interpreting quantitative data

Based on experiments and results from:

Henry L. Roediger, III, and Jeffrey D. Karpicke (2006). Test-Enhanced Learning: Taking Memory Tests Improves Long-Term Retention. *Psychological Science*, *17*(3), 249-255.

Testing effect

APA Dictionary of Psychology

- Taking tests on previously studied material leads to better retention compared to restudying that same material for the same amount of time
- This suggests that testing (*retrieval practice*) can be used as a learning tool, as exams or tests seem to activate retrieval processes that facilitate learning and effective storage in the long-term memory
- Testing effect has typically been studied using verbal learning: memorizing word lists or picture lists

Aims of the paper

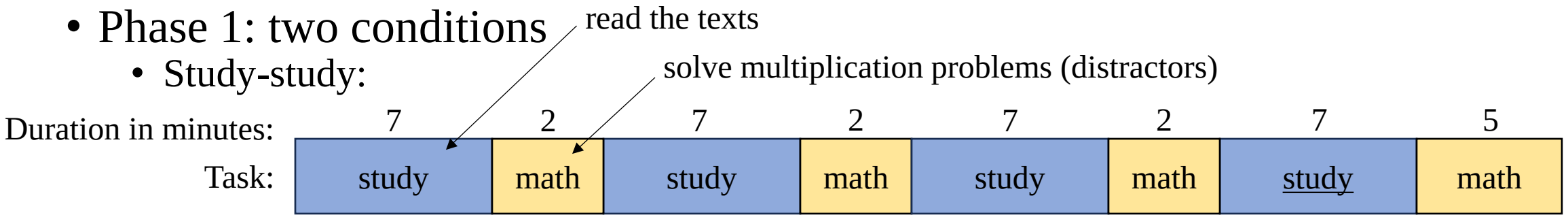
Henry L. Roediger, III, and Jeffrey D. Karpicke (2006). Test-Enhanced Learning: Taking Memory Tests Improves Long-Term Retention. *Psychological Science, 17*(3), 249-255.

- Two experiments investigating the testing effect under educationally relevant conditions using free-recall tests (similar to essay exams)
- Also determine whether testing is better for learning than simply re-studying the same material again

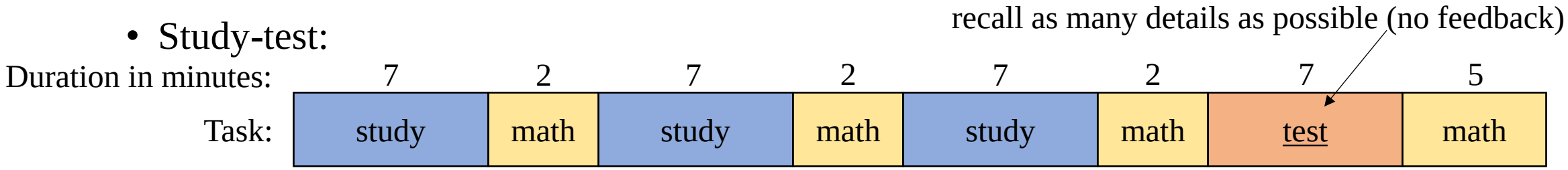
- Why is this article interesting for practitioners? → This is an example of experimental research that informs evidence-based teaching practices.

Experiment 1: procedure

- Two simple text passages; each passage contained 30 idea units (pieces of information contained in the story)
- Phase 1: two conditions
  - Study-study:



  - Study-test:



- Phase 2:
  - at one of three time points: 5 minutes, 2 days, or 1 week after Phase 1
  - participants recalled both passages they read in Phase 1

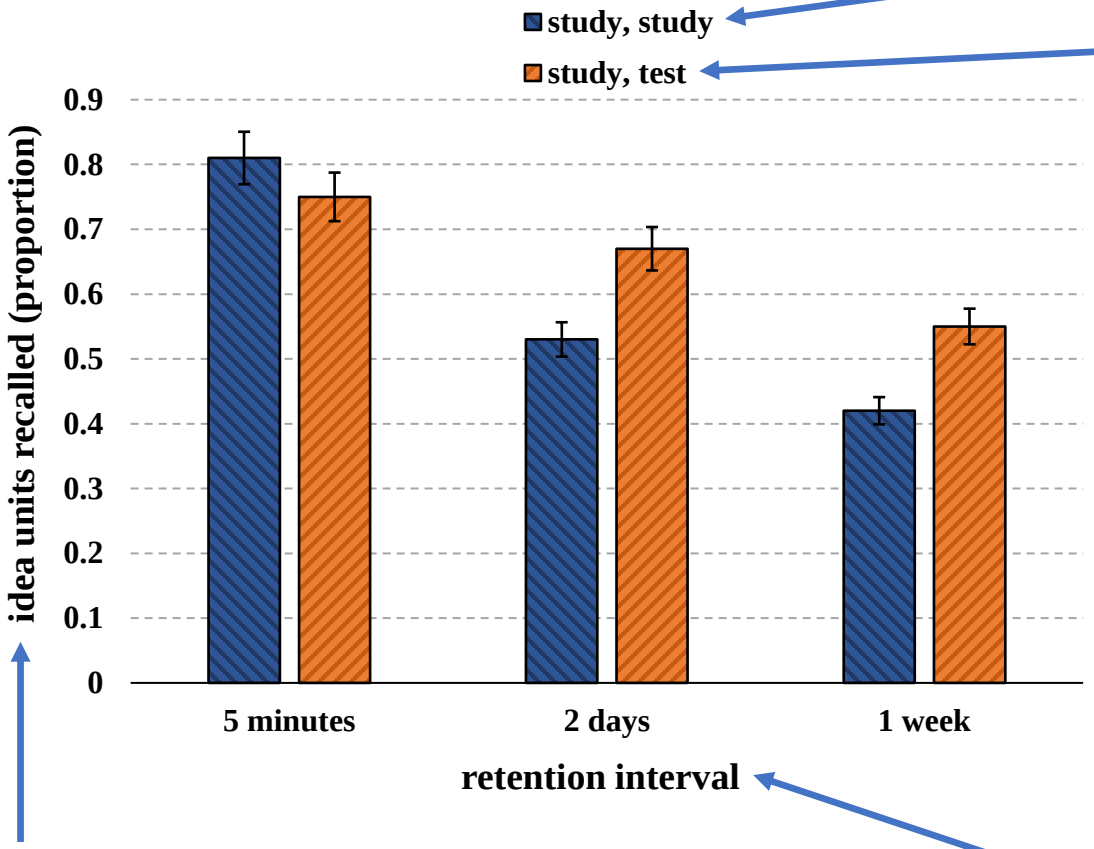
Experiment 1: procedure

- 2 x 3 design

		Phase II		
		5 minutes	2 days	1 week
Phase I	study-study			
	study-test			

note: this graph represents the trends found by Roediger & Karpicke (2006); it does not represent the exact data from the study

Experiment 1: results



participants read the story four times and took no recall tests during phase 1

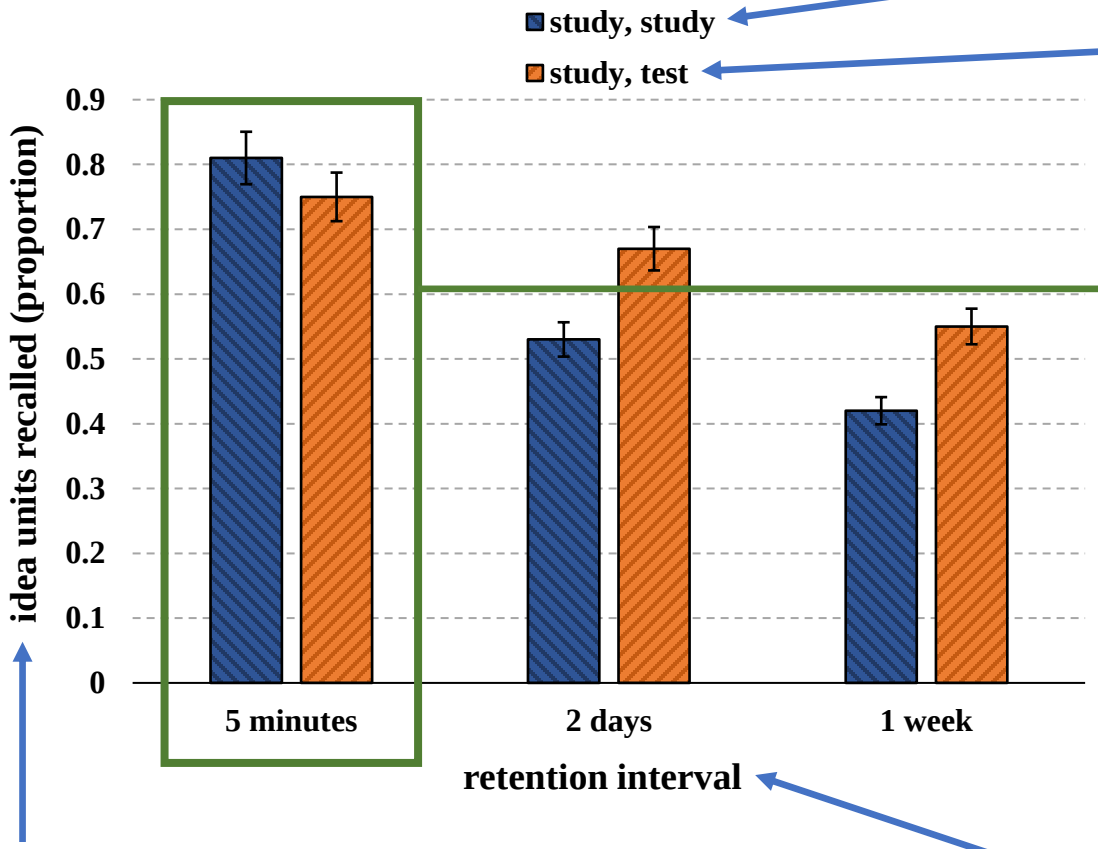
participants read the story three times and then took one recall test during phase 1

How well participants remembered the story

Period between Phase 1 and Phase 2 (recall only)

note: this graph represents the trends found by Roediger & Karpicke (2006); it does not represent the exact data from the study

Experiment 1: results



participants read the story four times and took no recall tests during phase 1

participants read the story three times and then took one recall test during phase 1

participants who read the story twice, and then five minutes later took the recall test

remembered more details about the story as compared to

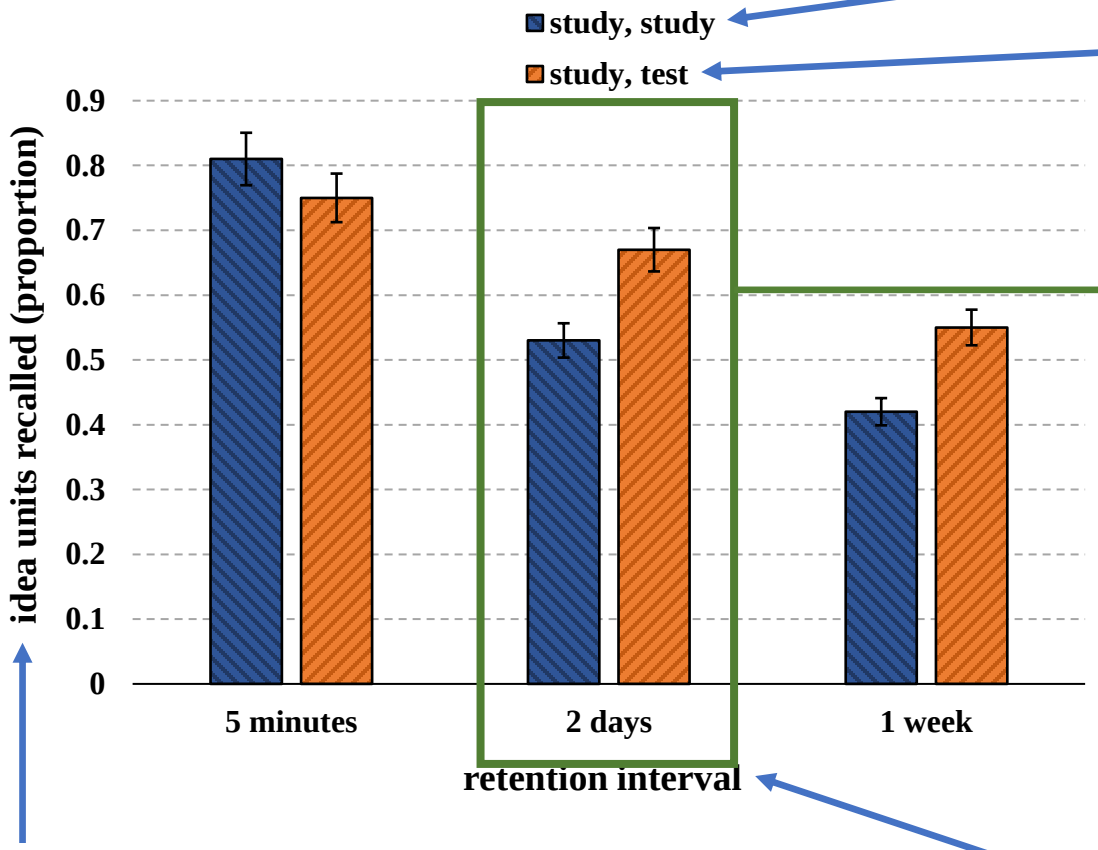
participants who read the story once, then took a recall test, and then took another test five minutes later

How well participants remembered the story

Period between Phase 1 and Phase 2 (recall only)

note: this graph represents the trends found by Roediger & Karpicke (2006); it does not represent the exact data from the study

Experiment 1: results



participants read the story four times and took no recall tests during phase 1

participants read the story three times and then took one recall test during phase 1

HOWEVER!
participants who read the story twice, and then two days later took the recall test

remembered fewer details about the story as compared to

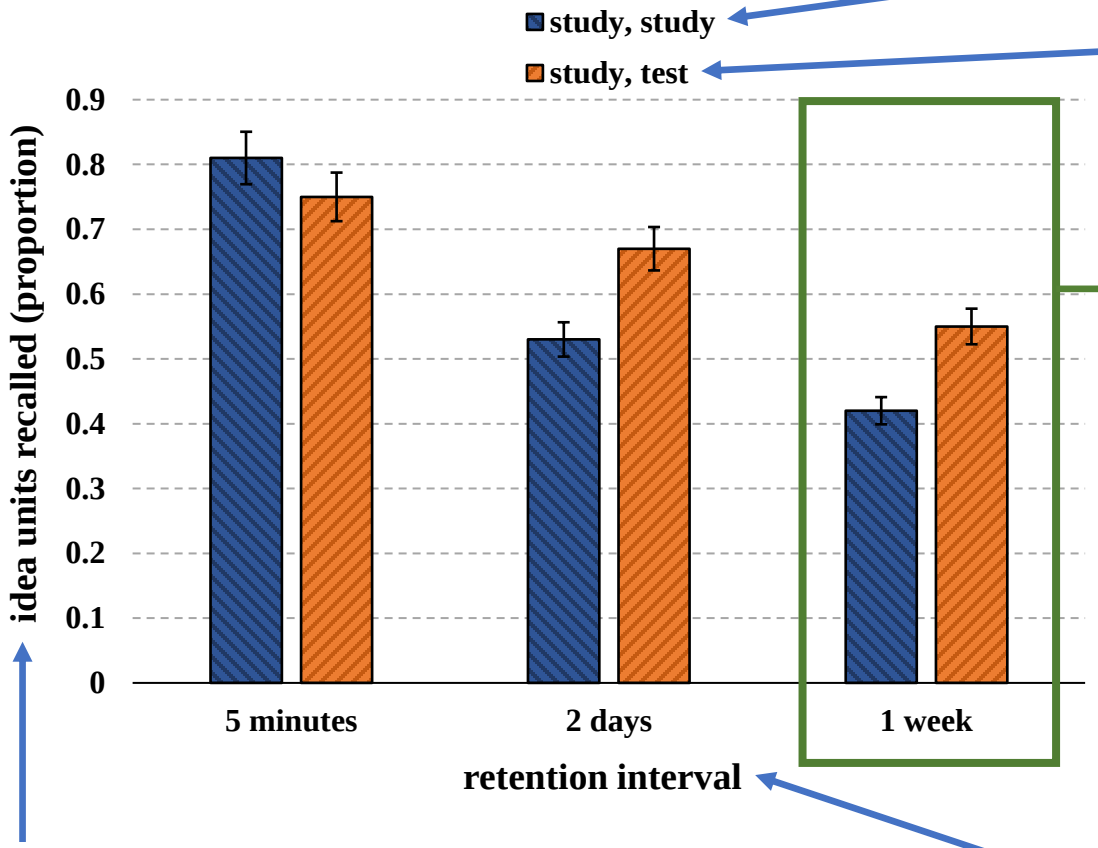
participants who read the story once, then took a recall test, and then took another test two days later

How well participants remembered the story

Period between Phase 1 and Phase 2 (recall only)

note: this graph represents the trends found by Roediger & Karpicke (2006); it does not represent the exact data from the study

Experiment 1: results



participants read the story four times and took no recall tests during phase 1

participants read the story three times and then took one recall test during phase 1

ALSO!
participants who read the story twice, and then one week later took the recall test

remembered fewer details about the story as compared to

participants who read the story once, then took a recall test, and then took another test one week later

How well participants remembered the story

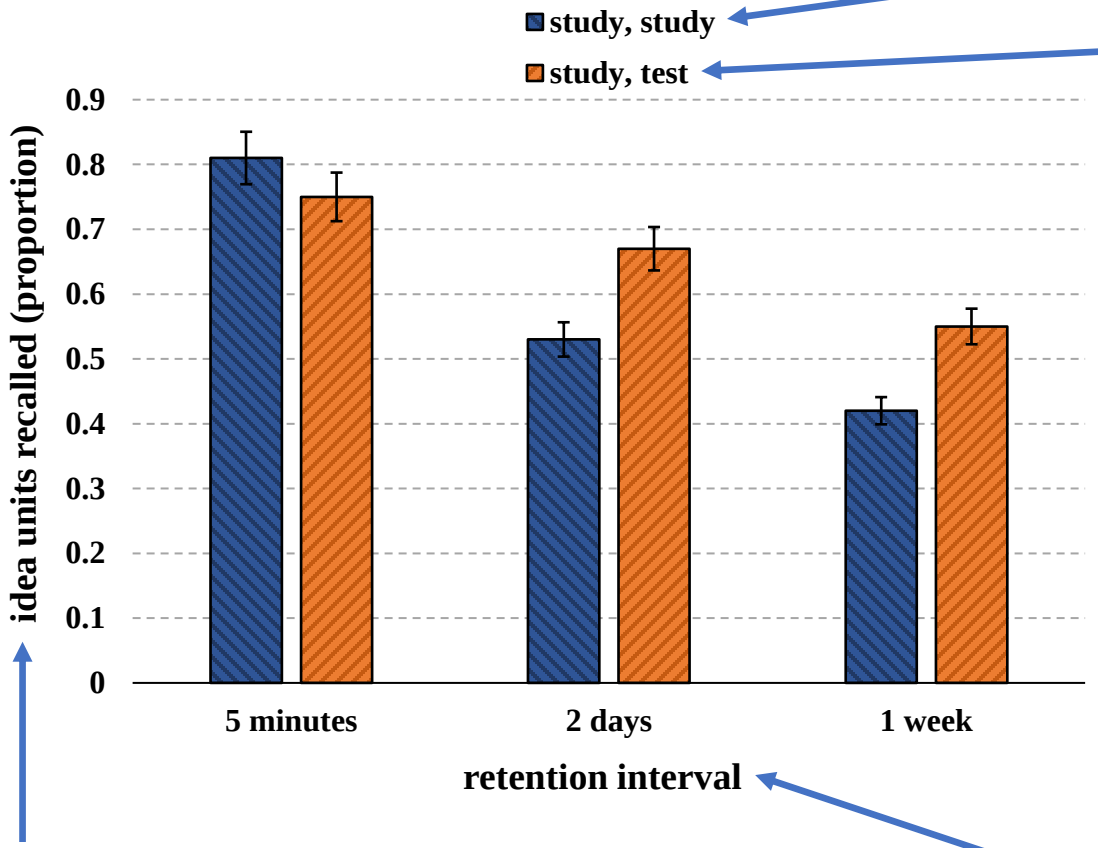
Period between Phase 1 and Phase 2 (recall only)

note: this graph represents the trends found by Roediger & Karpicke (2006); it does not represent the exact data from the study

Experiment 1: results

participants read the story four times and took no recall tests during phase 1

participants read the story three times and then took one recall test during phase 1



RESULTS SUMMARY:

- Overall, initial testing produced better final recall than additional studying
- The longer the retention interval, the more forgetting occurred
- Restudying produced better performance on the 5-minute test, but testing produced better performance on 2-day and 1-week tests

How well participants remembered the story

Period between Phase 1 and Phase 2 (recall only)

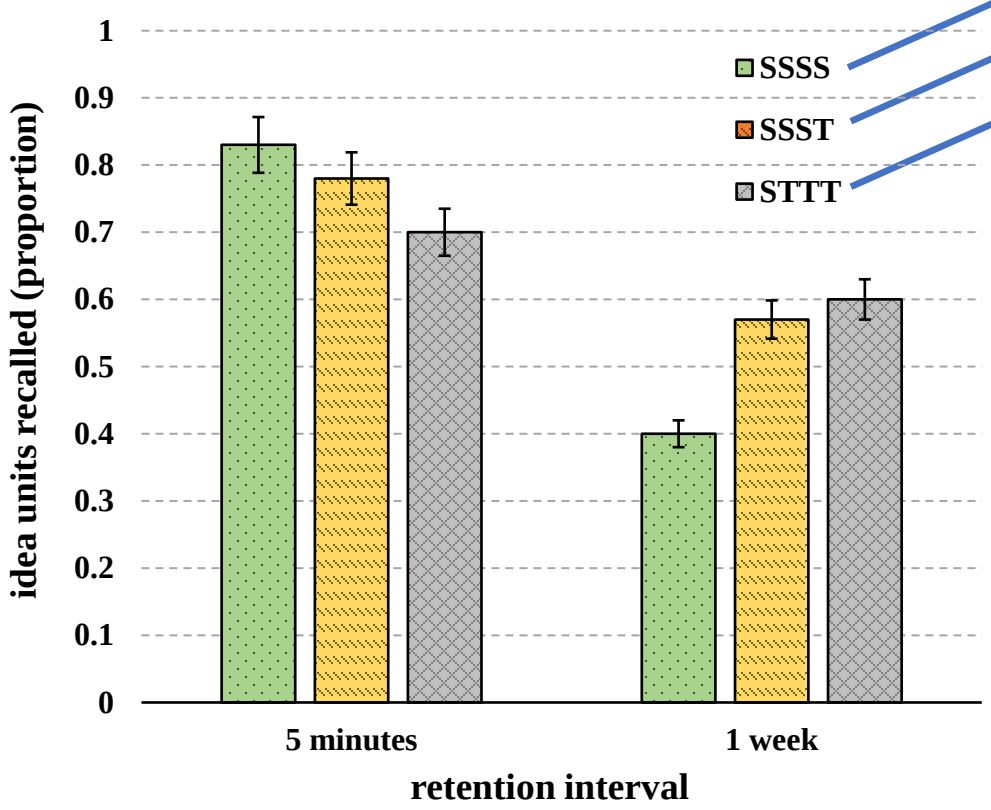
Experiment 2: procedure

- Three conditions:
  - Participant studied a passage four times and took no test: SSSS
  - Participant studied a passage three times and took one test: SSST
  - Participant studied a passage one time and took three tests: STTT
- Then final test:
  - 5 minutes later or
  - 1 week later

		Condition		
		SSSS	SSST	STTT
Final test	1 week later			
	5 minutes later			

note: this graph represents the trends found by Roediger & Karpicke (2006); it does not illustrate the exact data from the study

Experiment 2: results



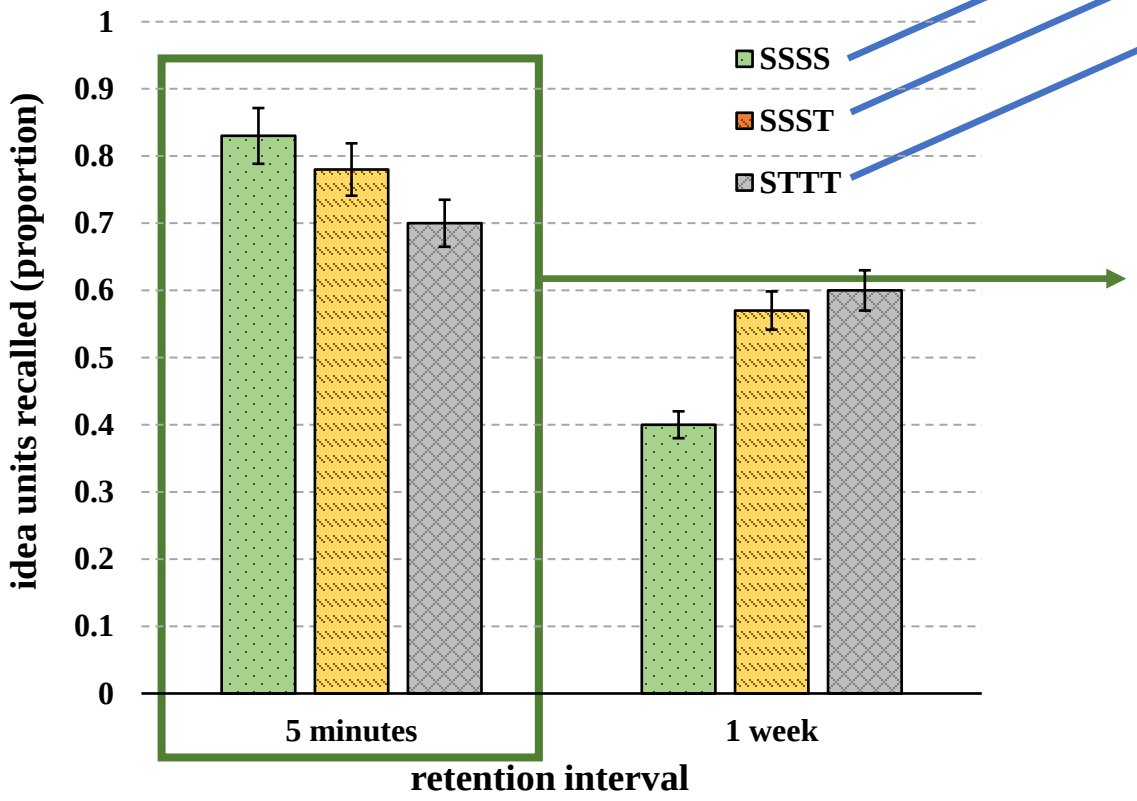
Participants read the story 4 times, never wrote a test

Participants read the story 3 times, and wrote 1 test

Participants read the story 1 time, and wrote 3 tests

note: this graph represents the trends found by Roediger & Karpicke (2006); it does not illustrate the exact data from the study

Experiment 2: results



Participants read the story 4 times, never wrote a test

Participants read the story 3 times, and wrote 1 test

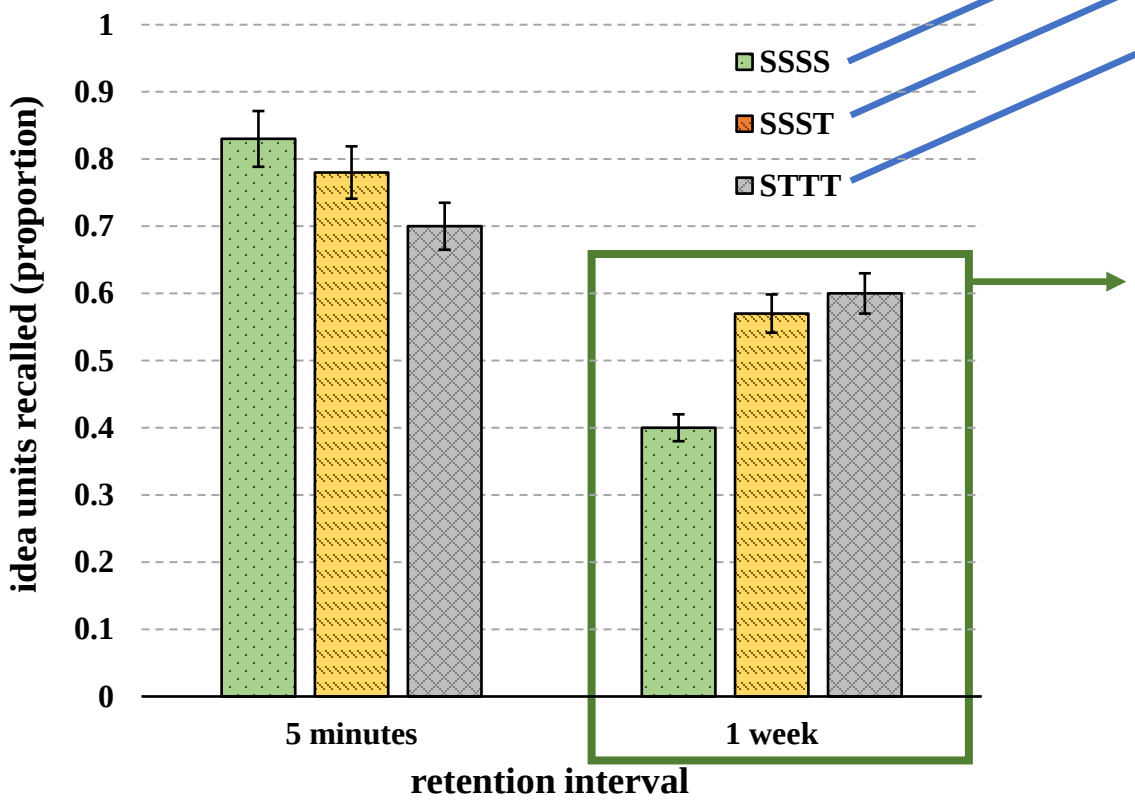
Participants read the story 1 time, and wrote 3 tests

participants who read the story more times, and wrote fewer tests, remembered more details about the story 5 minutes later

more studying = better short term recall
more testing = worse short term recall

note: this graph represents the trends found by Roediger & Karpicke (2006); it does not illustrate the exact data from the study

Experiment 2: results



Participants read the story 4 times, never wrote a test

Participants read the story 3 times, and wrote 1 test

Participants read the story 1 time, and wrote 3 tests

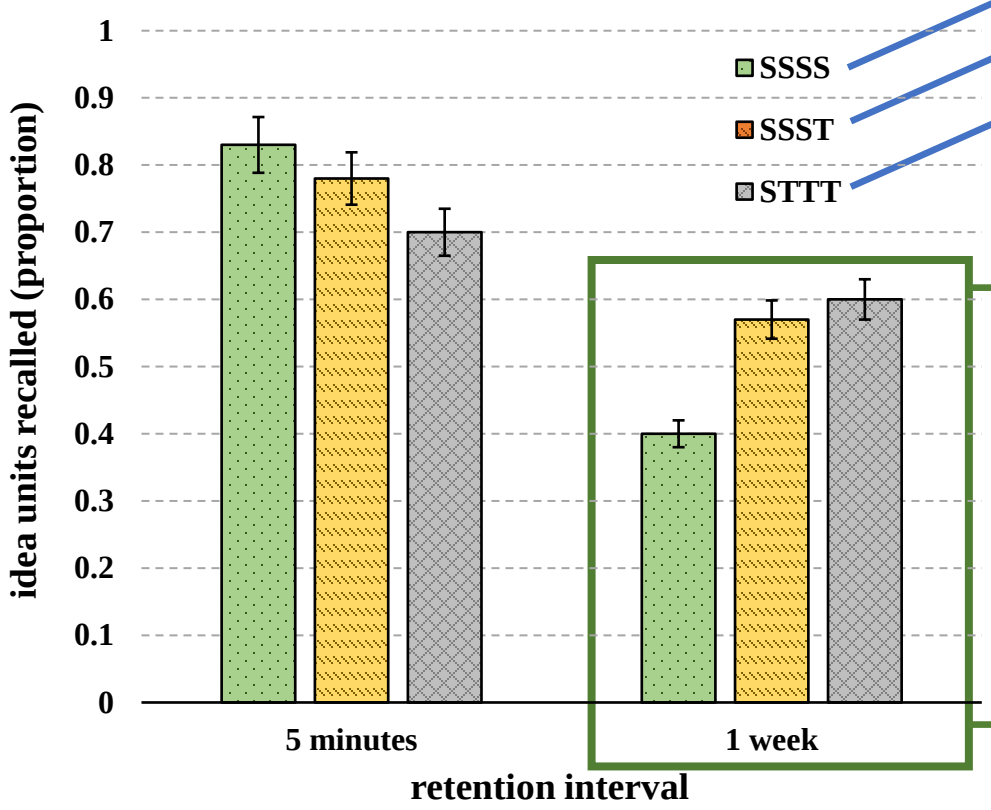
participants who wrote more tests recalled the story better after 1 week

more studying = worse long term recall
more testing = better long term recall

note: the graphs represent the trends found by Roediger & Karpicke (2006); they do not illustrate the exact data from the study

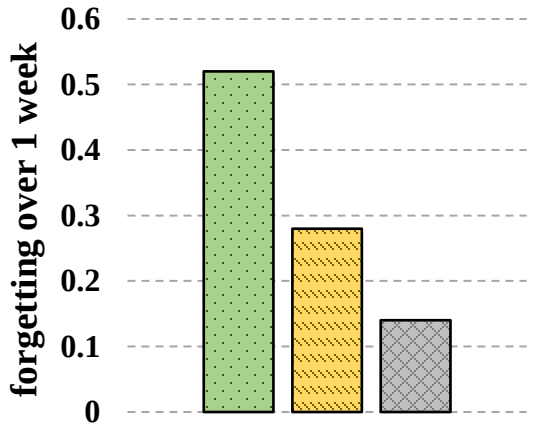
Experiment 2: results

Participants read the story 4 times, never wrote a test
Participants read the story 3 times, and wrote 1 test
Participants read the story 1 time, and wrote 3 tests



participants who wrote more tests recalled the story better after 1 week

more studying = worse long term recall
more testing = better long term recall



more studying = more forgetting in long term

more testing = less forgetting in long term

Discussion (1)

- Both experiments showed the same pattern: immediate testing after reading a prose passage promoted better long-term retention compared to repeatedly studying the passage.
- There was no feedback given for the tests, so participants could not check their answers: this effect was achieved only because there was an act of taking an (ungraded) test.
- Why?

Discussion (2): possible explanations

- Theories of transfer-appropriate processing: cognitive operations engaged during learning are compatible with the operations engaged during testing. If you learn a passage then get tested on it, you practiced test-taking skills which then help you perform better on subsequent tests.
  - Practicing retrieval skills during learning enhances retention
- Testing enhances learning by producing elaboration of existing memory traces.
- Repeated studying inflated students' confidence to remember passages in the future but it does not actually improve memory; students are overconfident in an ineffective learning strategy.

Main experimental finding

Taking Memory Tests Improves Long-Term Retention

Or: students who take more tests, as compared to students who study more, can recall more information after a long time.

What happens if you read the findings, but did not carefully read the methods section? → literal interpretation of the main finding

Literal interpretation of main finding:

Taking Memory Tests Improves Long-Term Retention

I want my students to memorize things without thinking about them critically, I want my students to memorize things and never forget them, and I will torture my students with repeated exams (instead of actually fostering their learning in the classroom) to achieve that goal.

Well… this sucks. And if we are evidence-based educators, then we should take these data presented by authors, and amend our teaching practice to include more exams. Even if that means our students will hate us. Correct?

Not really. Let's think about the findings from this article critically first.

Critical interpretation of main finding:

Taking Memory Tests Improves Long-Term Retention

I want my students to remember information, I want my students to remember that information for as long as possible, and to achieve that goal I will ask my students to re-tell me the information in their own words right after they learned it.

This sounds a little more palatable.

So how can we apply this in the classroom?

Summary

- When reading experimental and quantitative studies, you must critically assess actual methods and data, not just take other people's recommendations and interpretations of data at face value.
  - You could be misinterpreting authors' recommendations simply because you did not read all the information.
- In assessing data from experimental studies, look at:
  - What do the numbers *actually* represent? Think about how those data were collected, how the experimental design was implemented, what kind of tasks participants completed and under what circumstances.
  - Remember this trap of "testing" here: when we hear the word "test", we think exams and assessments and standardized scores. But the "test" in this article was simply a situation where students were retelling the story they read before. Another word for retelling a story would be "practice." The authors showed that retelling information improves how well we remember that information.