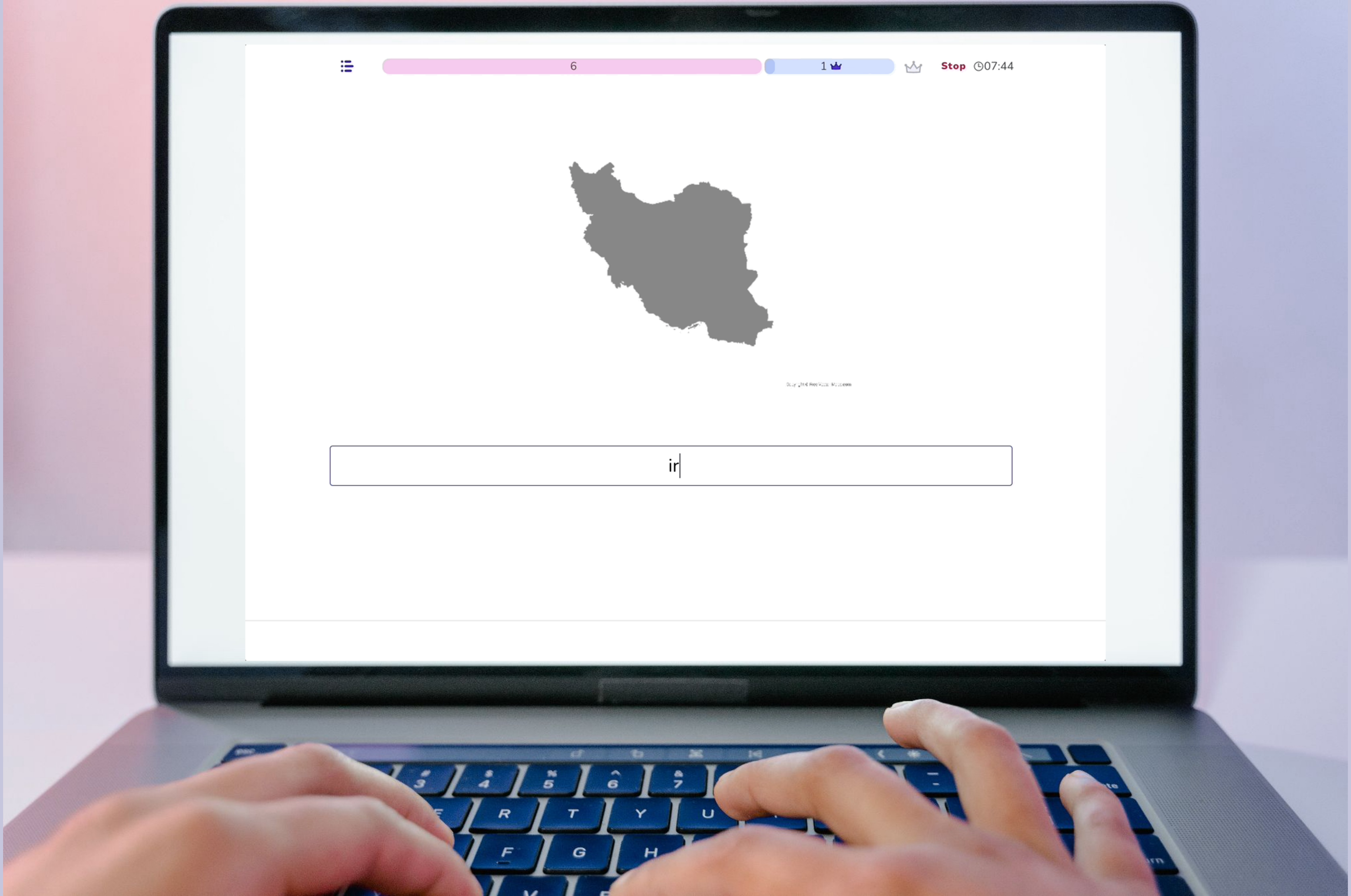
Predicting Longer-Term Retention from Learners' Retrieval Practice Performance *and its application in education*

Maarten van der Velde & Hedderik van Rijn

MemoryLab

university of groningen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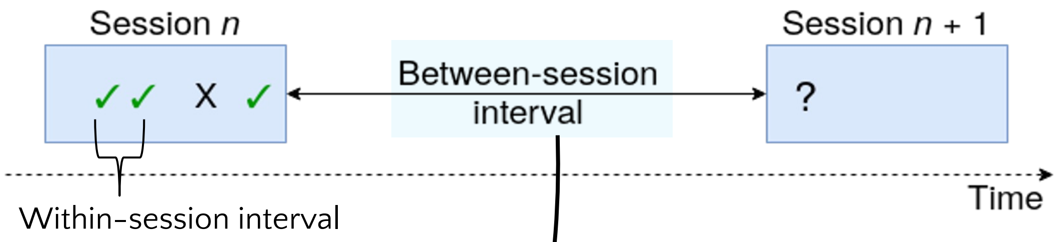
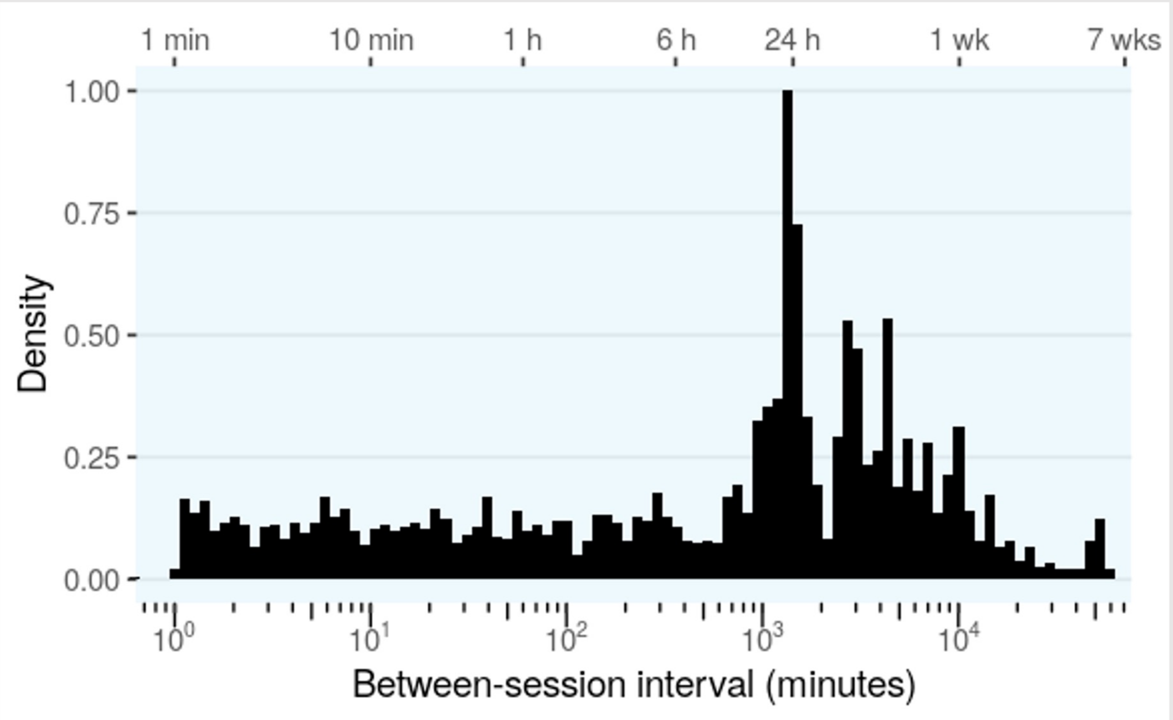
Multi-session retrieval practice

Learners typically do spaced retrieval practice over multiple sessions. Intervals range from seconds/minutes (within session) to hours/days/weeks (between sessions).





Data set: 25,843 fact learning sequences from university students in a Cognitive Psychology course.

Challenges

- Can we predict longer-term retention from retrieval practice performance?
- In terms of ACT-R: Can a single model describe cognition on multiple different timescales (seconds/minutes – hours/days/weeks)?
- Are these predictions sufficiently robust to be used in practical applications?

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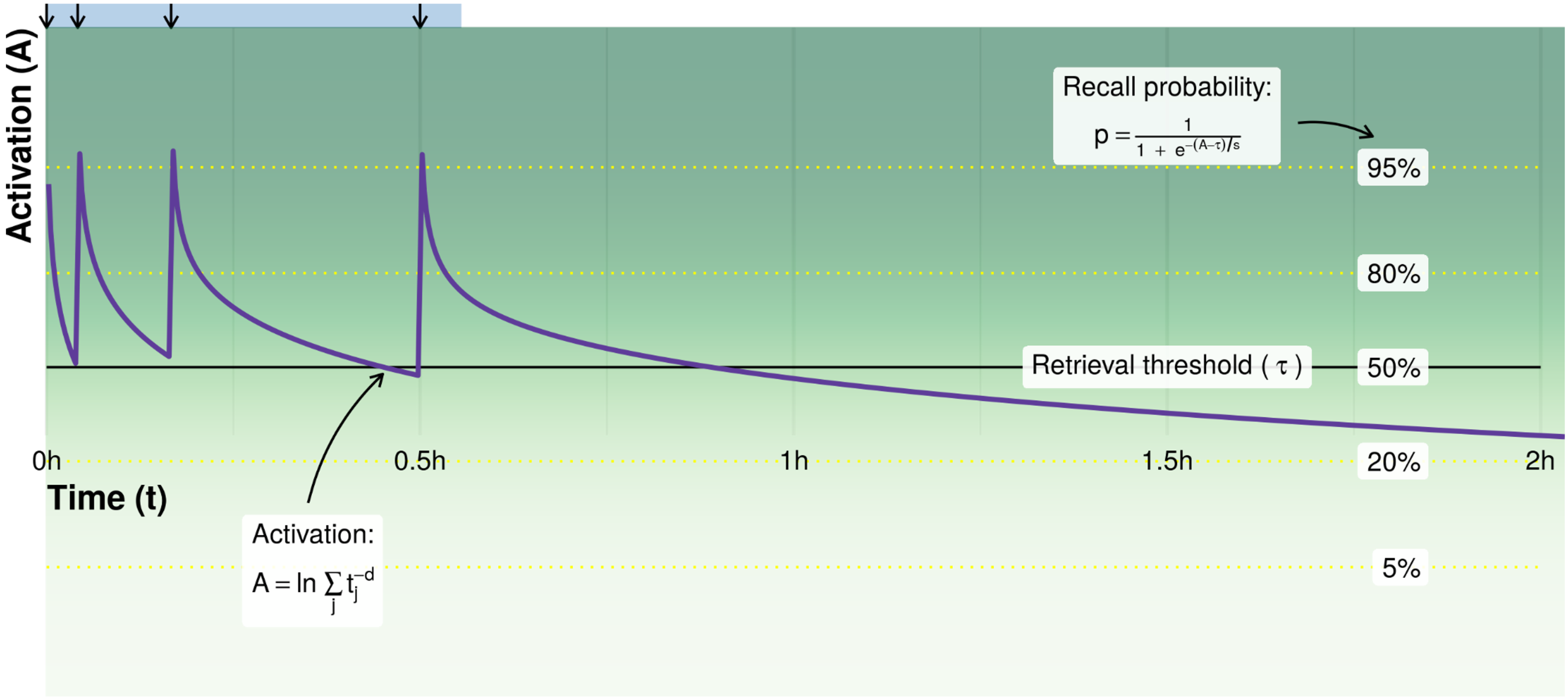
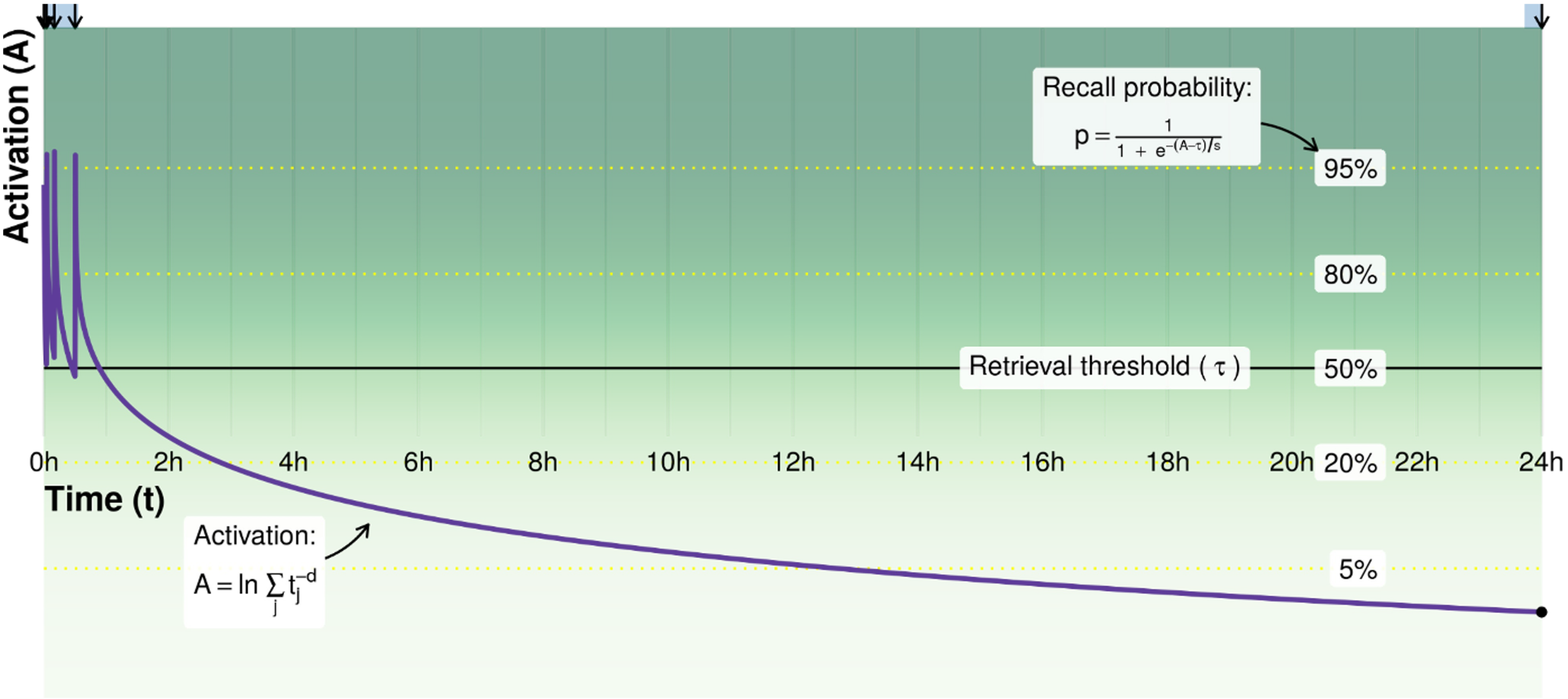
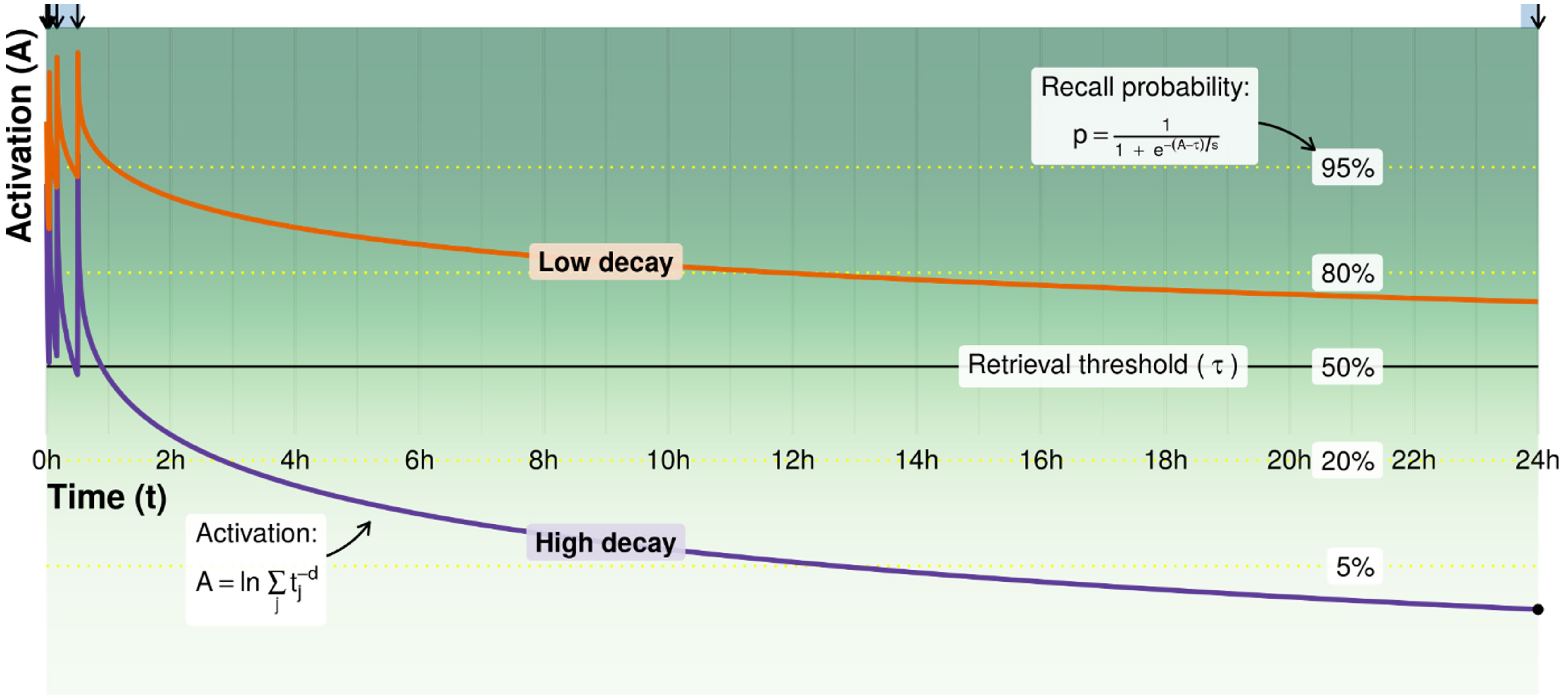
Activation in ACT-R's declarative memory



Activation in ACT-R's declarative memory



Activation in ACT-R's declarative memory



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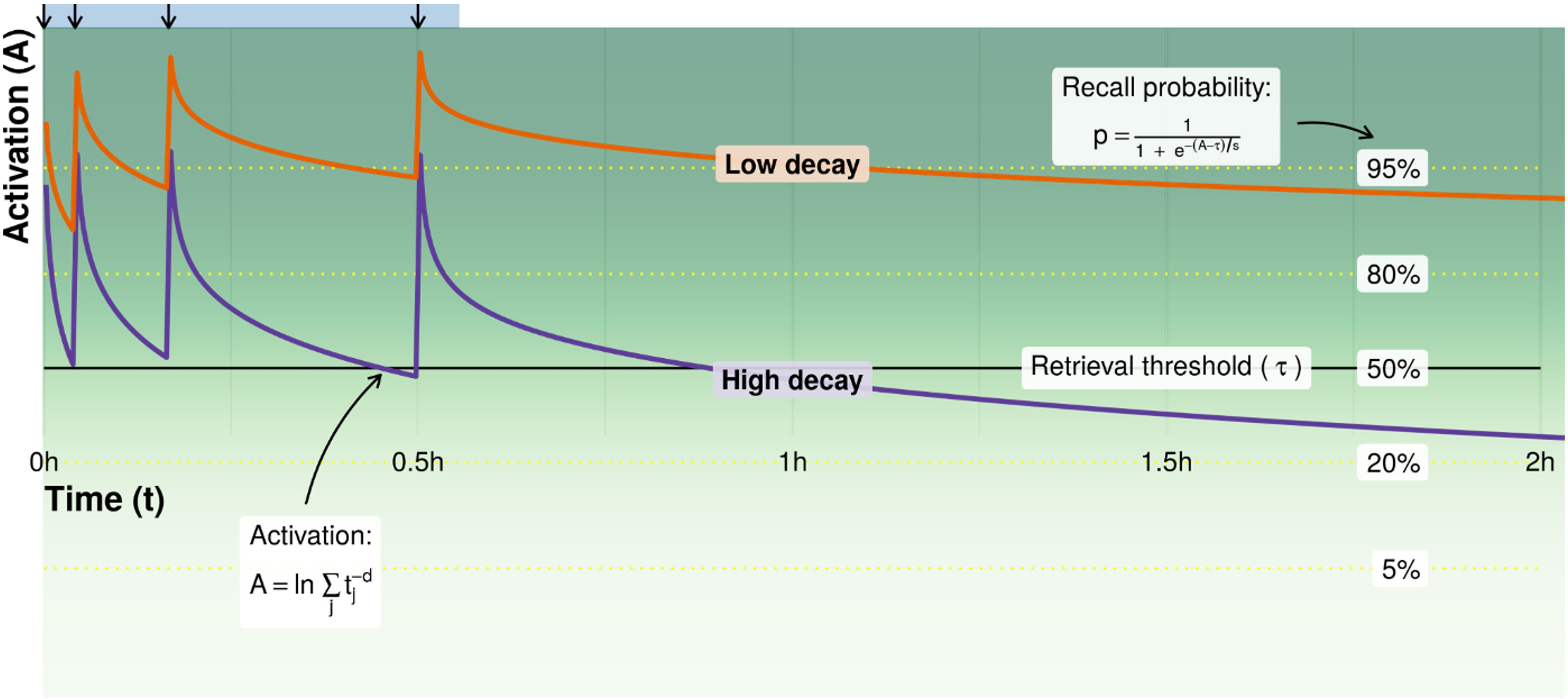

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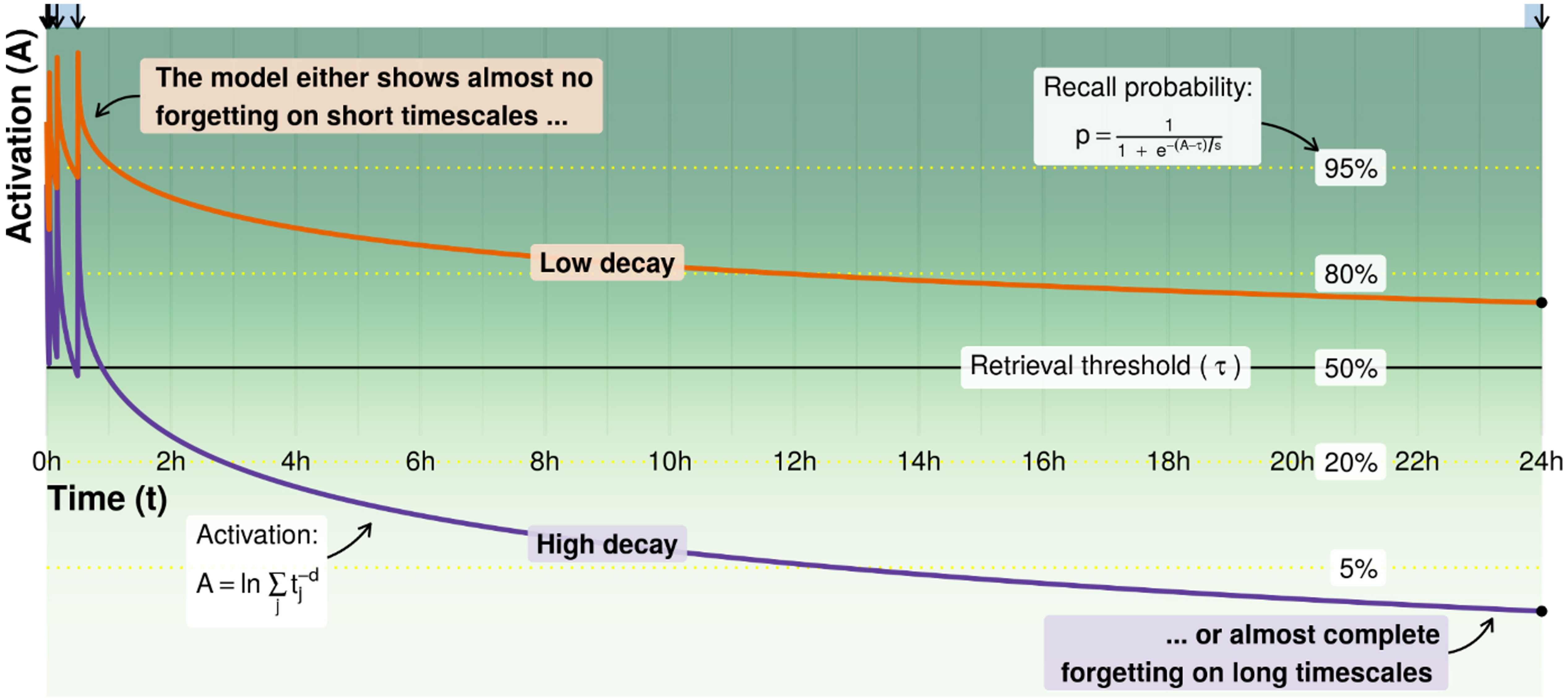

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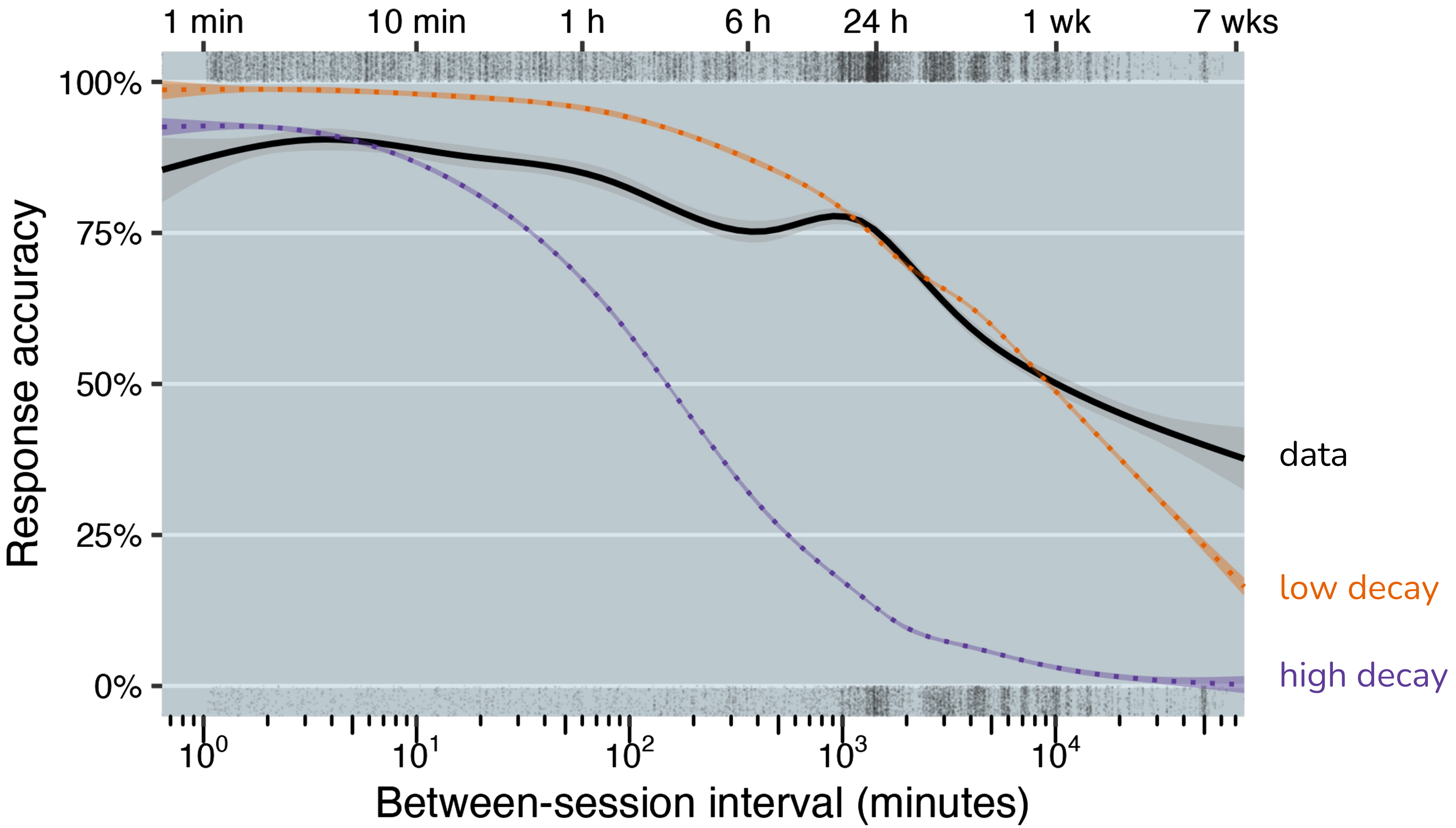
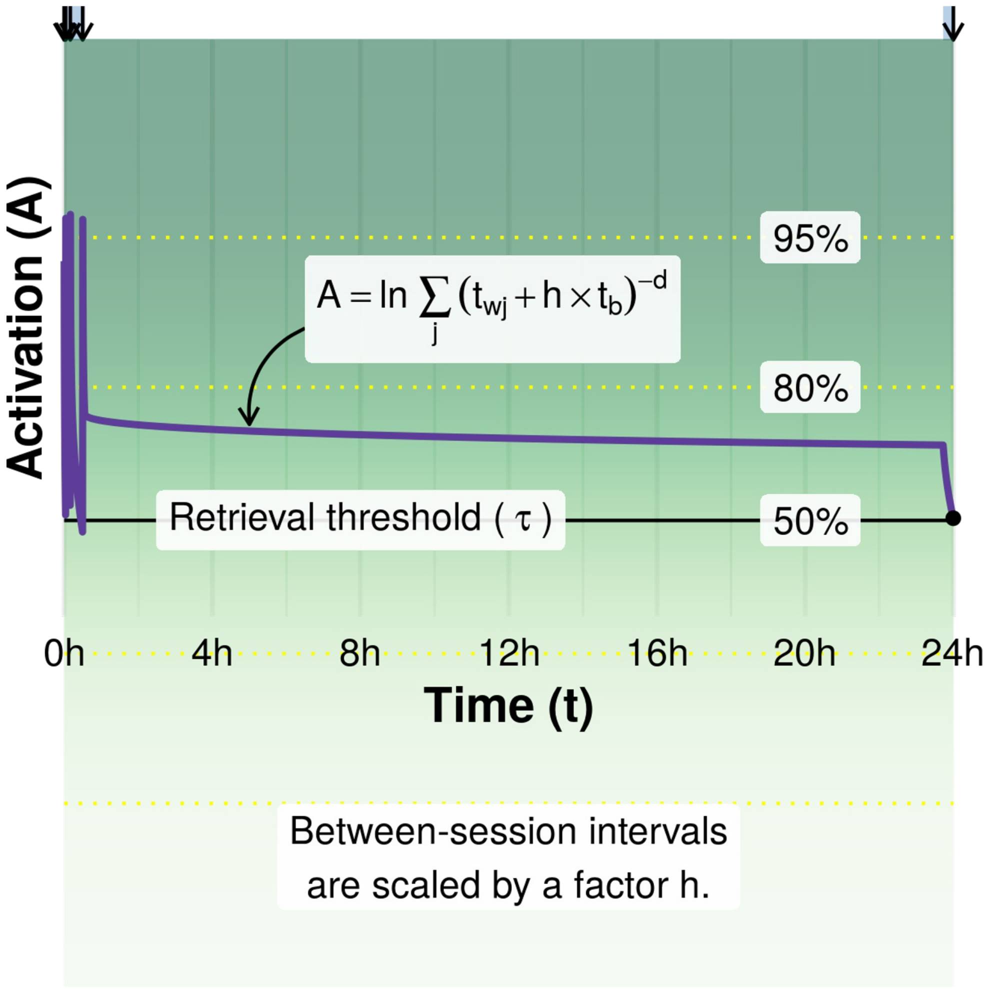
How does ACT-R do on our multi-session retrieval practice data?



Solution: "psychological time"?

Shrink between-session intervals by a scaling factor *h*.

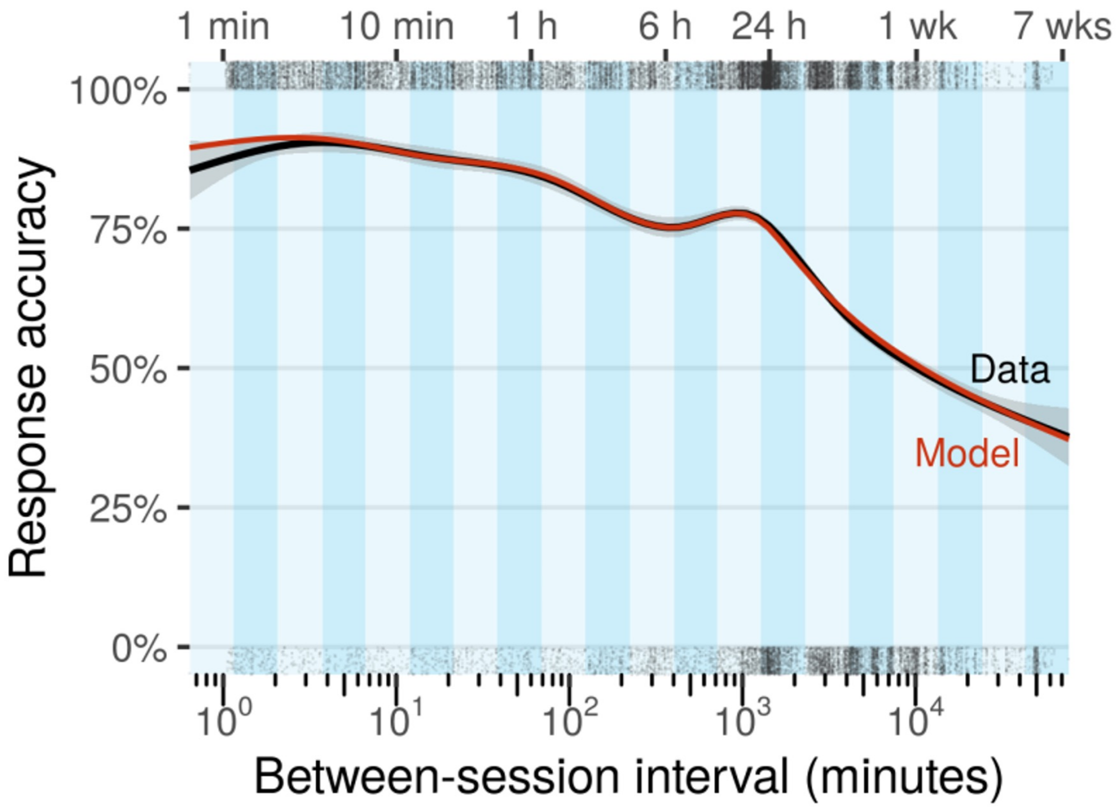
- There's less decay between sessions than expected based on elapsed clock time
  Elliott & Anderson (1995); Anderson, Fincham, & Douglass (1999); Pavlik & Anderson (2003)
- Is forgetting slower because of fewer intervening events?
  See also: context drift in SAM (Mensink & Raaijmakers, 1988), MCM (Mozer et al., 2009)
- "Slowed-clock" model: scale between-session intervals by a factor *h* (between 0 and 1).
  Different studies find different values: 0.00046, 0.0172, 0.025, 0.031
  Pavlik, Bolster, Wu, Koedinger, & Macwhinney (2008); Pavlik & Anderson (2008); Pavlik & Anderson (2005); Pavlik & Anderson (2003)

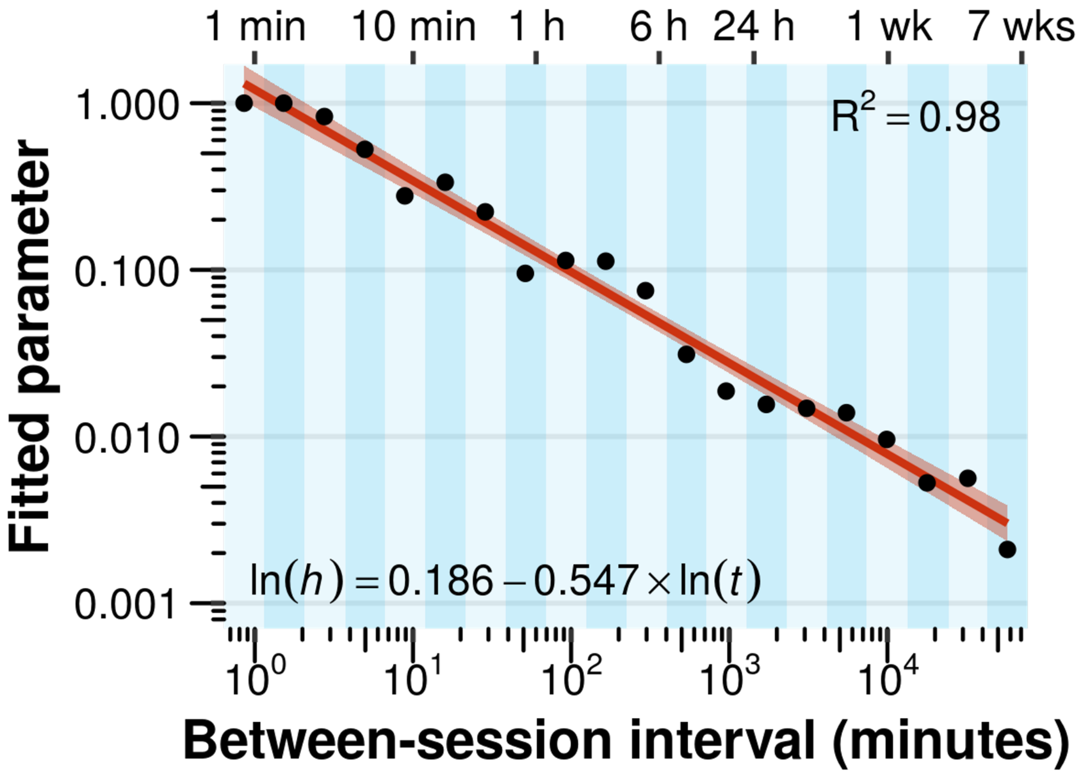


What is the right value of *h*? Does it depend on the interval?

Finding a time-variant h(t) in three steps

- Bin learning sequences based on between-session interval (here: 20 bins)
- Find best-fitting *h* for each bin
- Fit function *h(t)*





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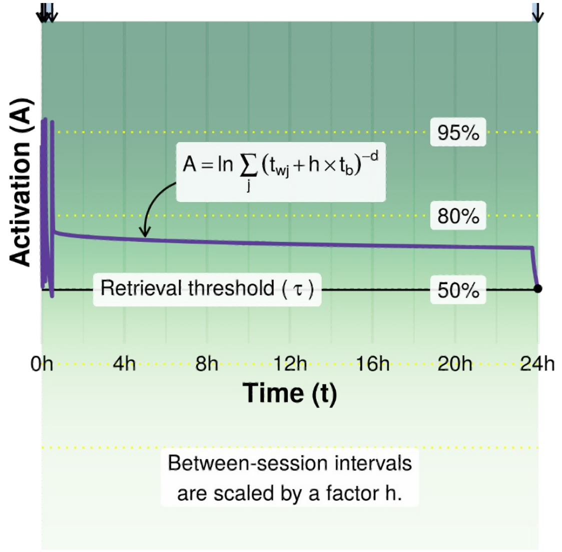
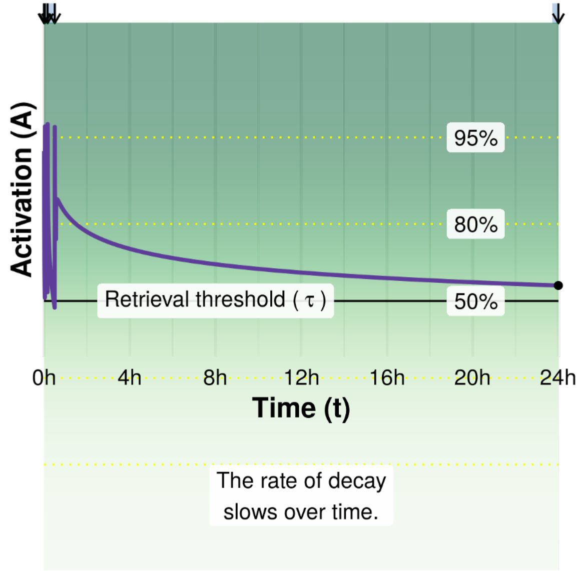
But there are (at least) two other solutions!

Scaling between-session intervals by a ***scaling factor h(t)***

Less interference → shorter "psychological time".
Bridge to context-drift-based accounts of forgetting.



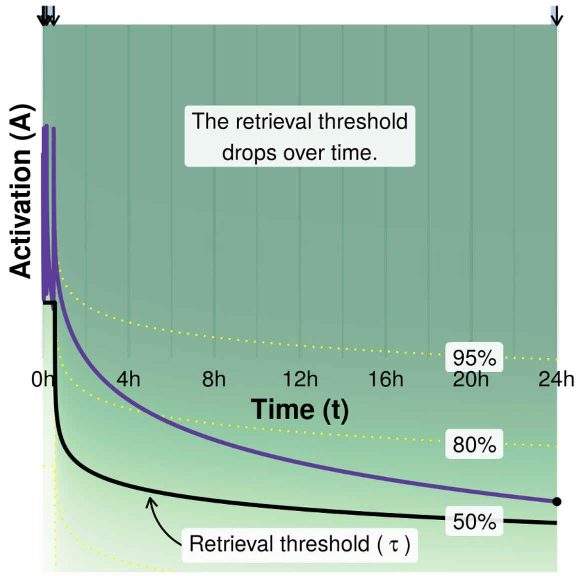


Time-variant ***decay d(t)***

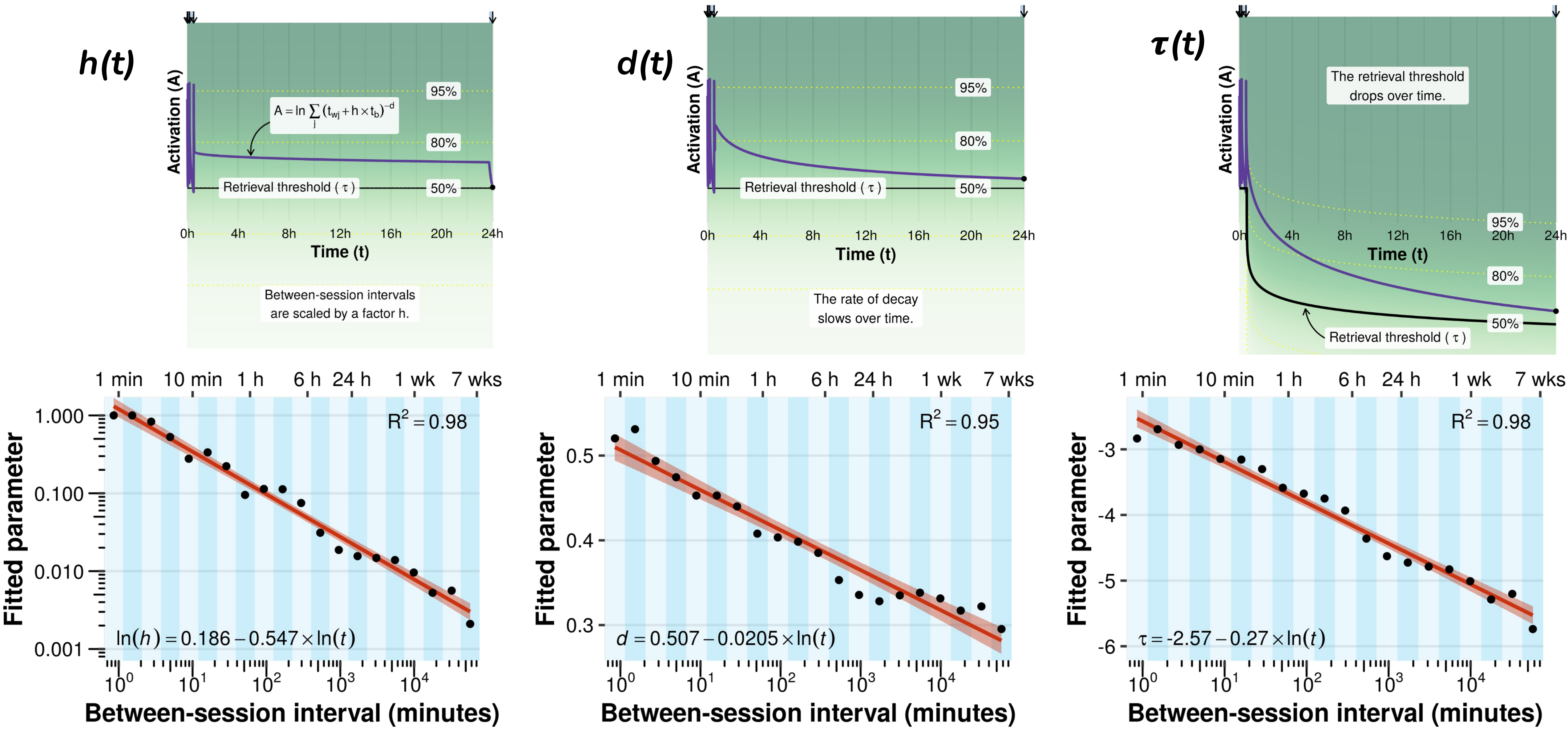
Lower decay over time → ever stronger "persistence" consolidation.
See Ribot's gradient: older memories are more resistant to disruption.

Time-variant ***retrieval threshold τ(t)***

Lower threshold over time → items retrievable at lower activation.
Suggests an increase in potential invested retrieval effort.



All three parameters change predictably with interval



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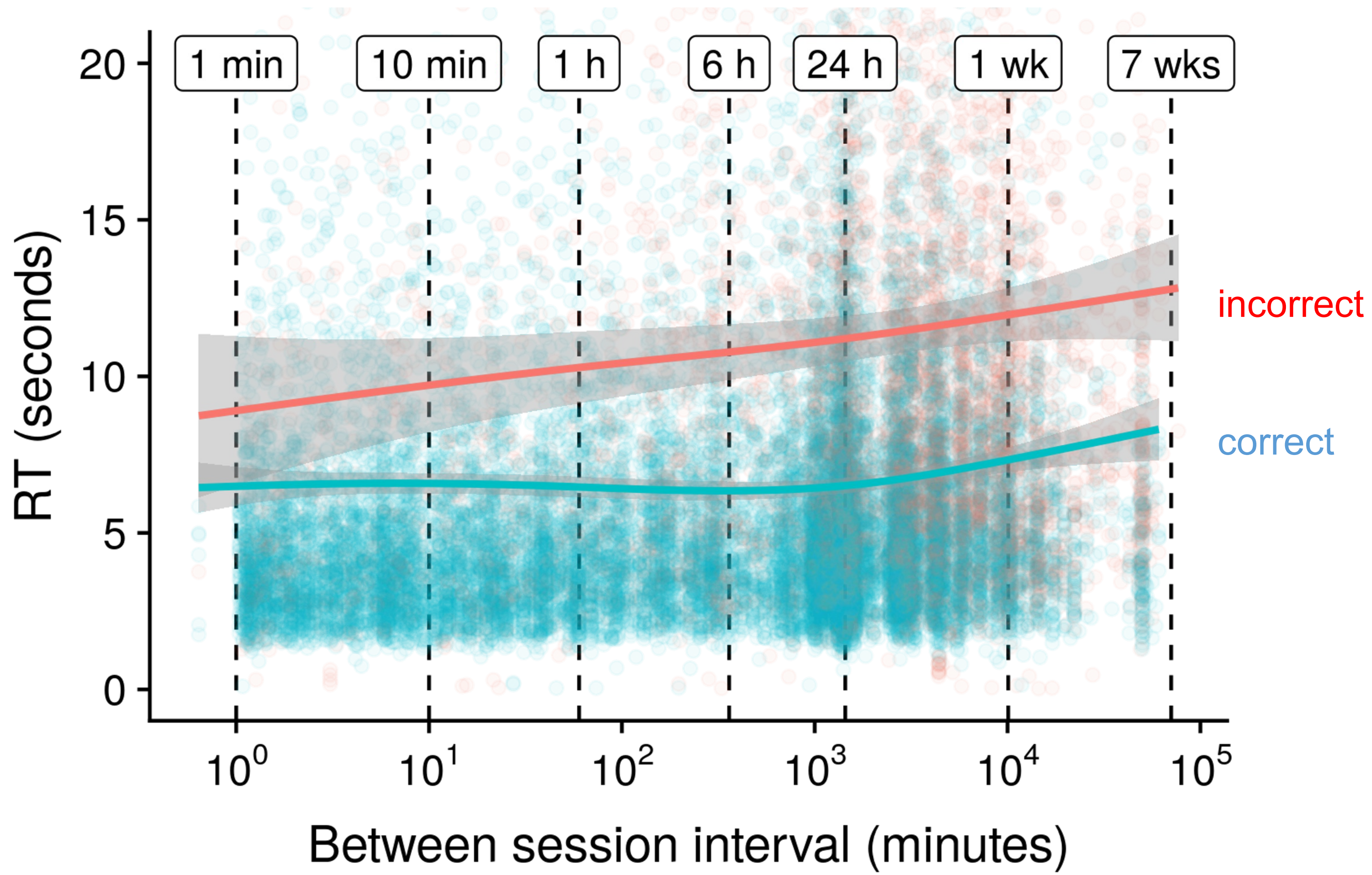
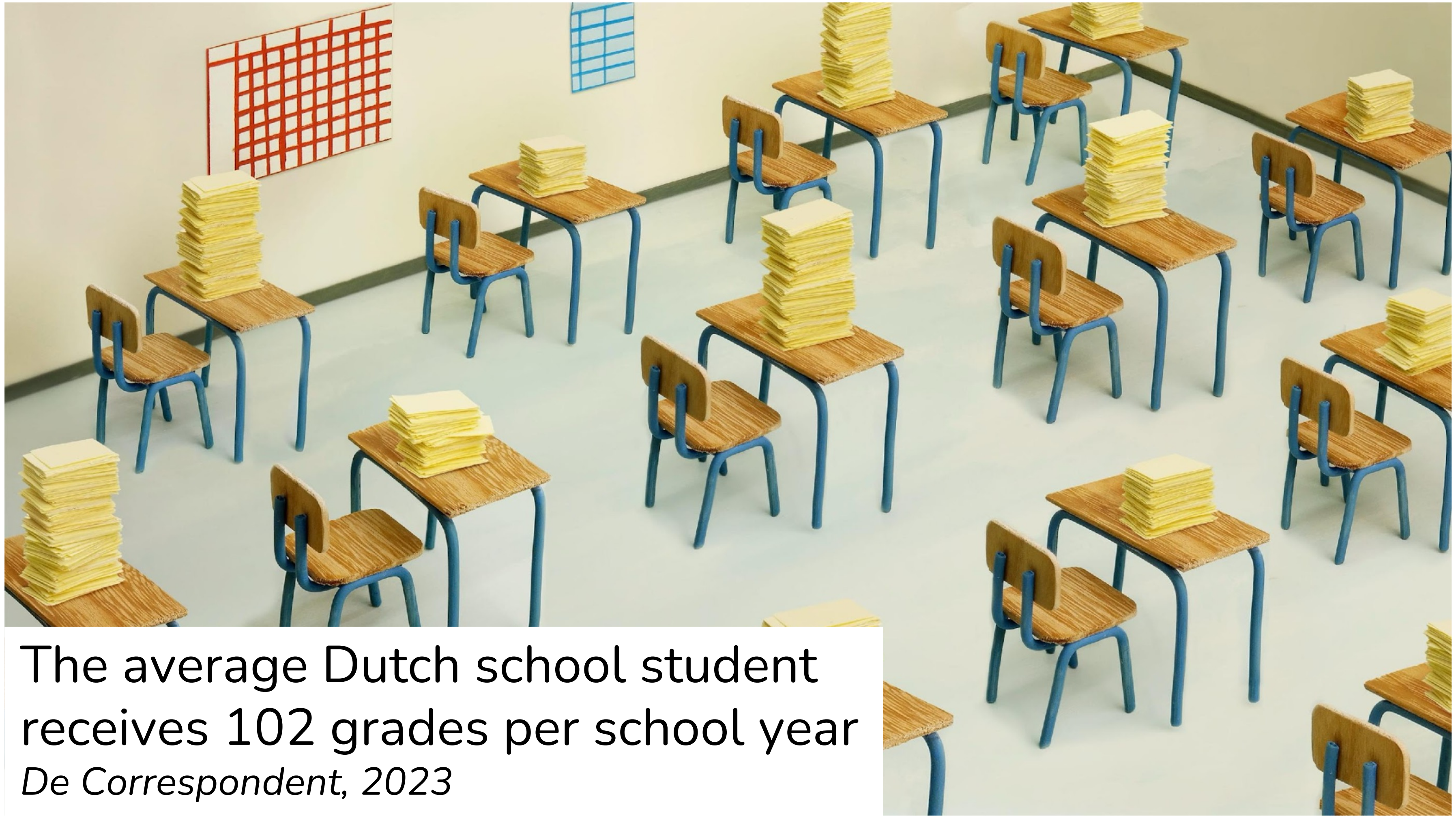
Conflicting evidence in RT



$$RT_f = F * e^{-\tau} + t_{er}$$

$$RT_c = F \cdot e^{-A_c} + t_{er}$$

Can predictions from practice replace traditional knowledge tests?



The average Dutch school student receives 102 grades per school year

De Correspondent, 2023

Montessori Scholengemeenschap Amsterdam

Universiteit Utrecht

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Can predictions from practice replace traditional knowledge tests?

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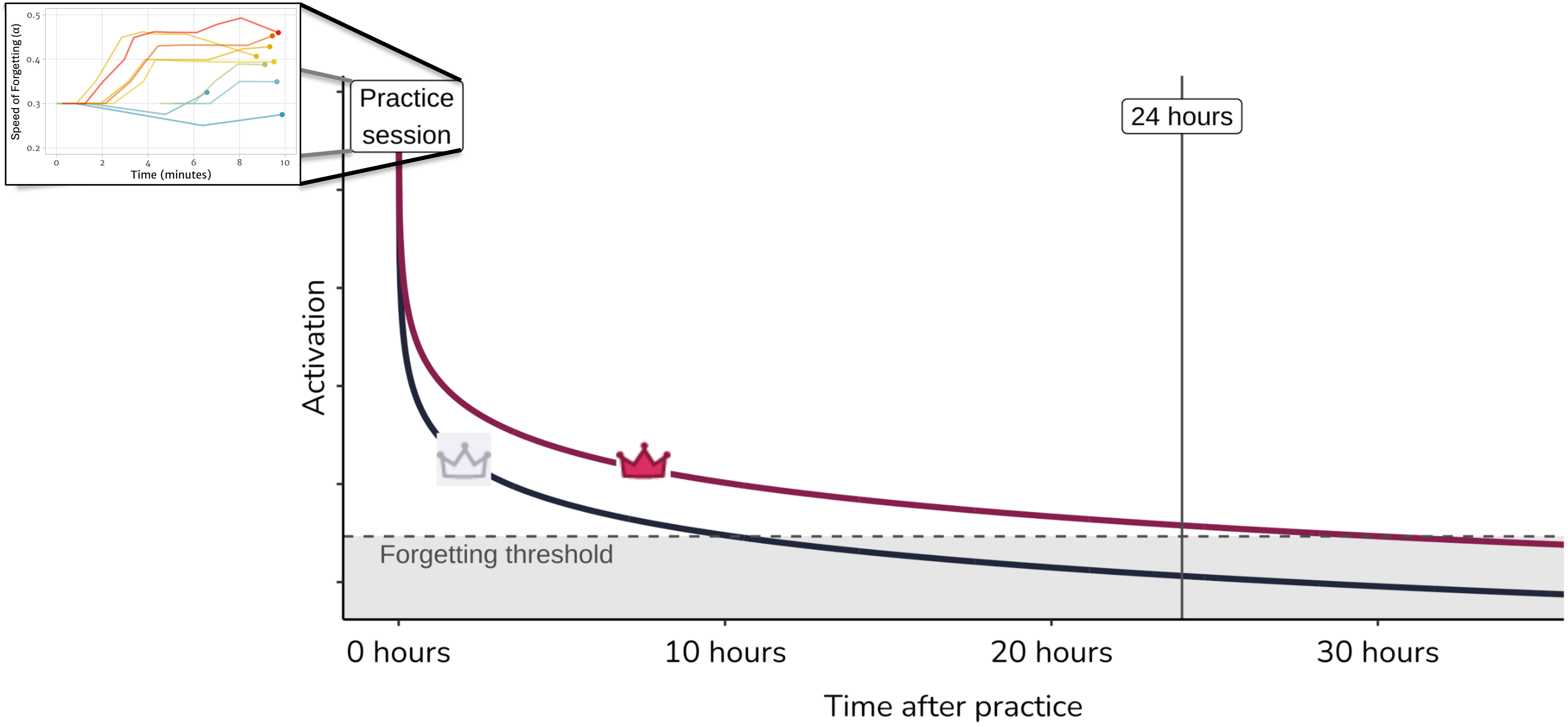
Model-based assessment of mastery

Define mastery in terms of projected retention, using the same threshold-based memory model:



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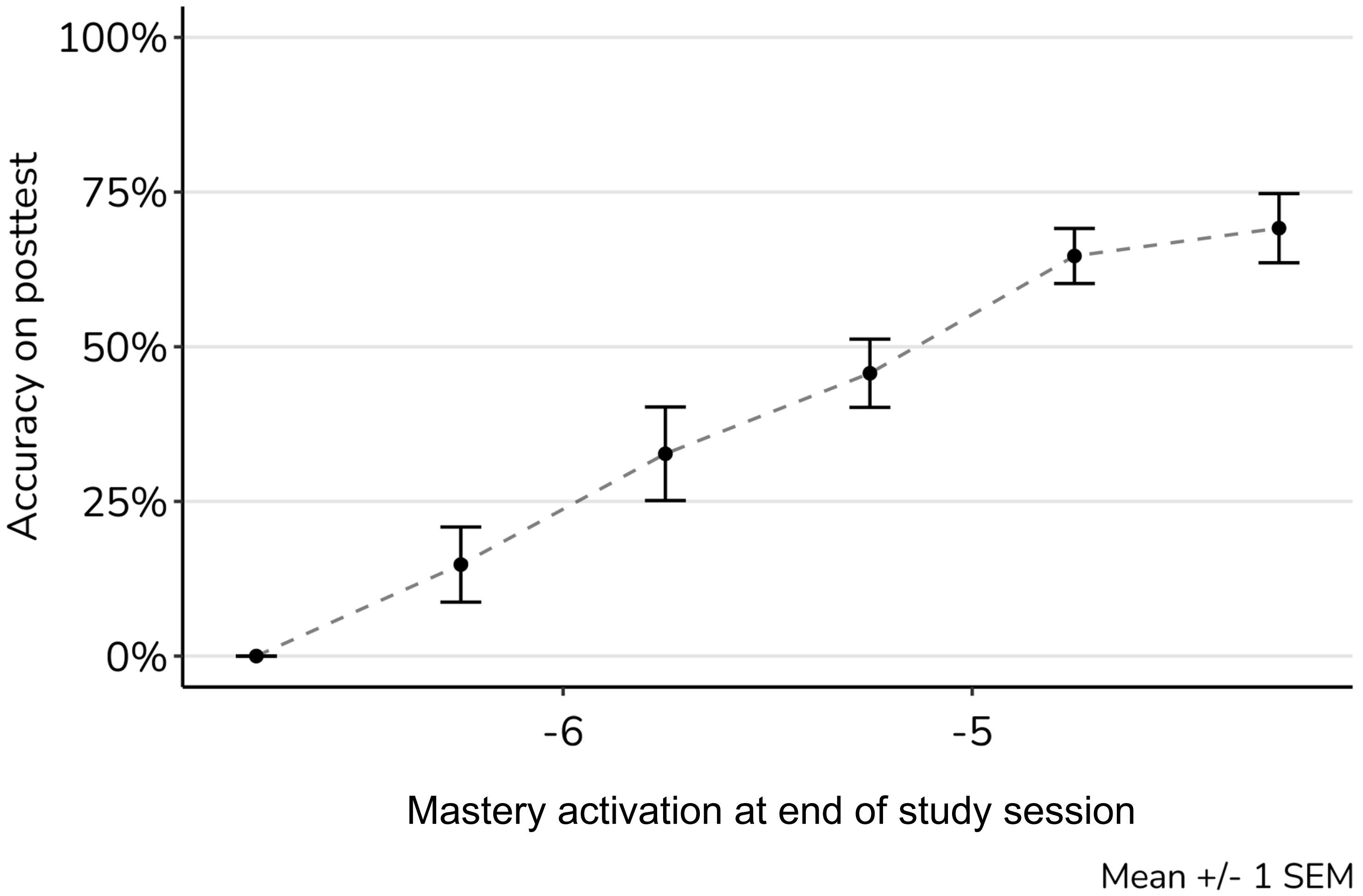
Memory activation predicts test performance



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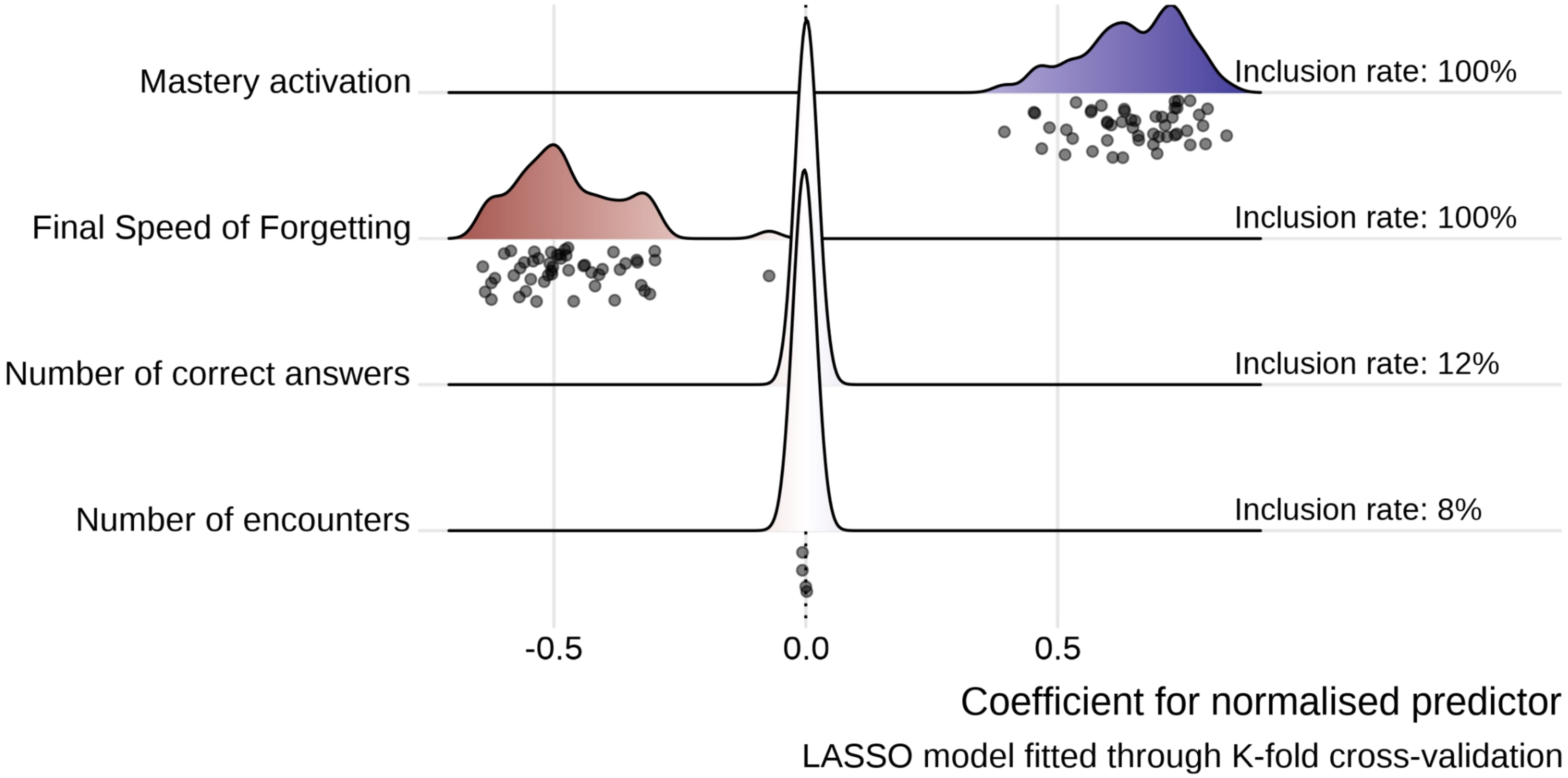
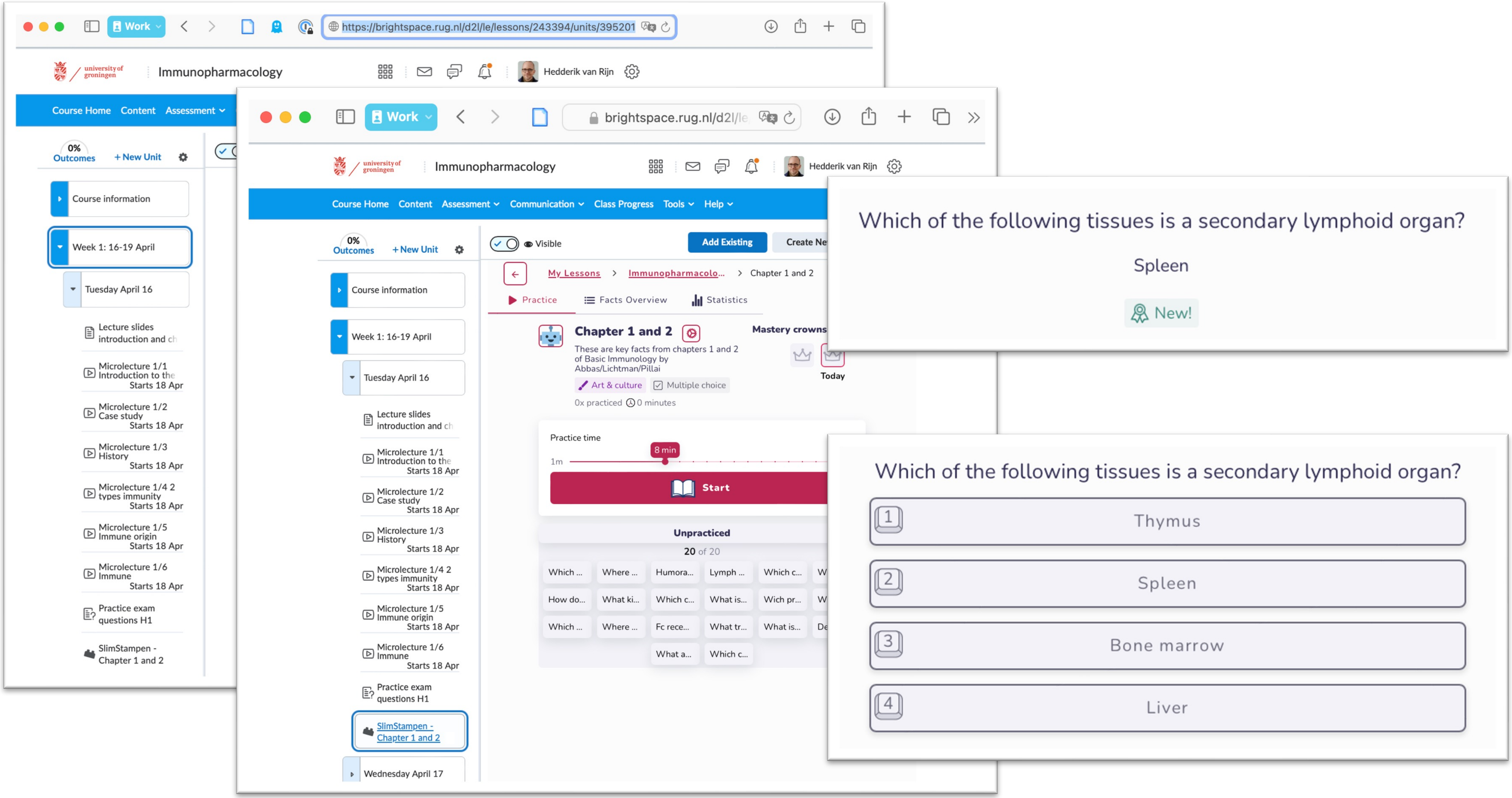
Model-based predictions outperform “raw” measures

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Immunopharmacology
Hedderik van Rijn
Course Home
Content
Assessment
Communication
Class Progress
Tools
Help
0% Outcomes
+ New Unit
Course information
Week 1: 16-19 April
Tuesday April 16
Lecture slides introduction and ch
Microlecture 1/1 Introduction to the Starts 18 Apr
Microlecture 1/2 Case study Starts 18 Apr
Microlecture 1/3 History Starts 18 Apr
Microlecture 1/4 2 types immunity Starts 18 Apr
Microlecture 1/5 Immune origin Starts 18 Apr
Microlecture 1/6 Immune Starts 18 Apr
Practice exam questions H1
SlimStampen - Chapter 1 and 2
Wednesday April 17
Visible
Add Existing
My Lessons
Immunopharmacolo...
Chapter 1 and 2
Practice
Facts Overview
Statistics
Chapter 1 and 2
These are key facts from chapters 1 and 2 of Basic Immunology by Abbas/Lichtman/Pillai
Art & culture
Multiple choice
0x practiced 0 minutes
Mastery crowns
Today
Practice time
8 min
1m
Start
Unpracticed
20 of 20
Which of the following tissues is a secondary lymphoid organ?
Spleen
New!
Which of the following tissues is a secondary lymphoid organ?
1 Thymus
2 Spleen
3 Bone marrow
4 Liver

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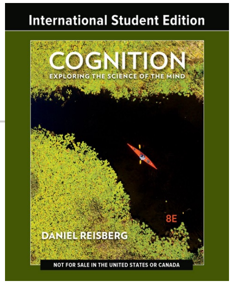

Cognitive Psychology

- Students have to know all glossary items by heart (of some of these, the definition will be given on the exam, with the answer being the term)
  - Account for 30% of total grade

- Previous years: students could use MemoryLab to study (=> 6.2/10 grade)

- 2023-2024: ***if*** two Mastery Credits per chapter were obtained, students were garanteed a ***7.5/10 grade*** on the fact-part of the exam.

  - The exam could also be taken without MemoryLab studying.

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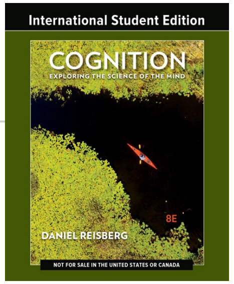
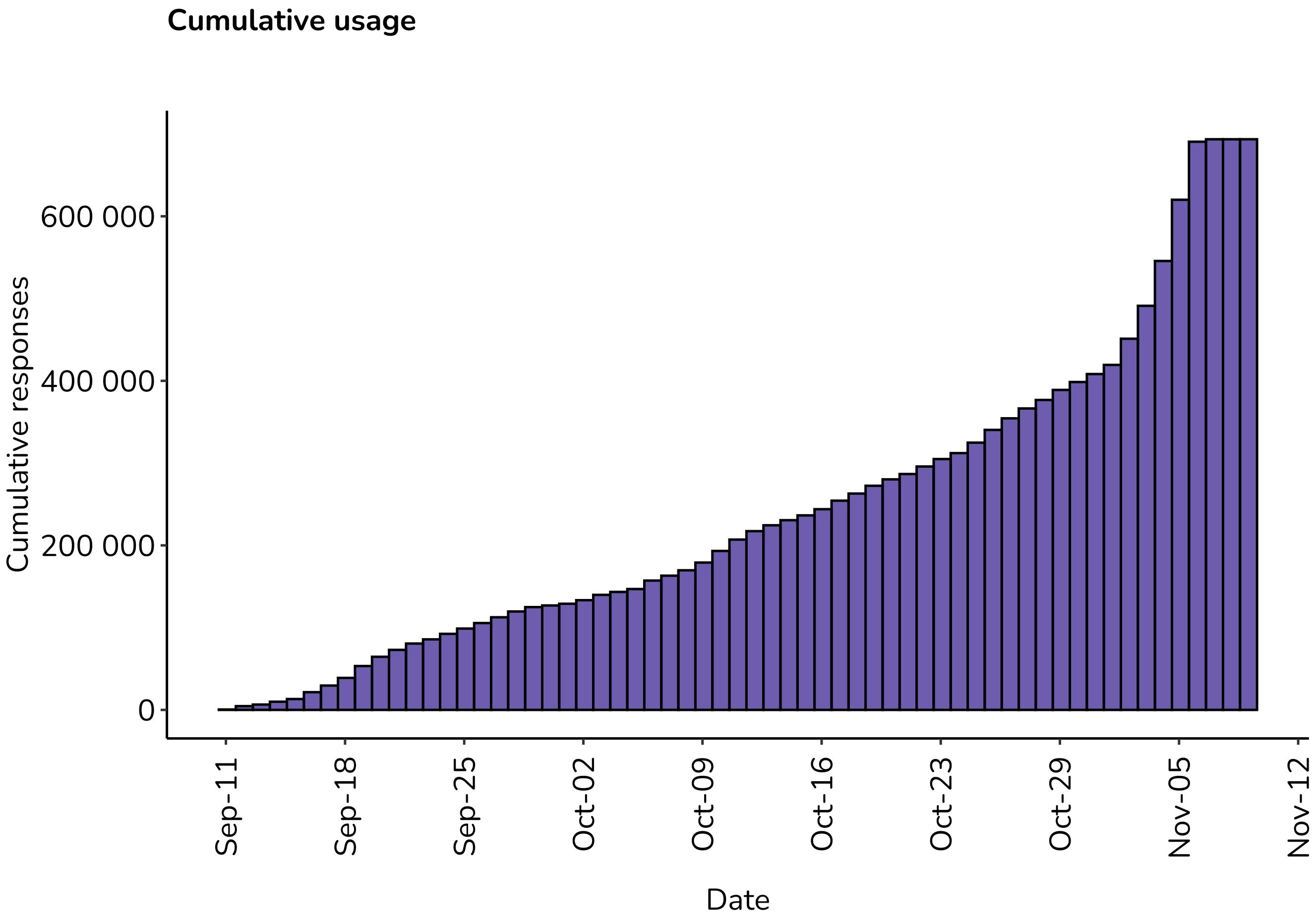
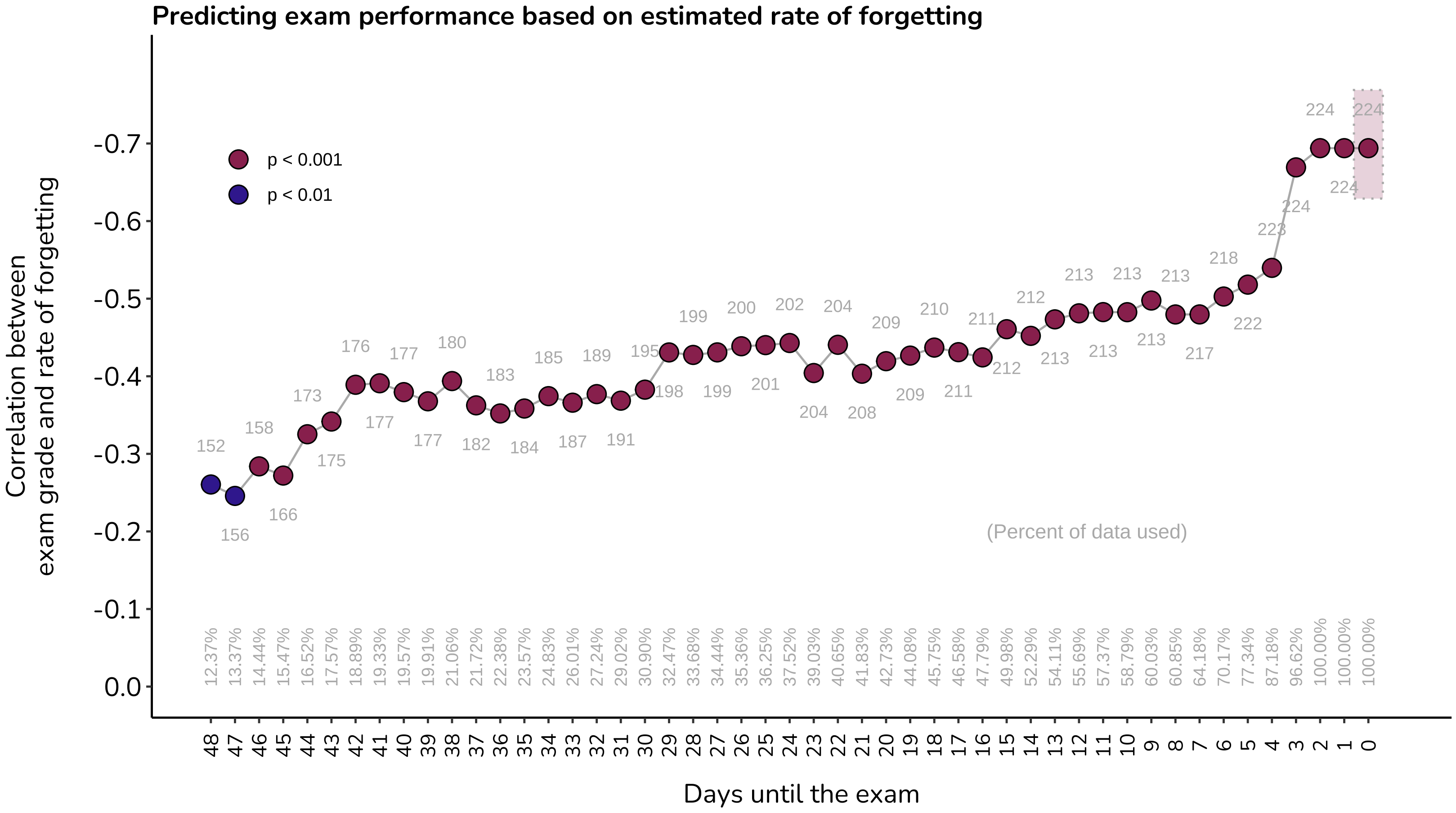


Students Start Earlier!



Data: RuG Cognitive Psychology 2023/2024

Prediction accuracy increases



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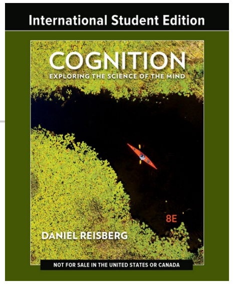
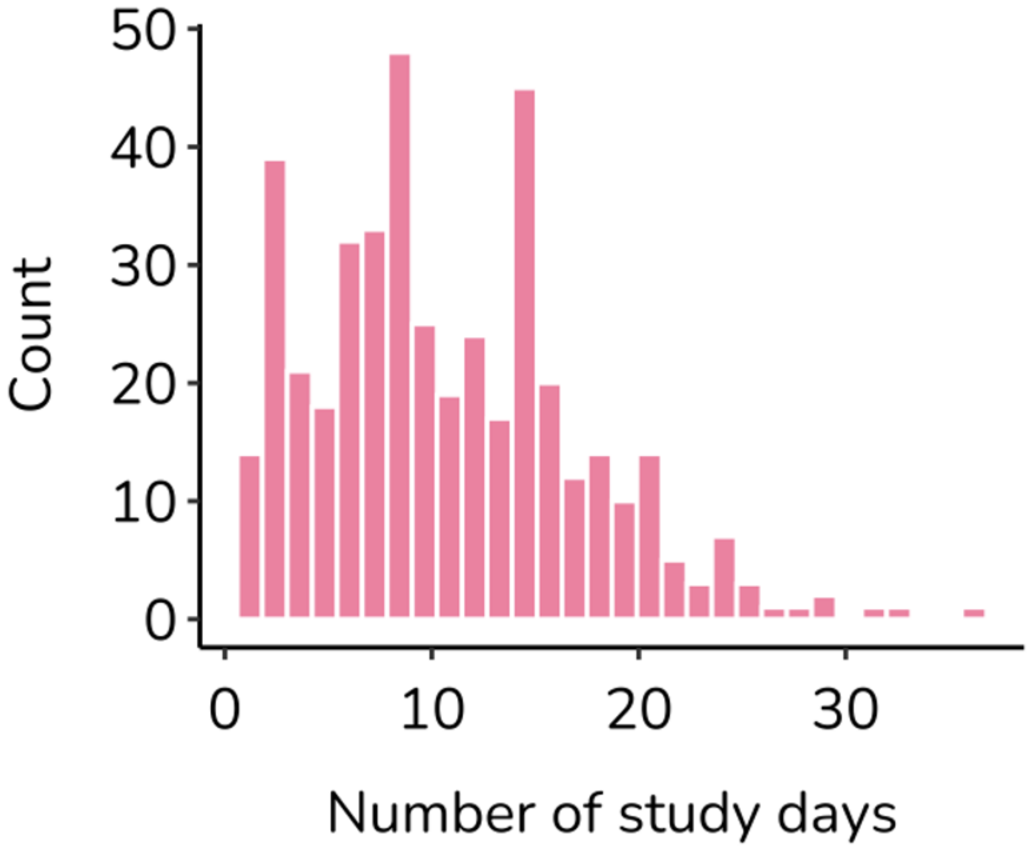


Students Distribute Learning



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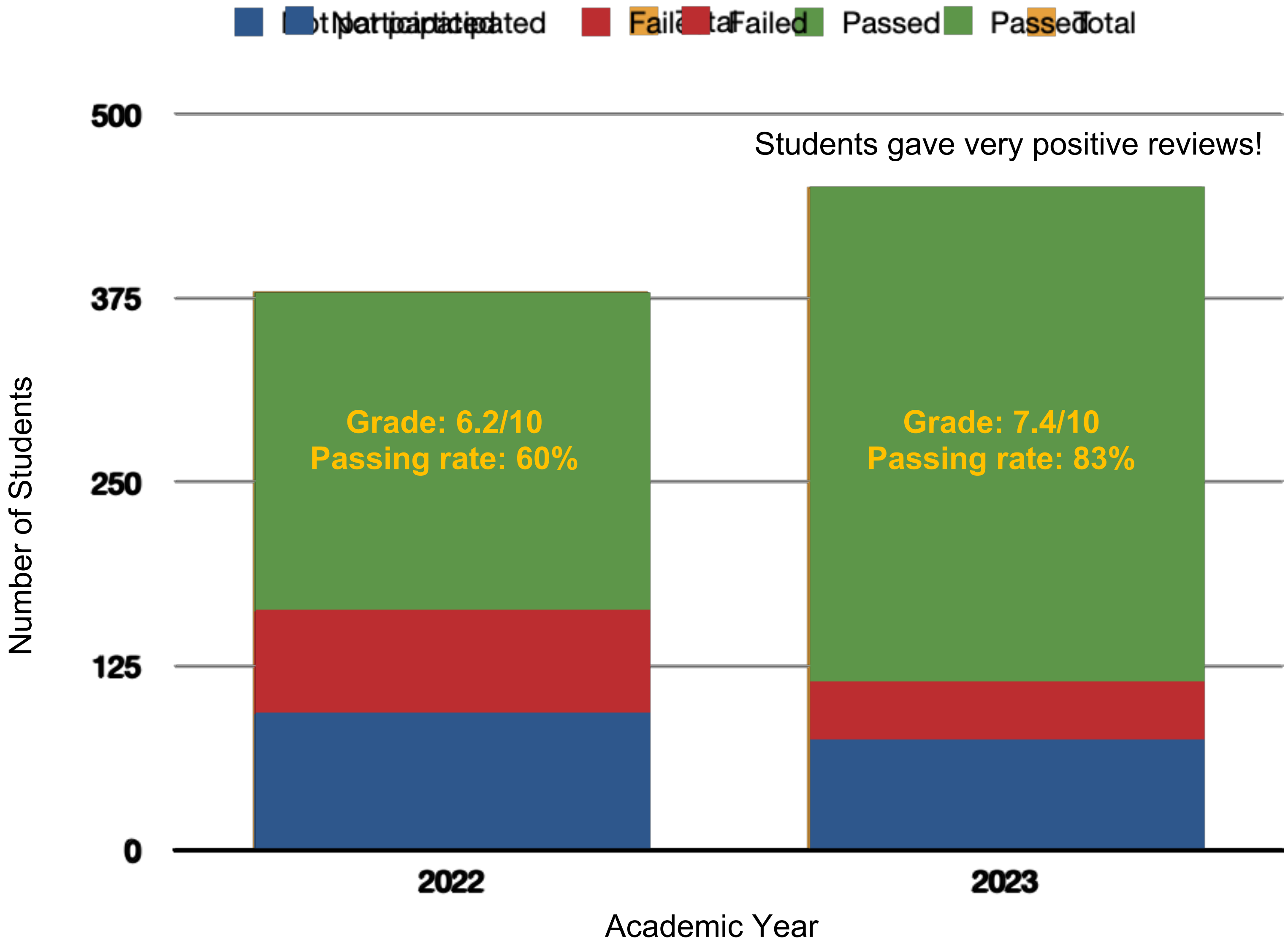
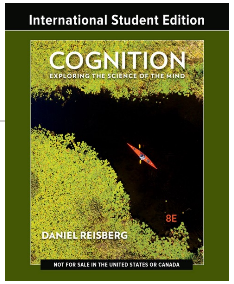
Proof of the Pudding





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