Outline

**MemoryLab**

**Dinosaur Task**

**LBA Analysis**

# Measuring memory in Children

- Understand the development of memory
  - Understand memory over the lifespan
  - Gap of understanding memory in children

- Using a **model-based approach**: MemoryLab!

# MemoryLab

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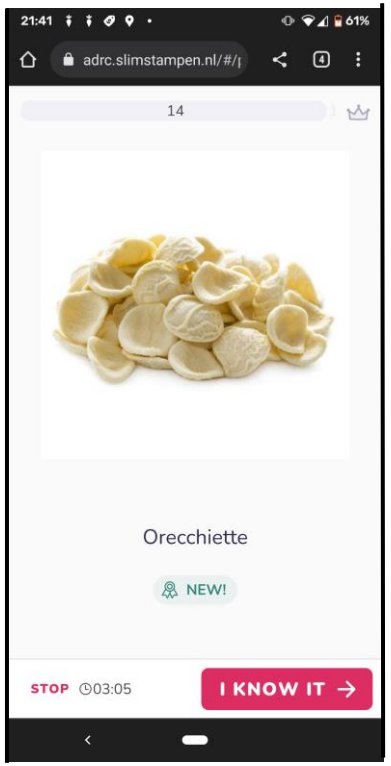
# MemoryLab Task


New Pair


Test Probe




New Pair

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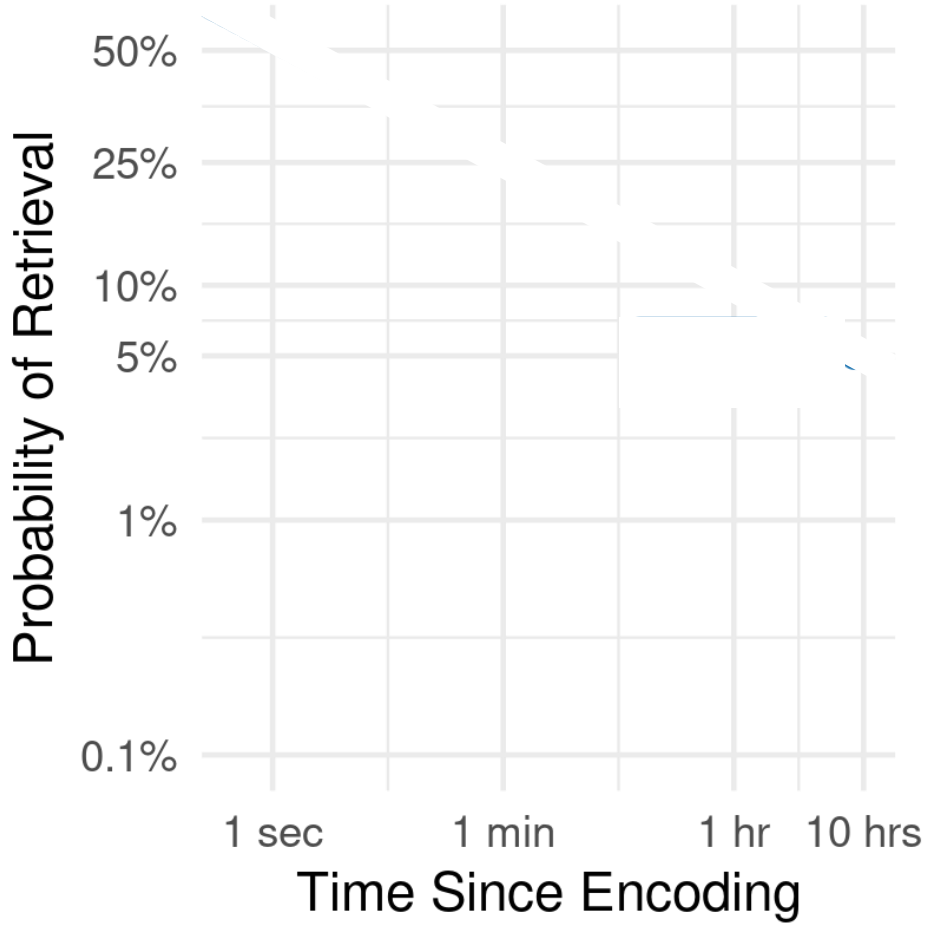
# Understanding Speed of Forgetting

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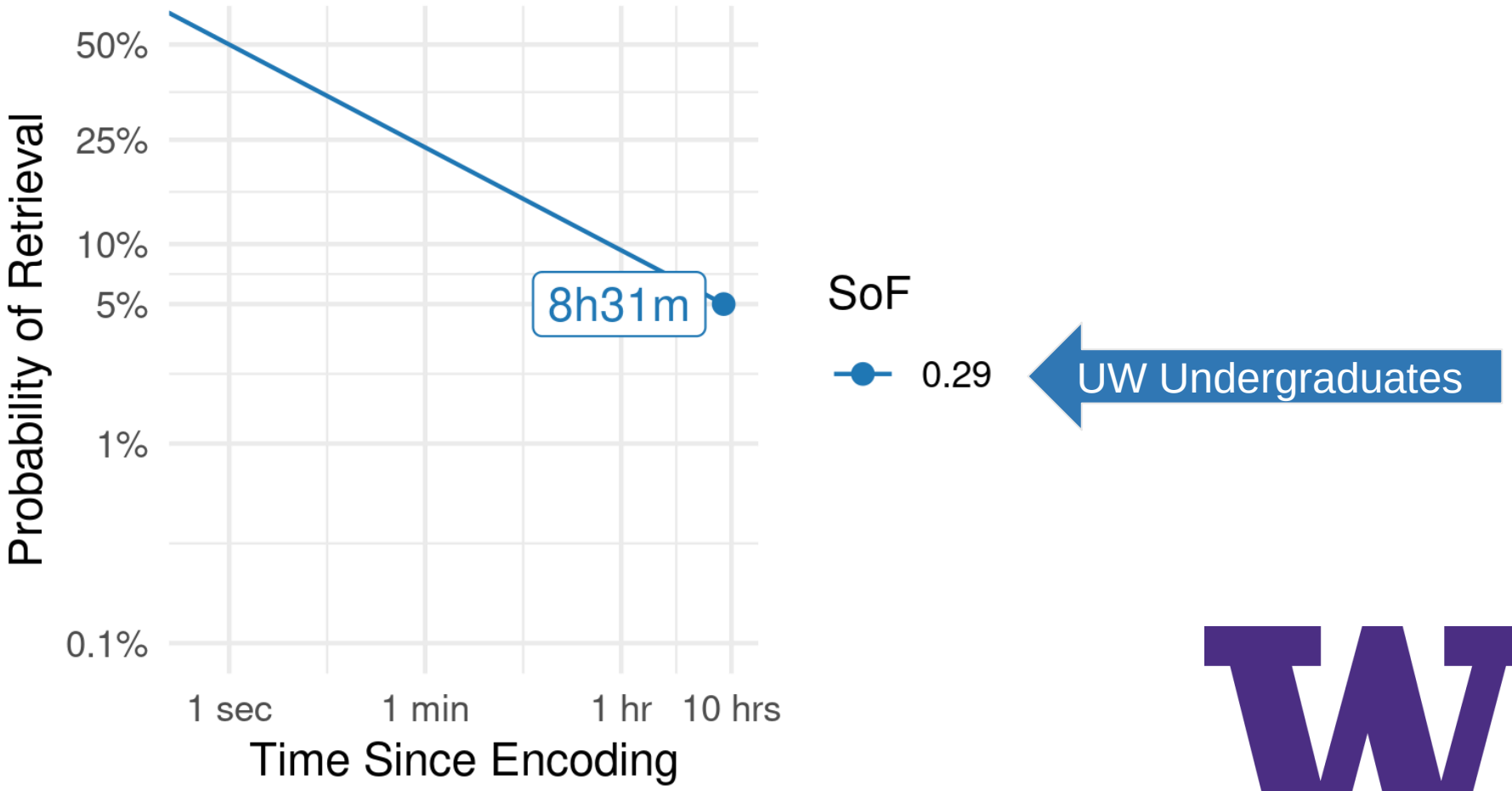


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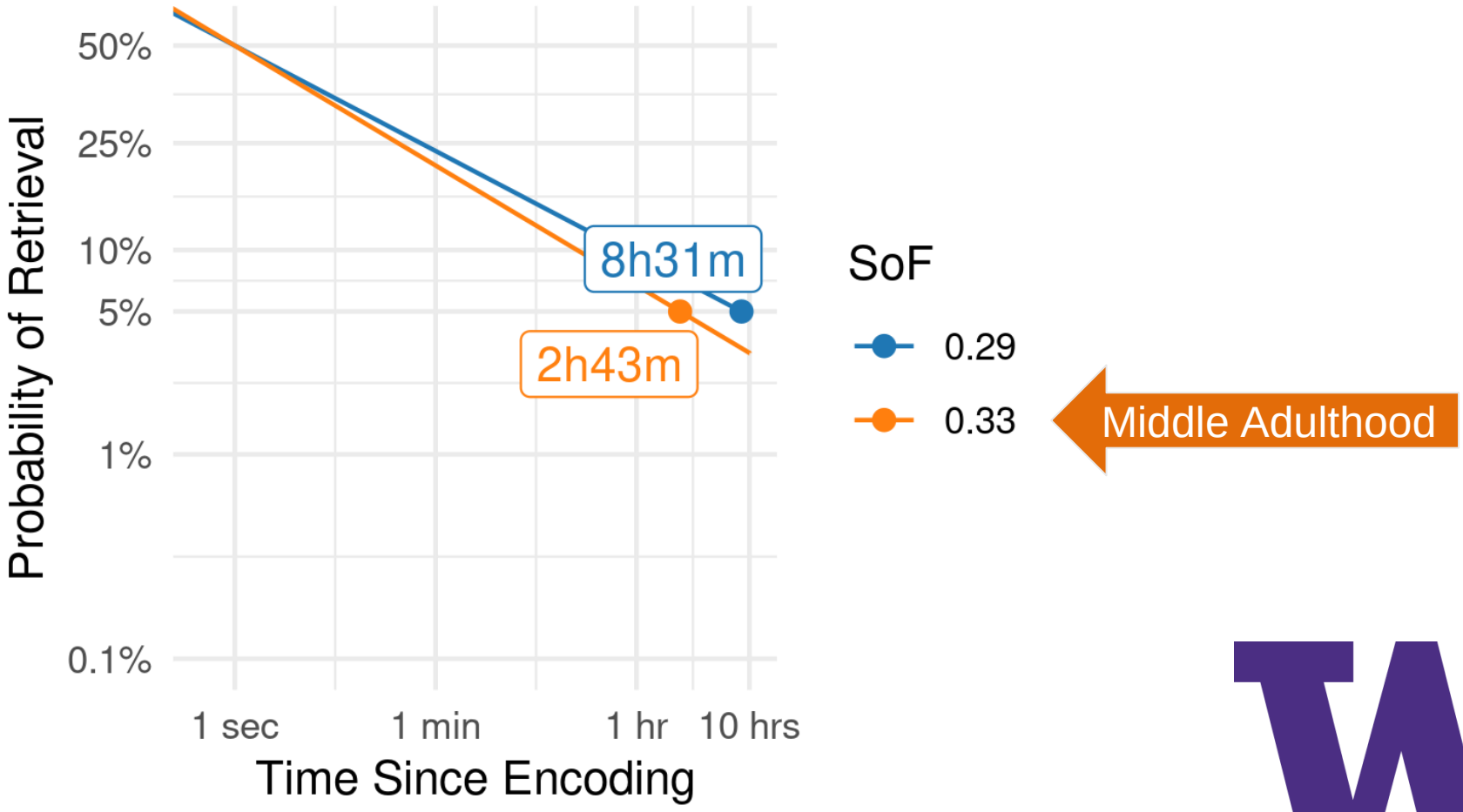
# Understanding Speed of Forgetting

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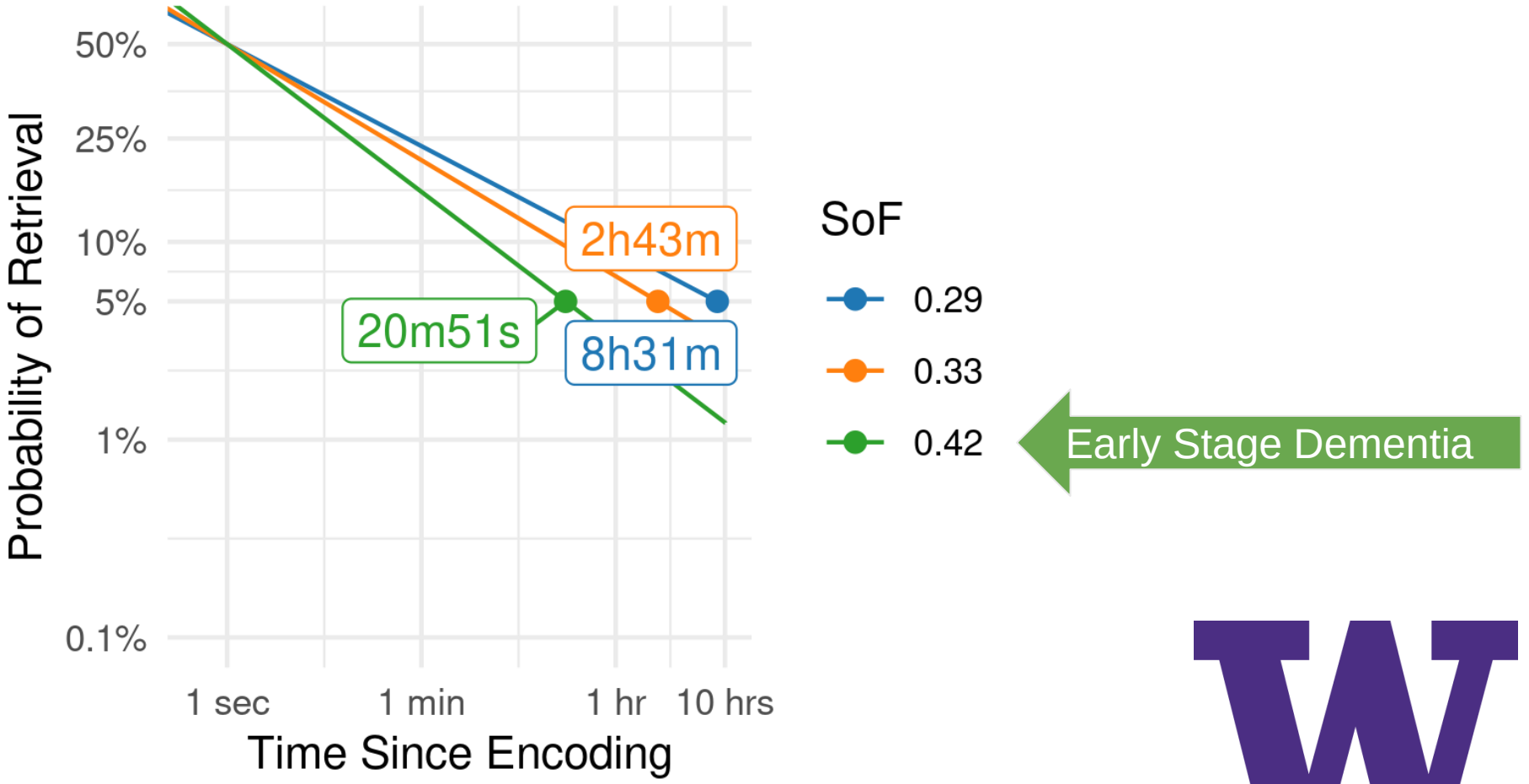
# Understanding Speed of Forgetting

**Challenging to follow a *Law & Order* episode**

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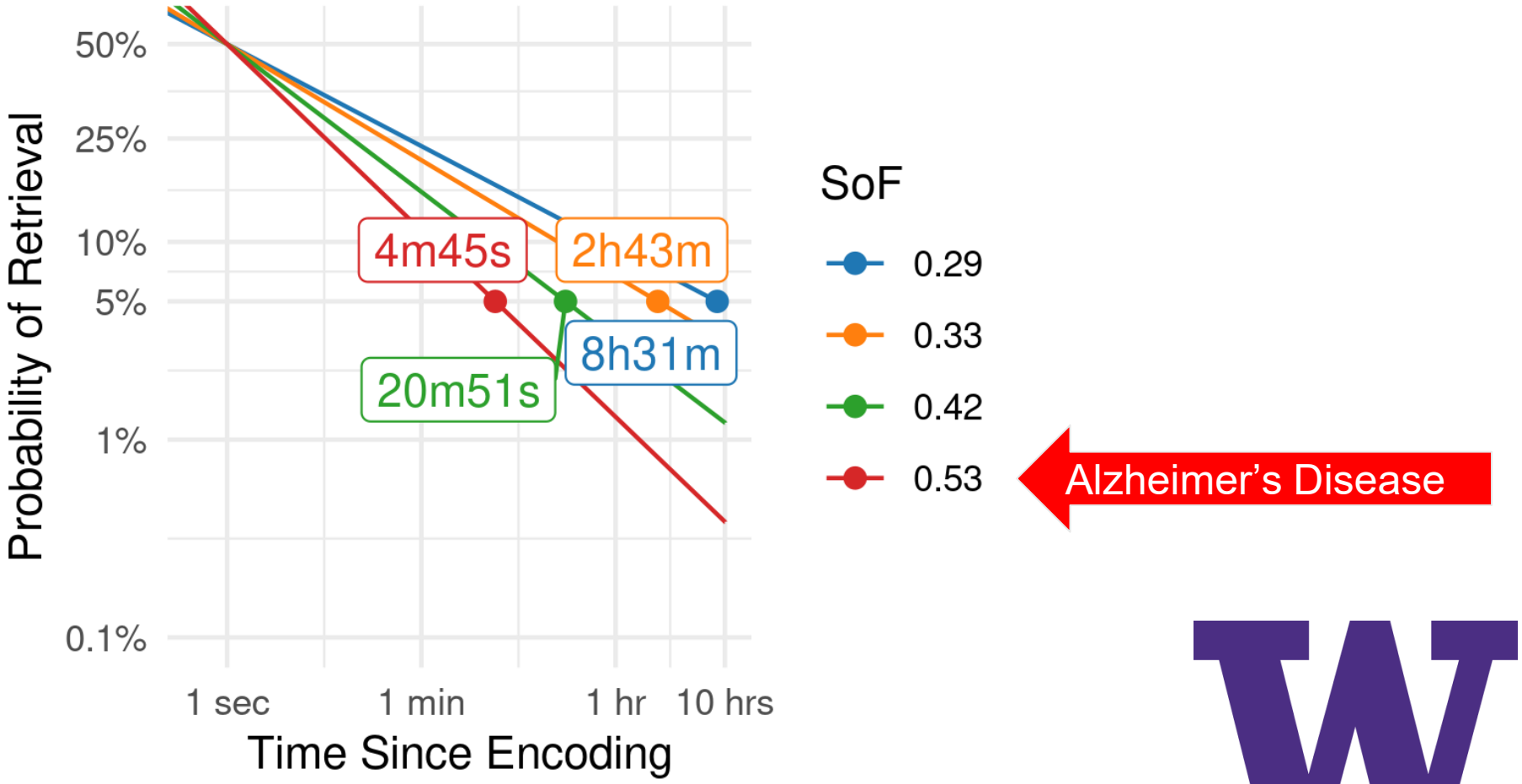
# Understanding Speed of Forgetting

**Challengine to follow a *Law & Order* episode**

**Challenging to follow a conversation**

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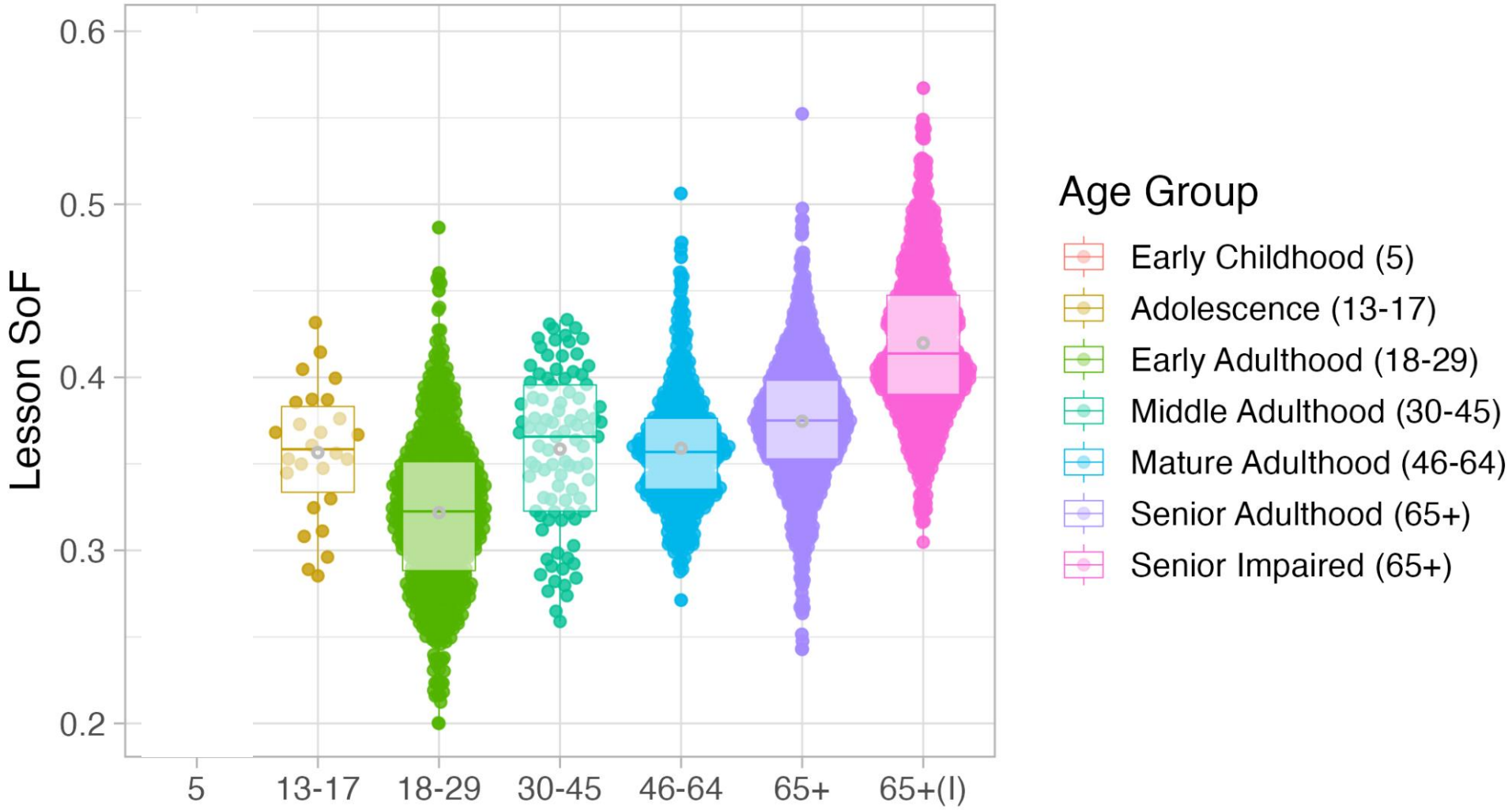
# Speed of Forgetting Across Age

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# Dinosaur Task

(Meet **BARNEY**)

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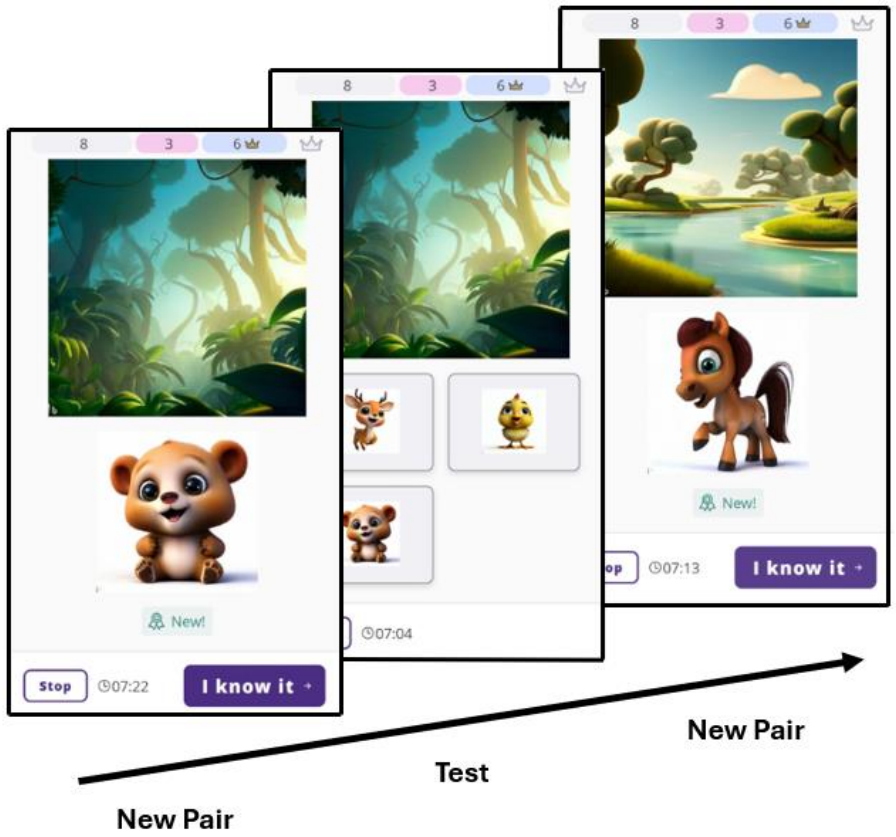
# Goals of the Study




- Understand Children's memory development
- Compare memory from childhood to senior stages of life

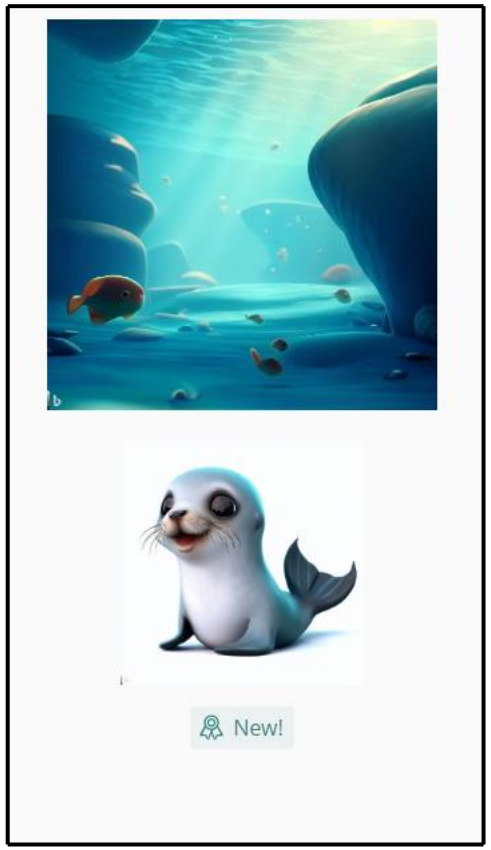
Create a MemoryLab test suitable for Children

# MemoryLab for children

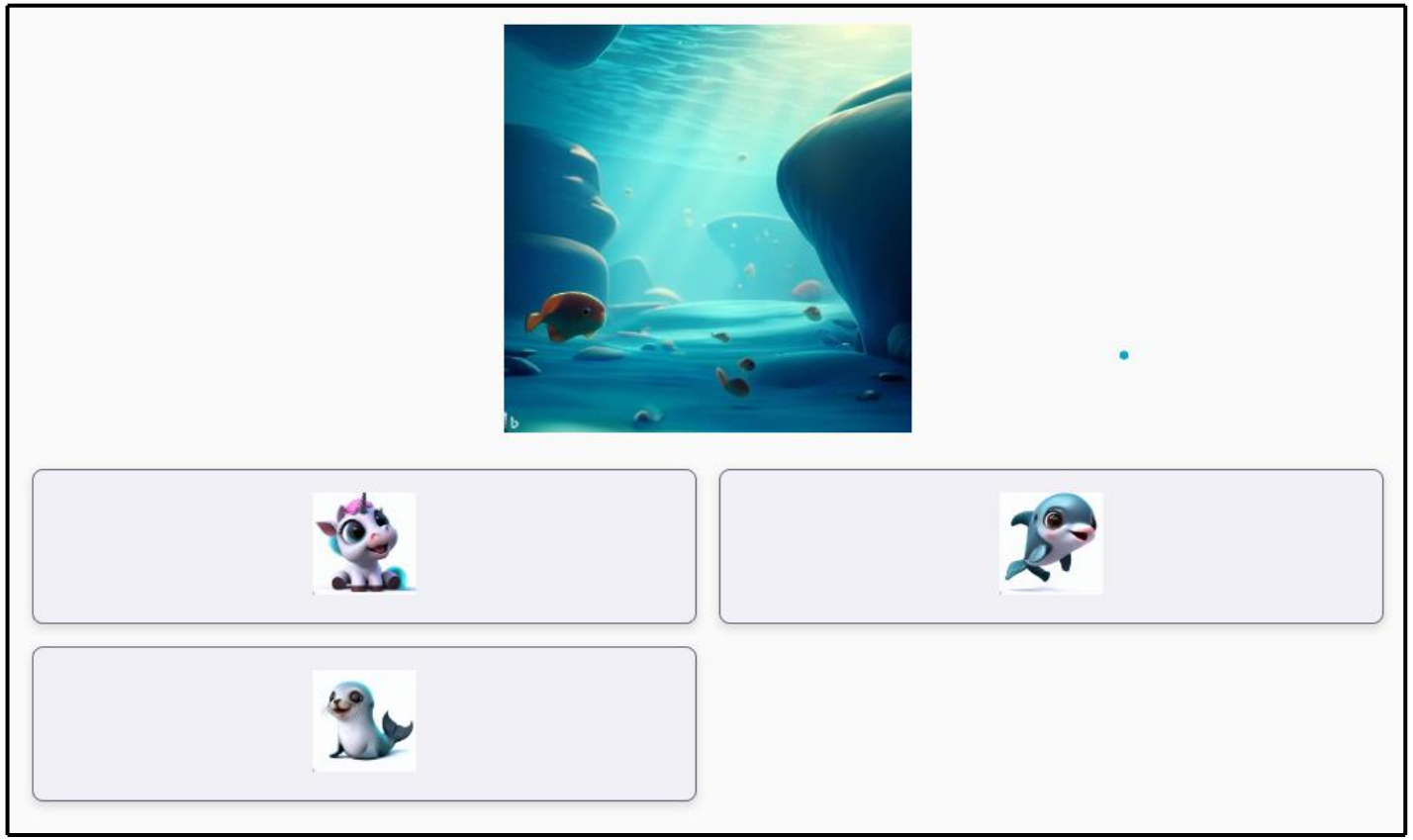
- Participants  are 5 years old
  - can’t read yet!
  - No text, image-image recognition!

- How to keep all of the participants interested?
  - Turn the task into more of a game
  - Diversify stimuli (bunny, dinosaur, unicorn …)

# Dinosaur Task in action

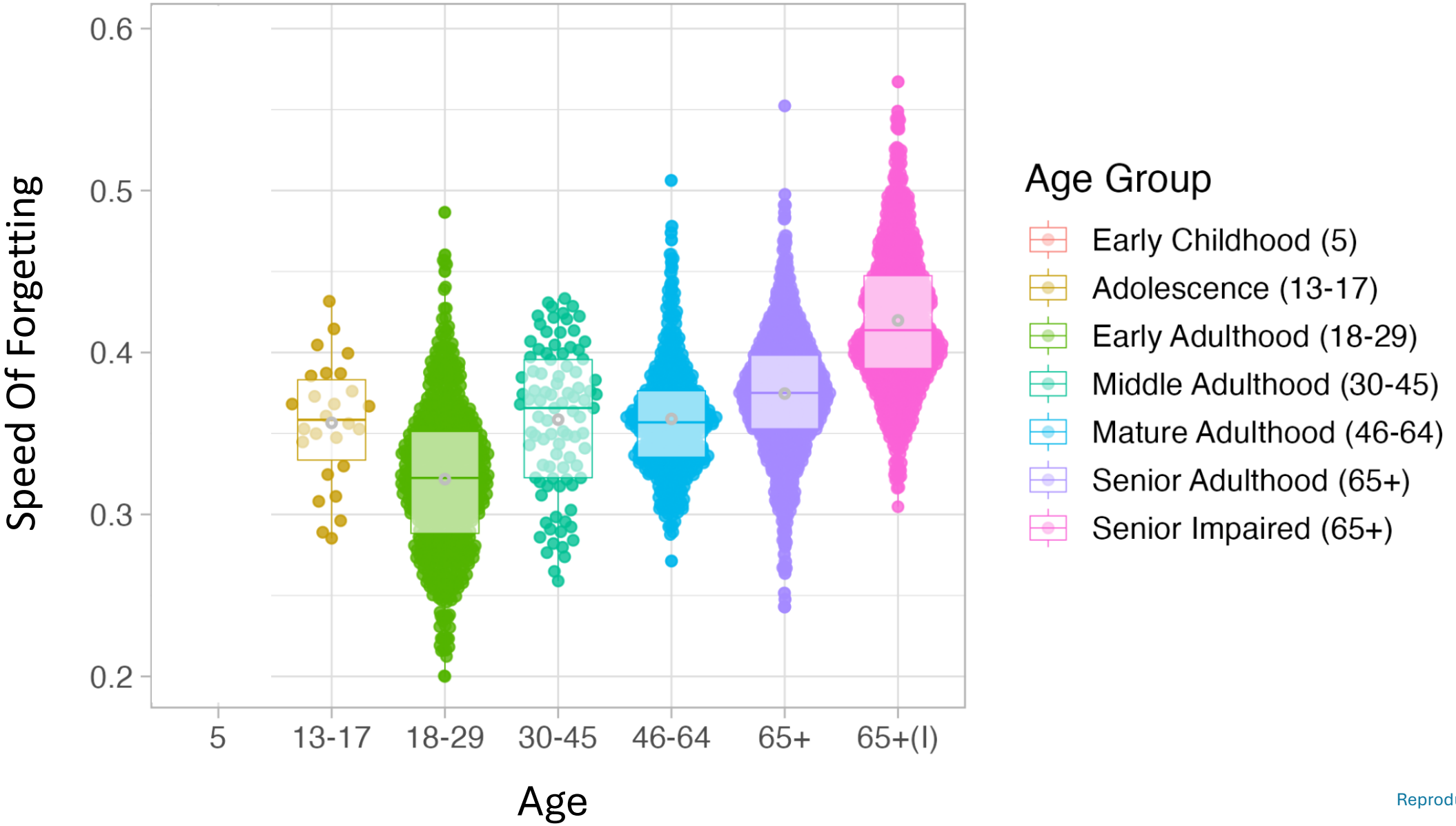



New Pair



Test Probe

# Speed of Forgetting Across Age

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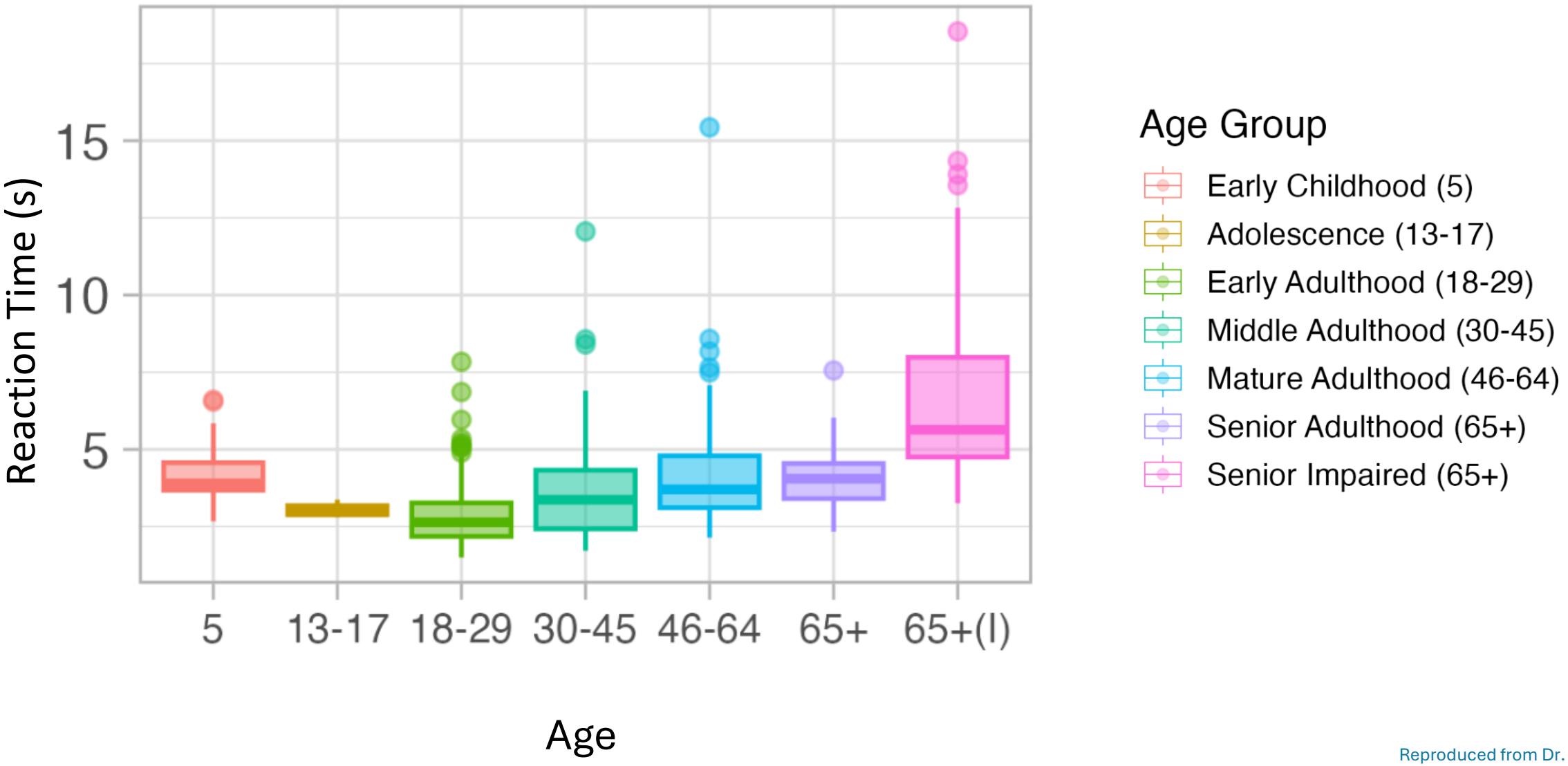
# Reaction Time Across Age

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# LBA Analysis

(**BARNEY** is calculating …)

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# Linear Ballistic Accumulator

LBA response time equation:

$$RT = \frac{d-(\frac{A}{2})}{v} + ter$$

$d$ = threshold of Activation
$A/2$ = average starting point
$ter$ = non-decision time
$v$ = drift rate

ACT-R response time equation:

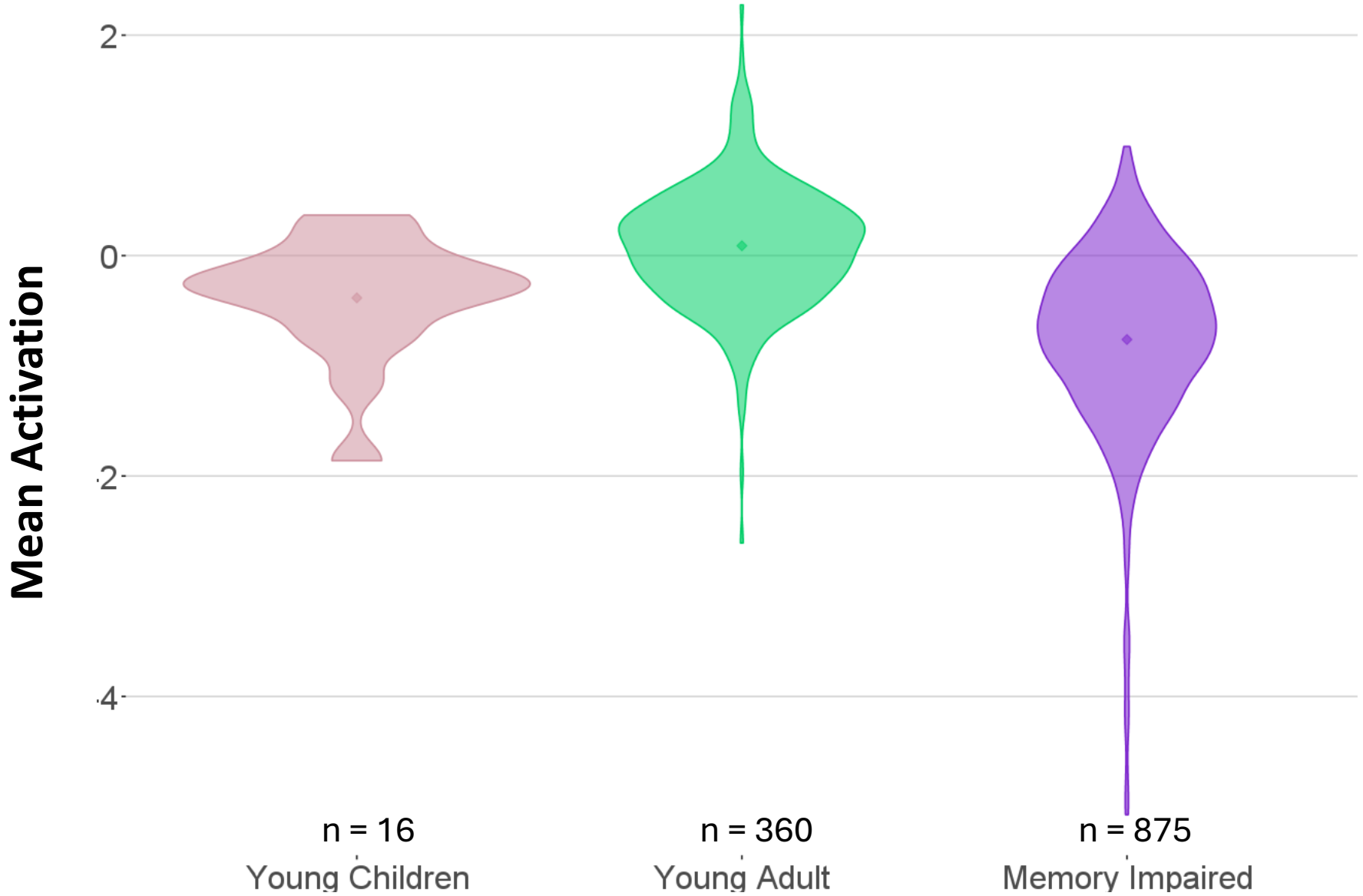
$$RT = F \times e^{-A} + t0$$

$$= \frac{F}{e^{A}} + t0$$

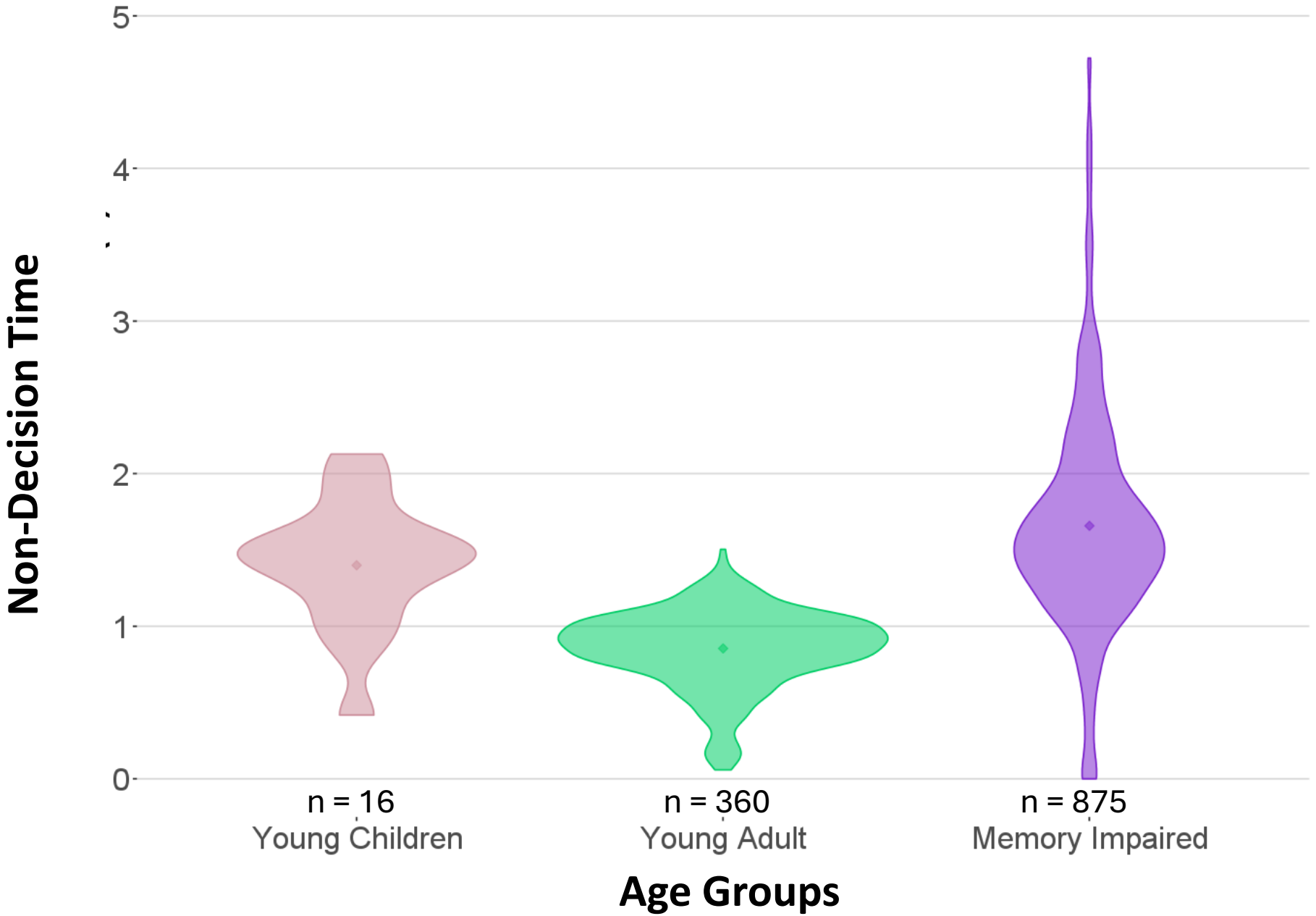
$F$ = Response Caution
$e^{A}$ = Activation of memory
$t0$ = non-decision time

Previous work from
Maarten Van Der Welde, ICCM 2021

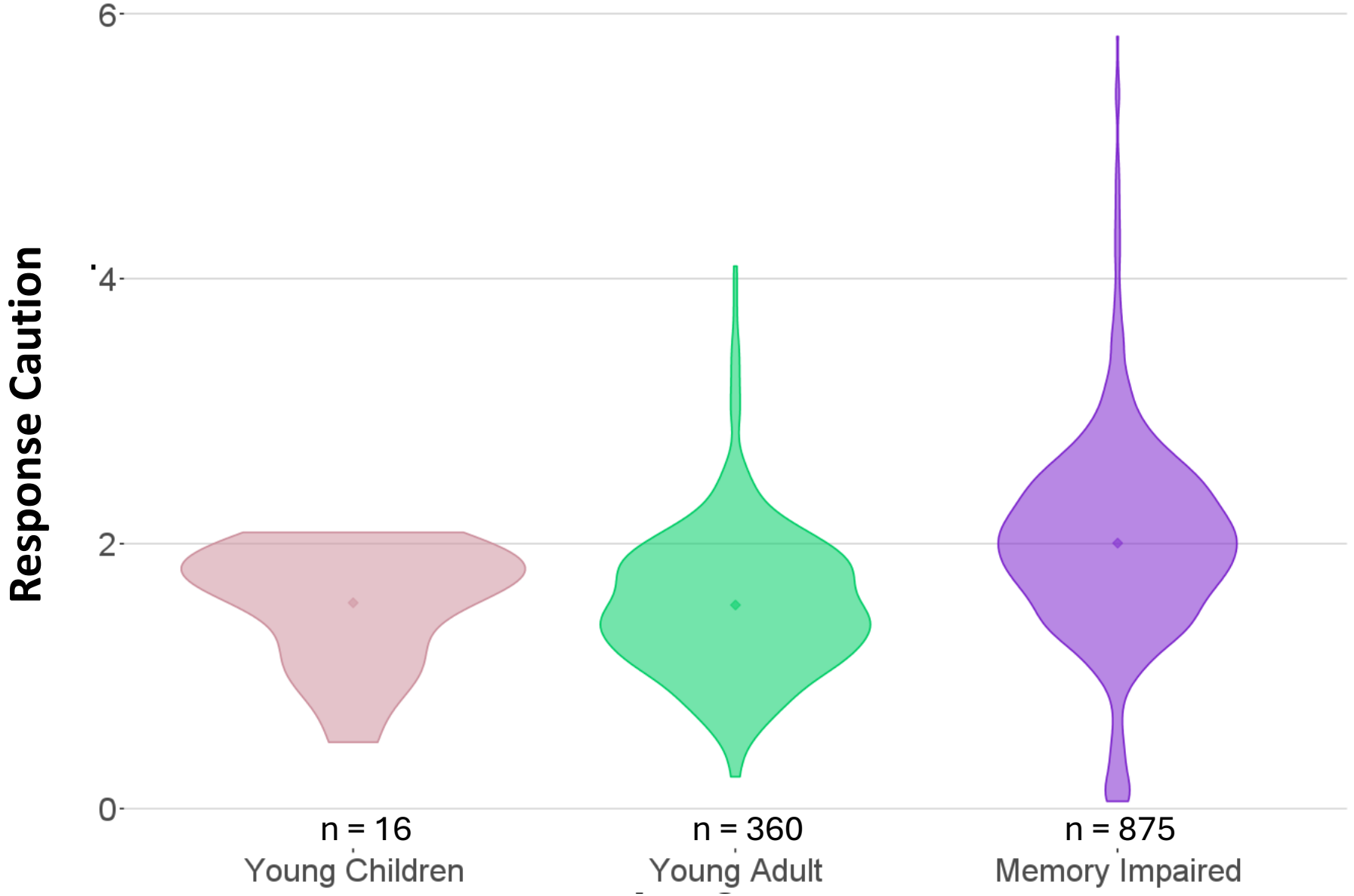
# Mean Activation of a Memory Across Age Groups



# Non-Decision Time Across Age Groups



# Response Caution Across Age Groups



# Limitations

- These results are in their very early stages
- Children's small pilot sample size
  - N = 16 vs n = 875
  - Different number of sessions per participant in each group

# Future Directions

- Collect more data with young children
  - Different age groups: 4-6, 7-9 y.o
- Expand on LBA analysis

# Conclusion

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# Conclusion

- Young children and MCI population have a similar SoF
- LBA analysis helps us better understand the underlying differences in these groups
  - Response caution and non-decision time

# Thank You!

> **CCDL lab:**

**Andrea Stocco**

**Holly Hake**

> **MemoryLab:**

**Hedderik Van Rijn**

> **LCD lab:**

**Ariel Star**

**Bahar Sener**

<u>Our research assistants:</u>

**CCDL:** Siqi Mao, Nevada Simpson, Pumipat Chetpaophan, Shripad Guntur,
**LCD:** Felix Quach, Arianne, and Olivia Ellingwood

# Questions?

(For **BARNEY**)

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# ACT-R memory equation

Model Equation

**Odds of memory retrieval**

$$A(m,t) = \log \sum i \, (t - t(i))^{-d(i)}$$

$A(m,t)$ = Activation (A) or odds of retrieving any of the memory (m) traces (i) at a specific time (t)

$-d(i)$ = Characteristic decay rate

$$-d(i) = e^{A(m,\, t = t(i))} + \sigma$$

$\sigma$ = decay intercept that is used as the decay value for the first trace

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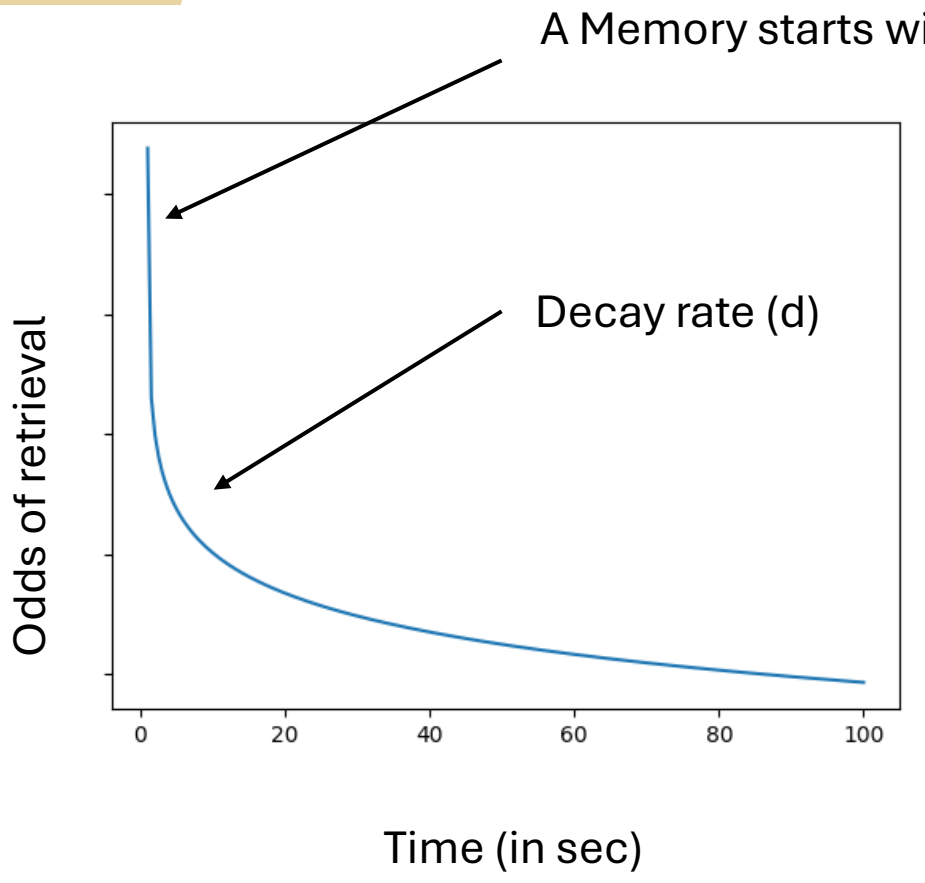
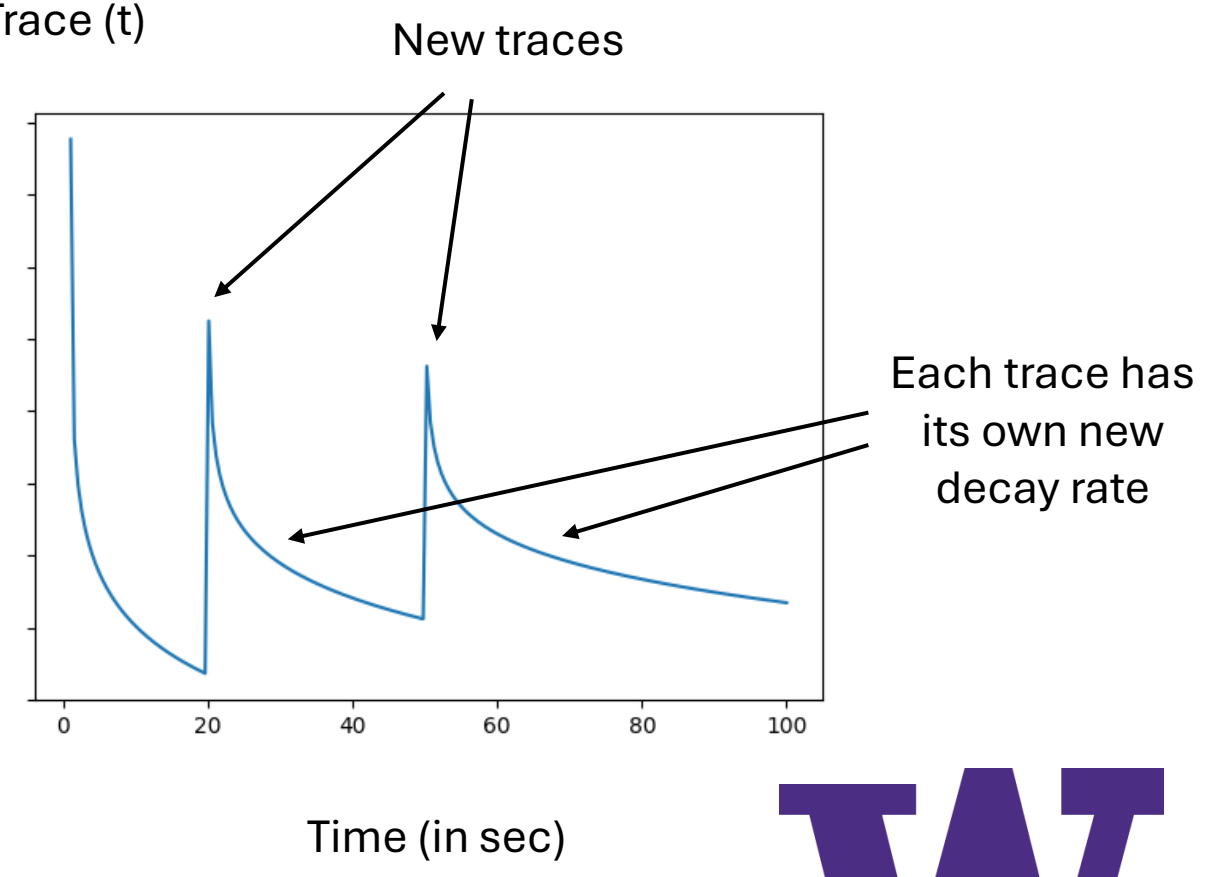
# The Model

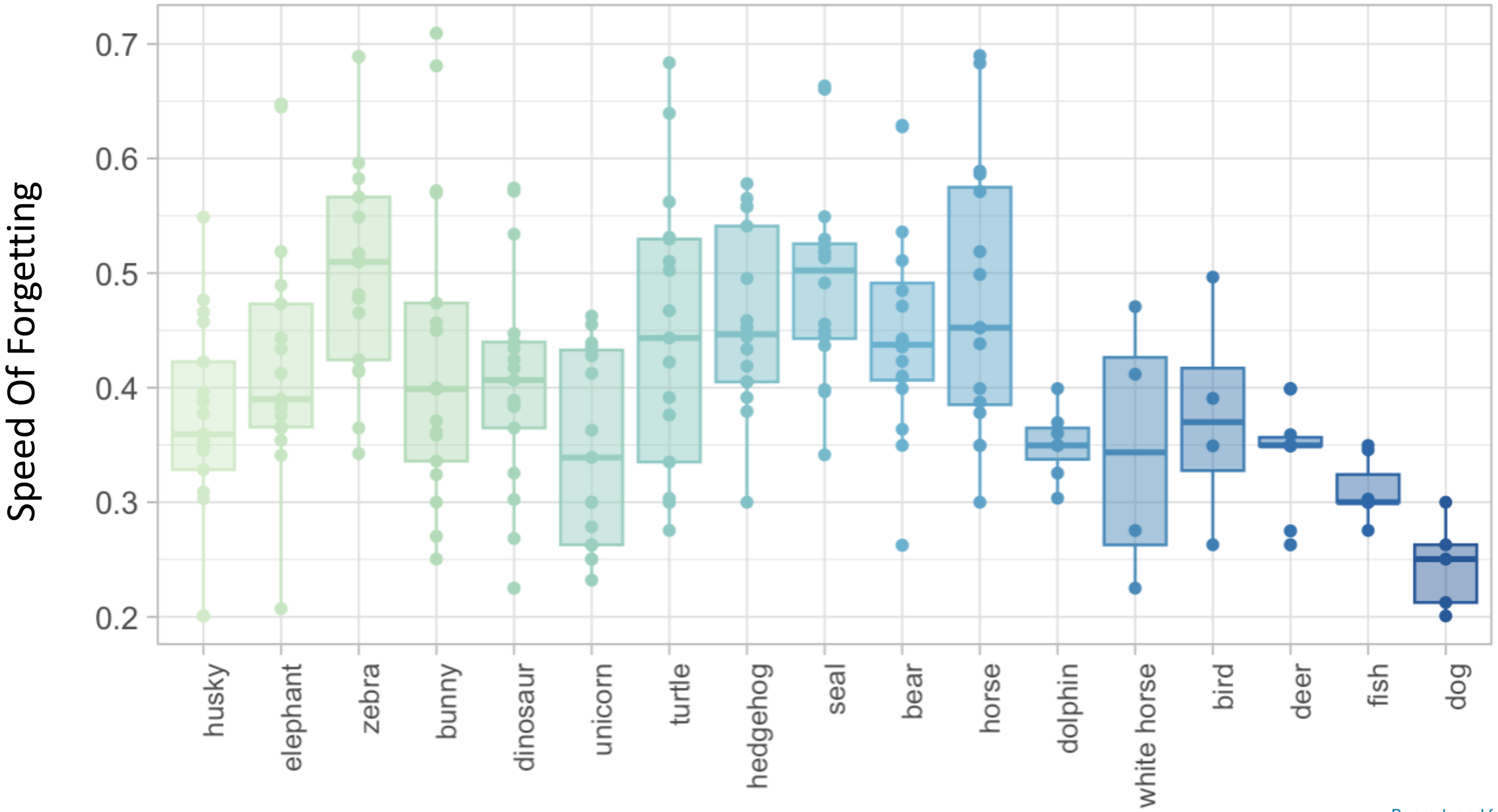
**Odds of memory retrieval**

$$A(m,t) = \log \sum i \, (t - t(i))^{-d(i)}$$



# Speed of Forgetting by Animal

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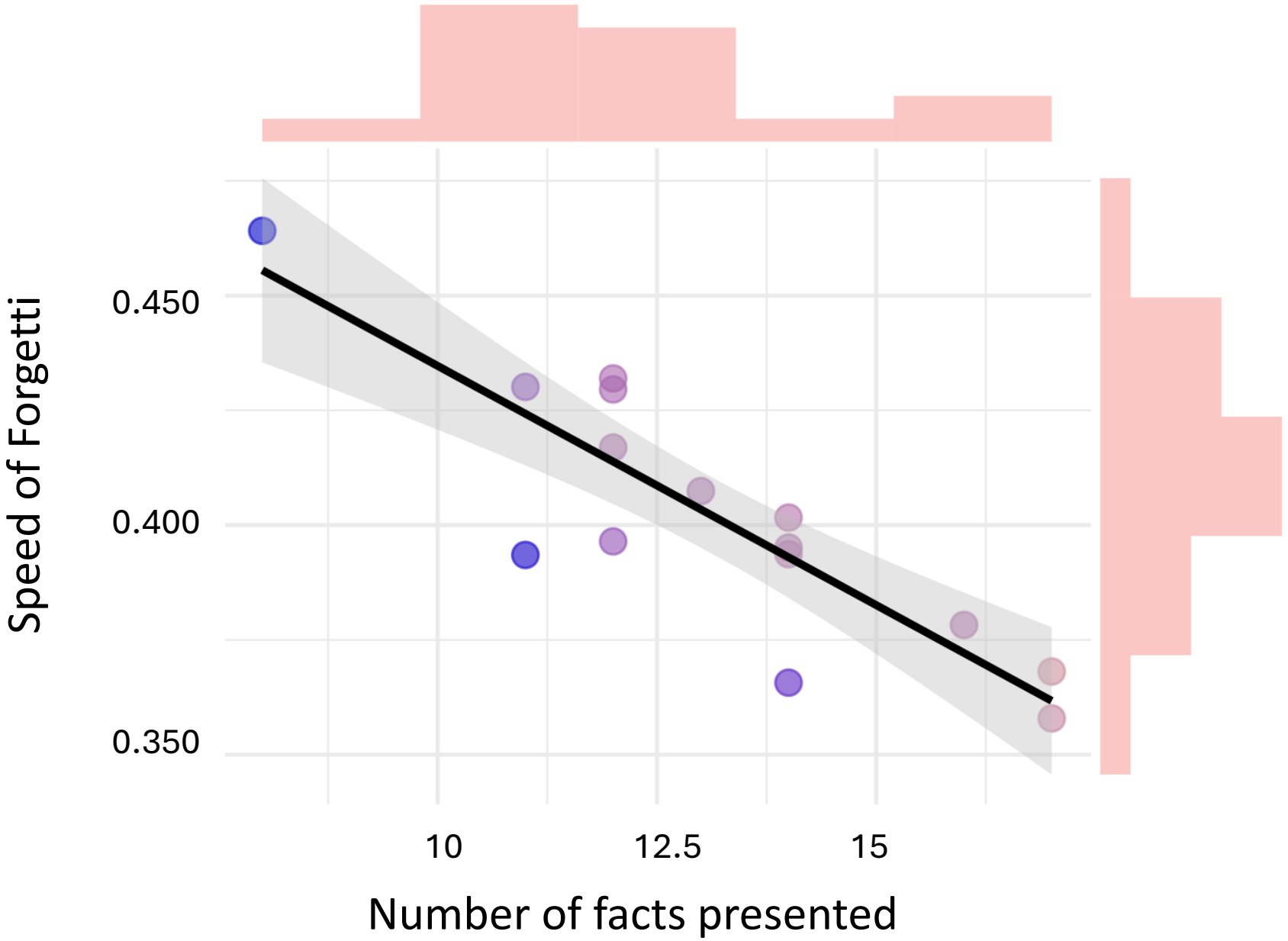
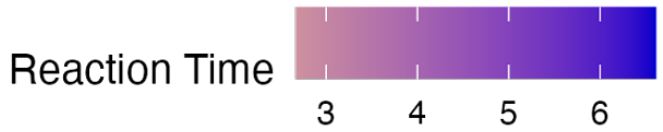
# Effects on Speed of Forgetting




- SoF correlated with number of facts presented
  (Pearson $r$ (15) = -0.87, $p$ < 0.001)
- No correlation found between SoF and Reaction time
  - Possible small sample size



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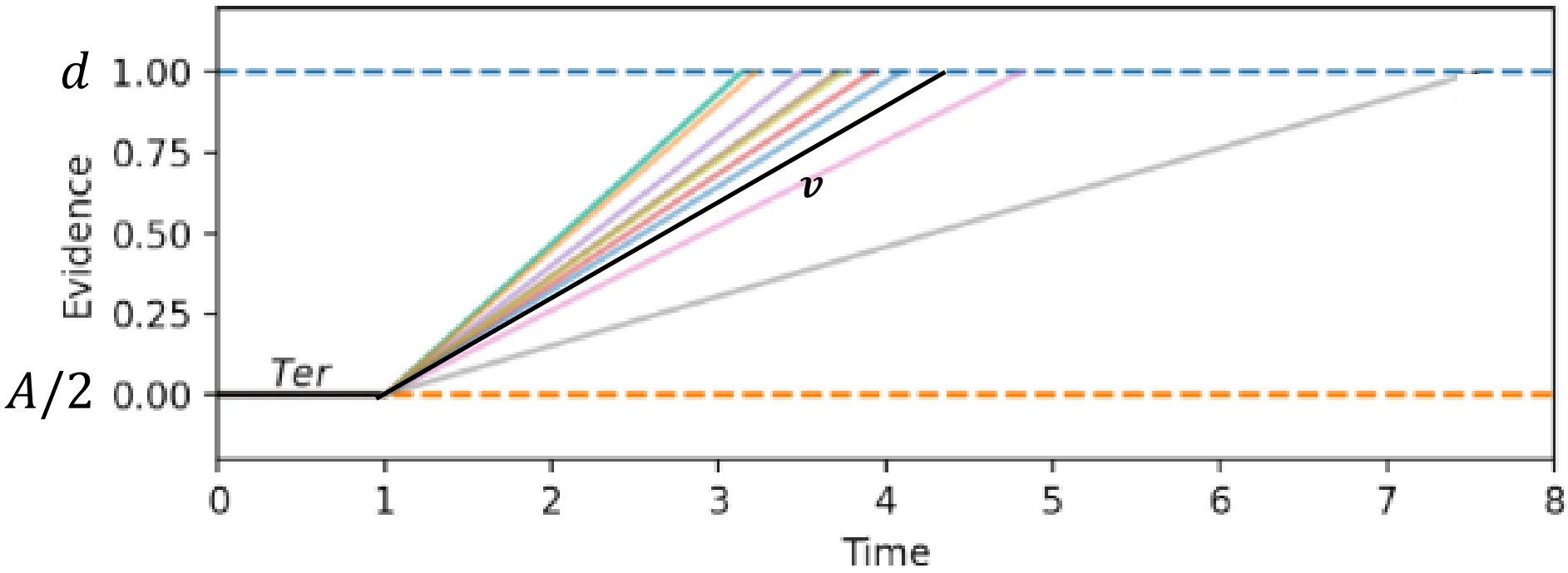

# Linear Ballistic Accumulator

ACT-R response time equation:

RT = F x $e^{-A} + t0$

$= \frac{F}{e^{A}} + t0$

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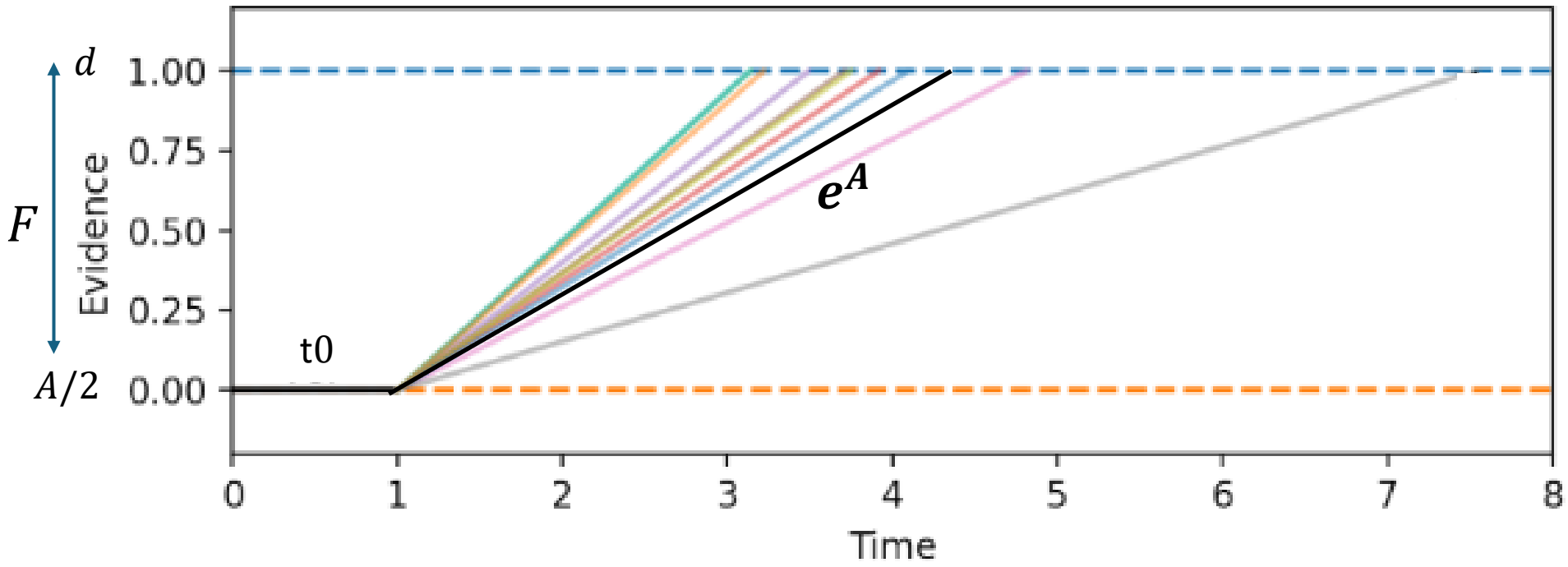
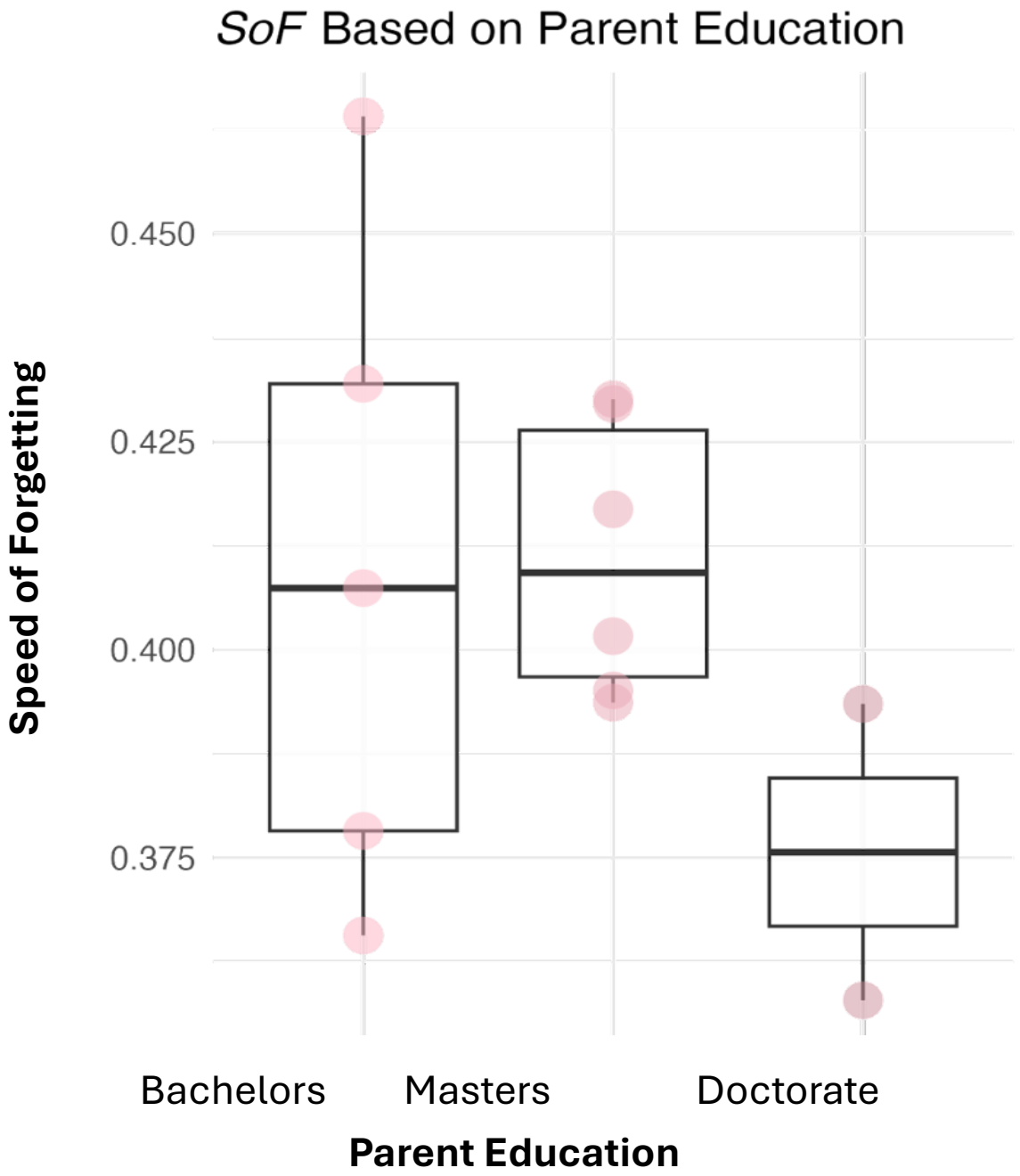
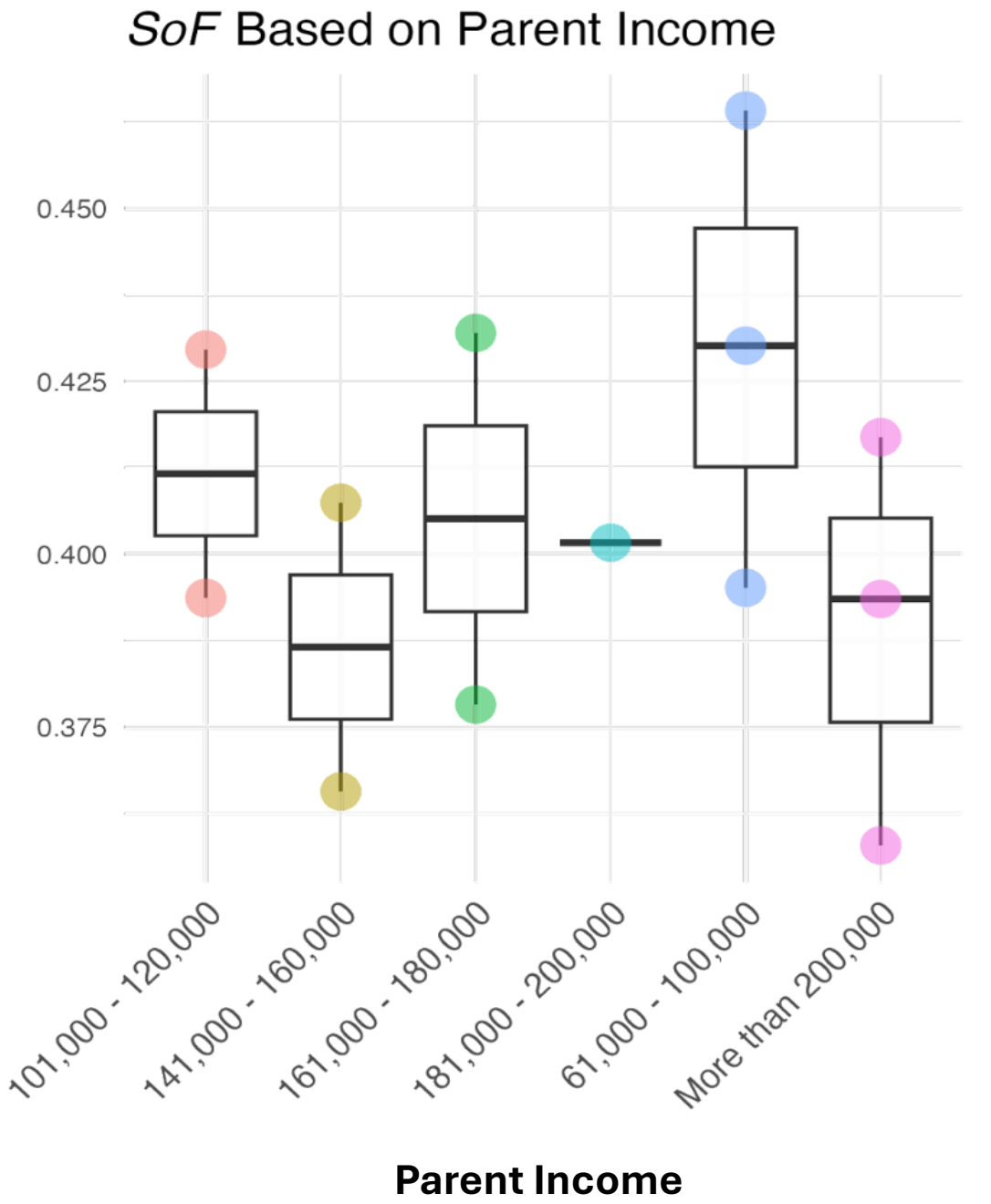
$e^{A}$ = Activation of memory

t0 = non-decision time

$F$ = Response Caution




SoF Based on Parent Education
Speed of Forgetting
0.450
0.425
0.400
0.375
Bachelors
Masters
Doctorate
Parent Education


SoF Based on Parent Income
0.450
0.425
0.400
0.375
101,000 - 120,000
141,000 - 160,000
161,000 - 180,000
181,000 - 200,000
61,000 - 100,000
More than 200,000
Parent Income