How should Students Study?

(*and How Should Educators Teach?)*

Evidence from Cognitive Science

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Thanks to Mark McDaniel & Roddy Roediger, Washington University, Bob Bjork, UCLA, John Dunlosky & Katherine Rawson, Kent State,

“Total Study Time = Learning”

Implicitly Adopted by Students

Expectation that grade is a function of time (or maybe time + effort….)

Implicitly Encouraged by Educator

We emphasize how much time students should spend studying, even ask about “time spent” on evaluations

Bjork's "Desirable Difficulties"

Techniques that promote long-term retention even though they slow initial learning

What Does Work? General Principles

Encourage Student-generated effort

Encourage Spaced (not Massed) Study

Incorporate *Testing* as a key part of *Learning*, not just as *assessment*

Maybe the most significant insight of the last decade

Massed v. Spaced Study

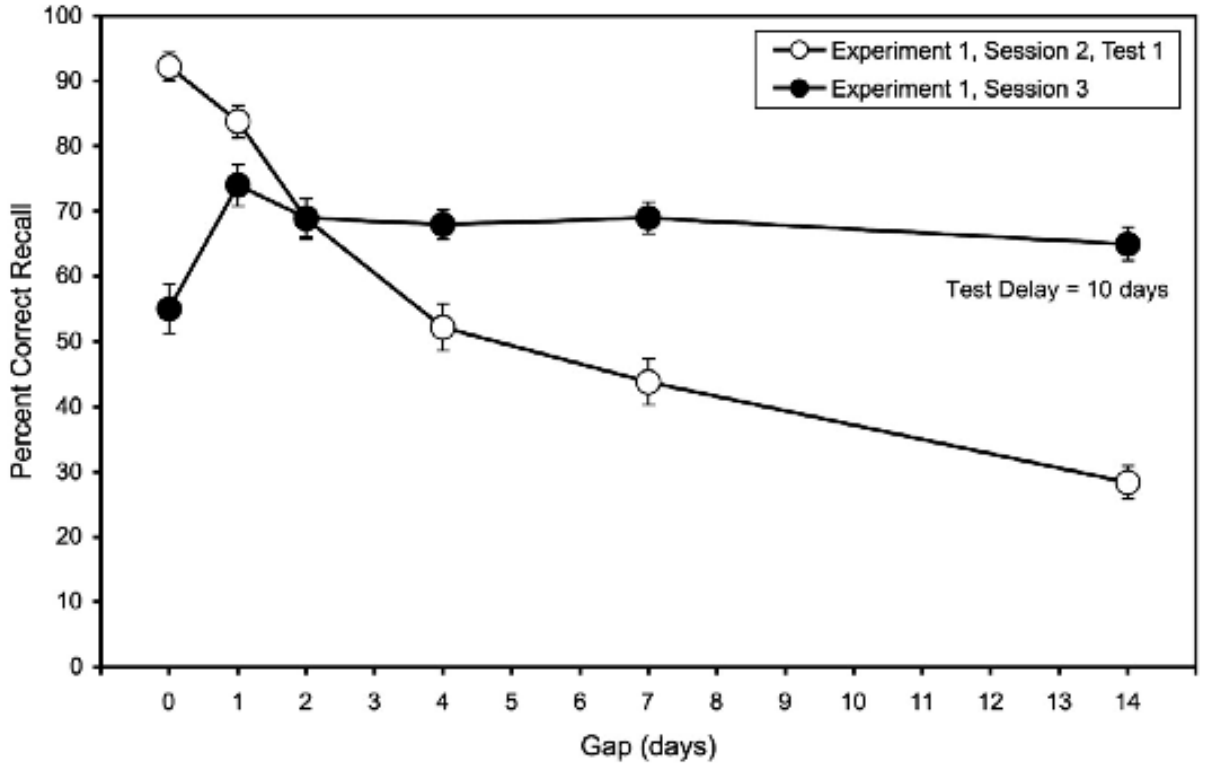


Figure 3. Percentage of items recalled during the first test of Session 2 and the final retention test, for Experiment 1. Bars represent one *SEM*. A 1-day gap produced optimal retention at the final test.

Cepeda et al (2009)

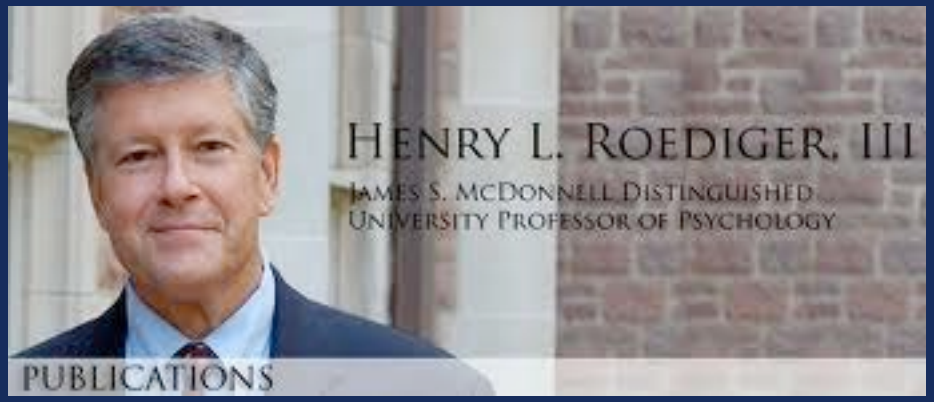
Roediger and Colleagues:

Testing as an Important Teaching Tool

Testing was considered ***assessment:***

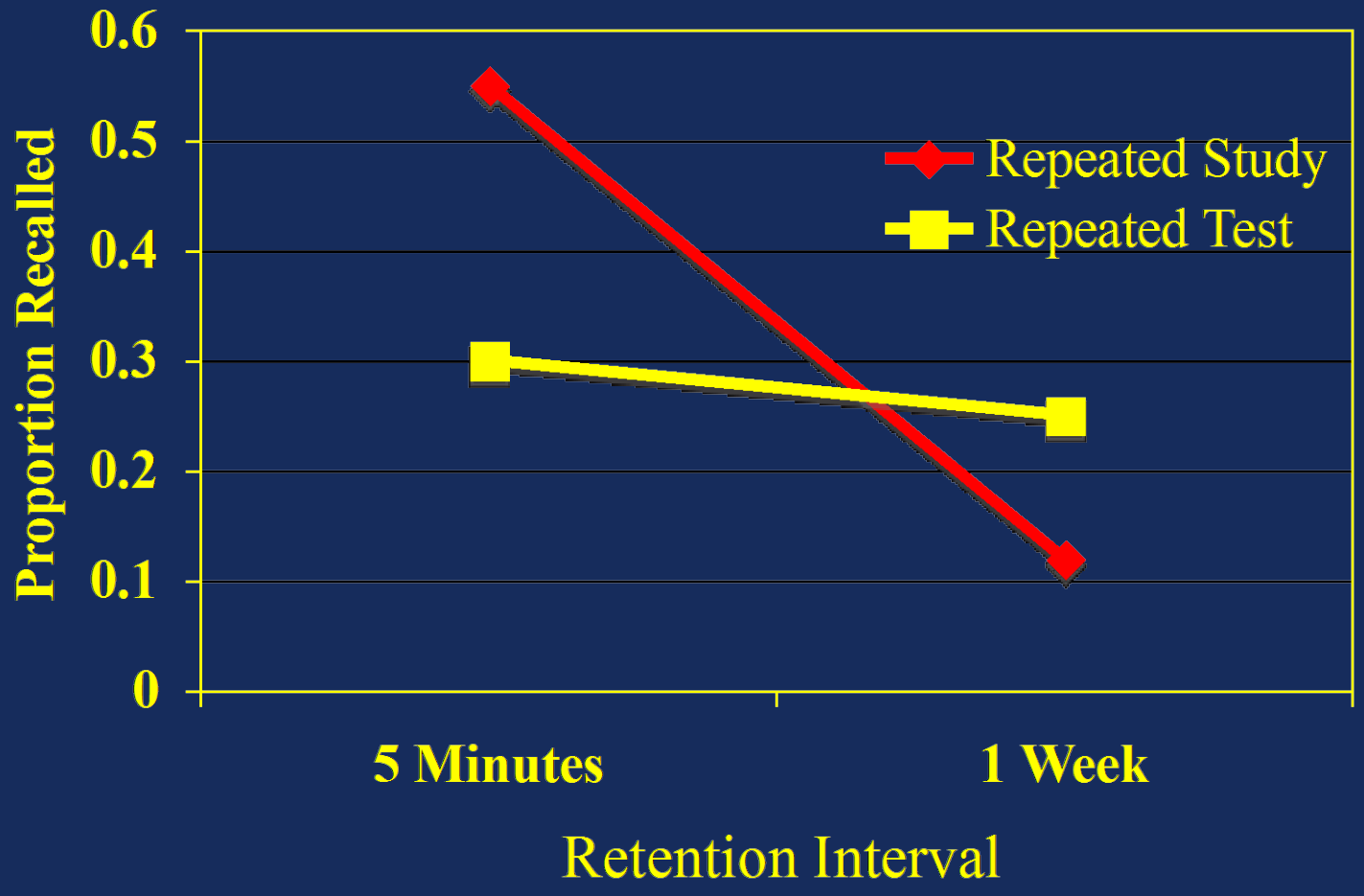
Study - Test ***Study*** - Test ***Study*** -Test . . .

Now, we recognize that testing produces large gains in ***learning***



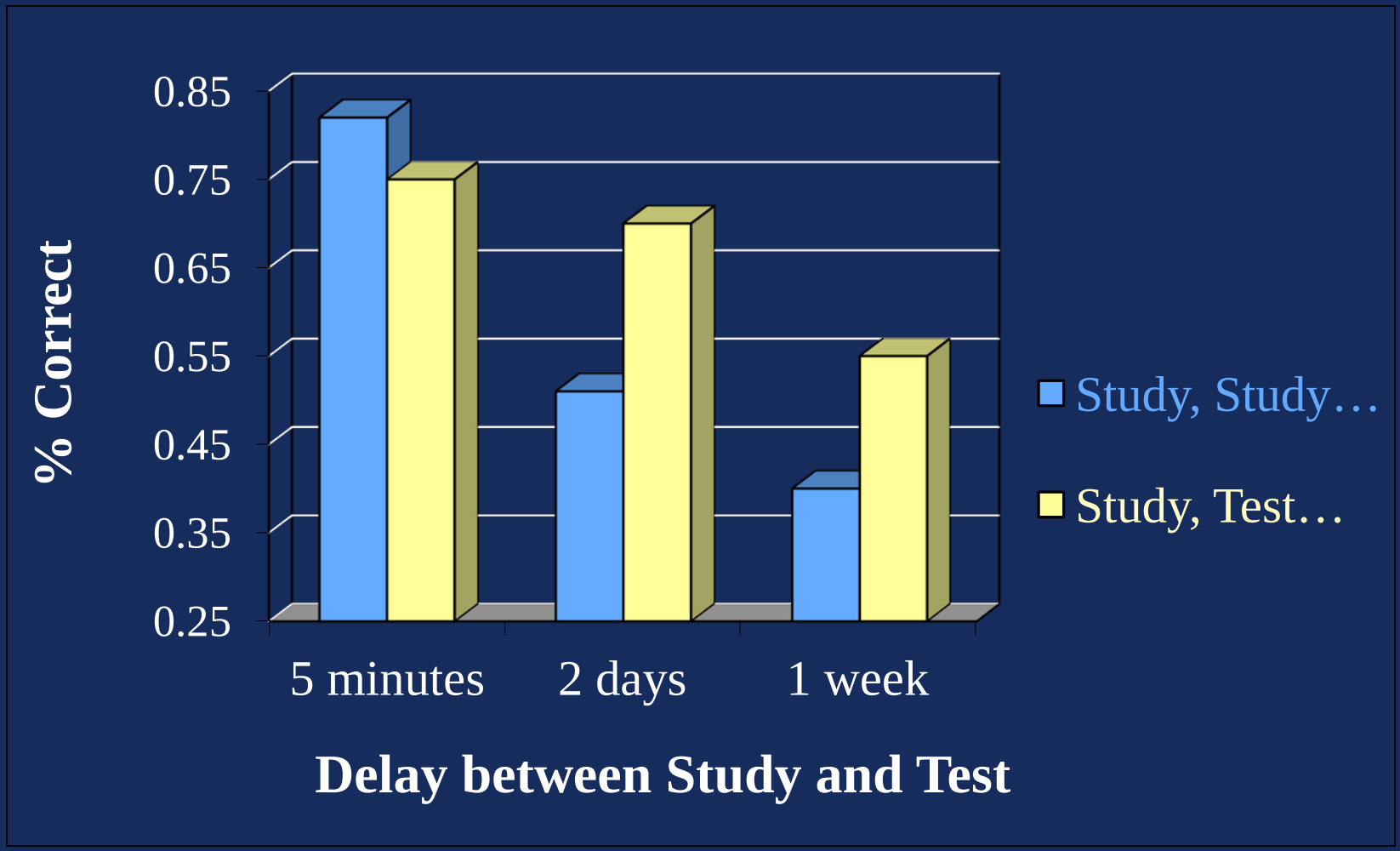
Roediger & Karpicke (2006)

Compared "Frequent study" to "Frequent Test"



Roediger & Karpicke (2006)

True even if testing time takes away from study time!



Smith, Roediger, & Karpicke (2013)

True even if testing is "covert" (silent)

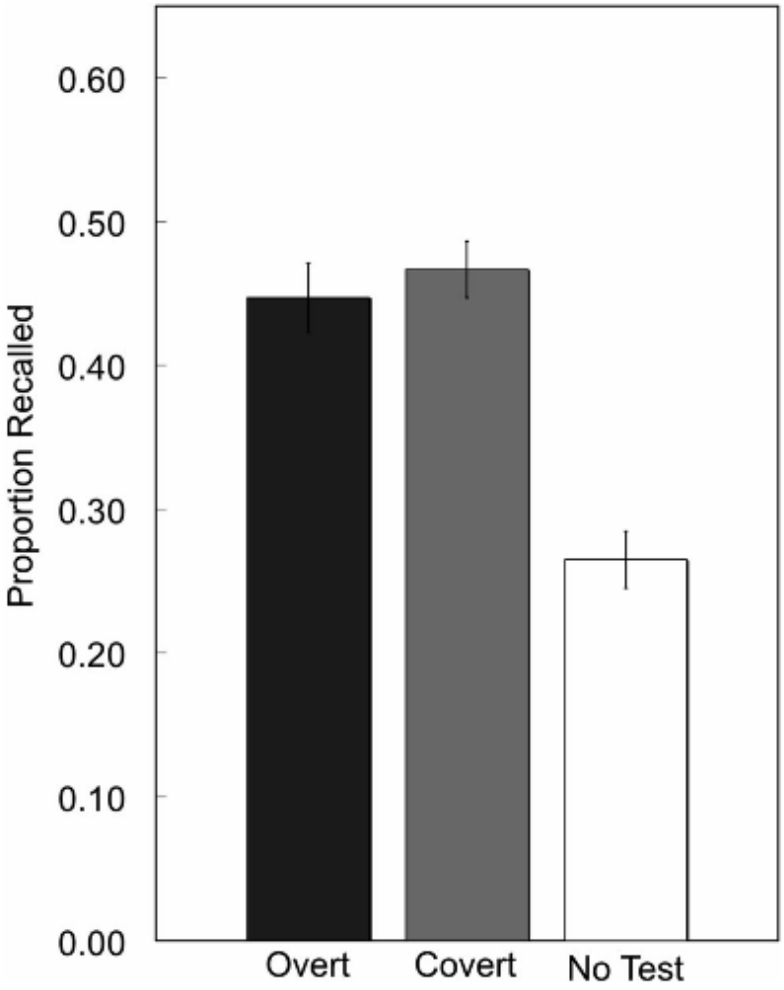


Figure 1. Performance on the final free recall test for the overt retrieval, covert retrieval, and no test conditions in Experiment 1. Error bars represent within-subject standard errors of the mean (Cousineau, 2005; Morey,

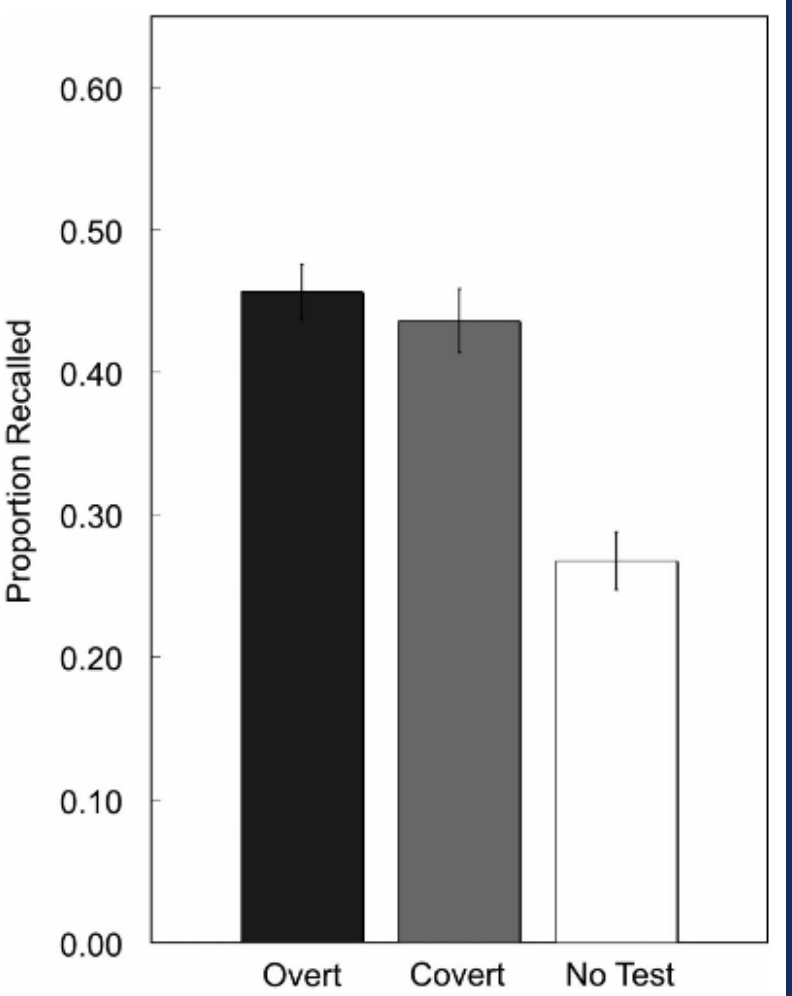
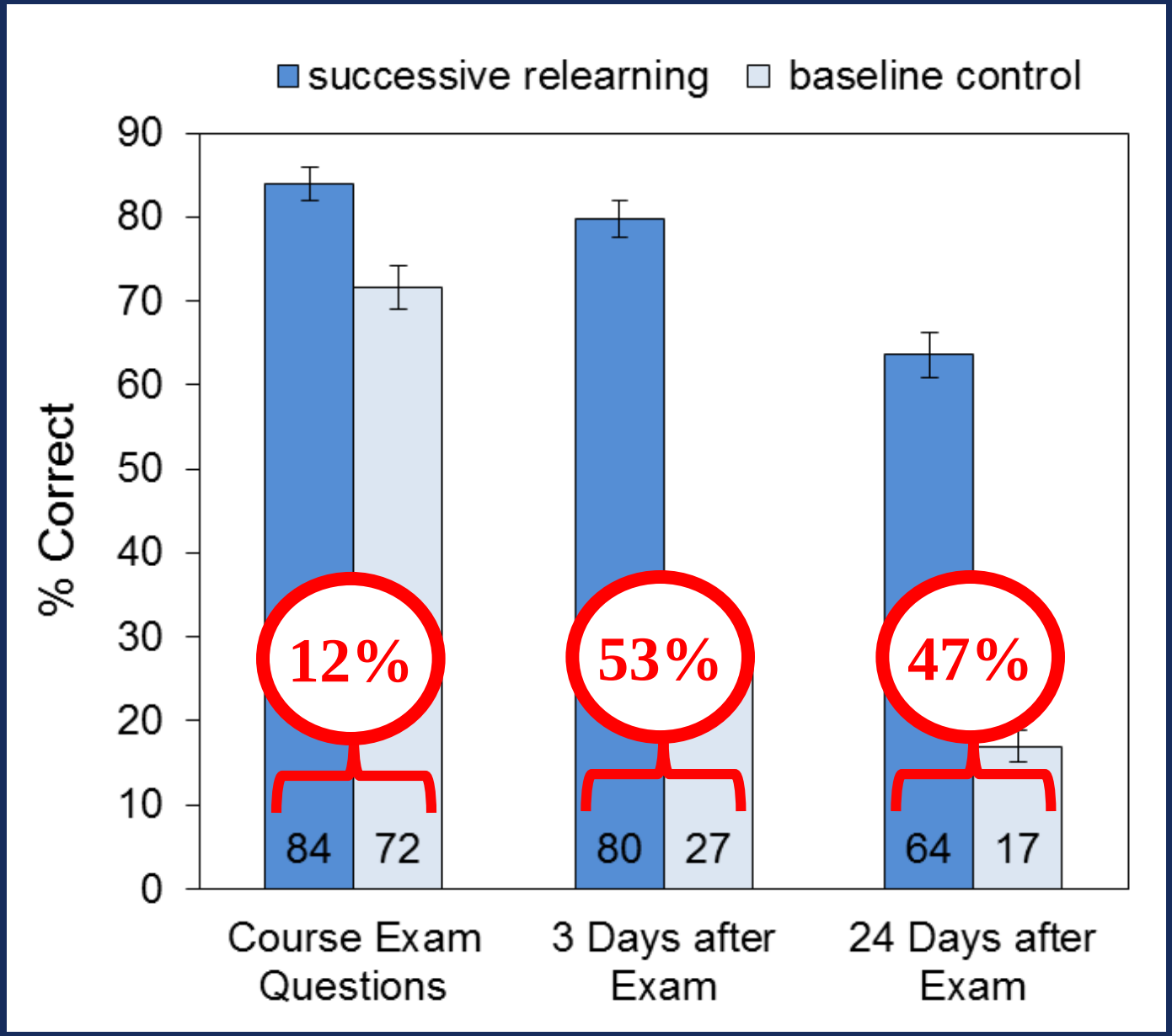


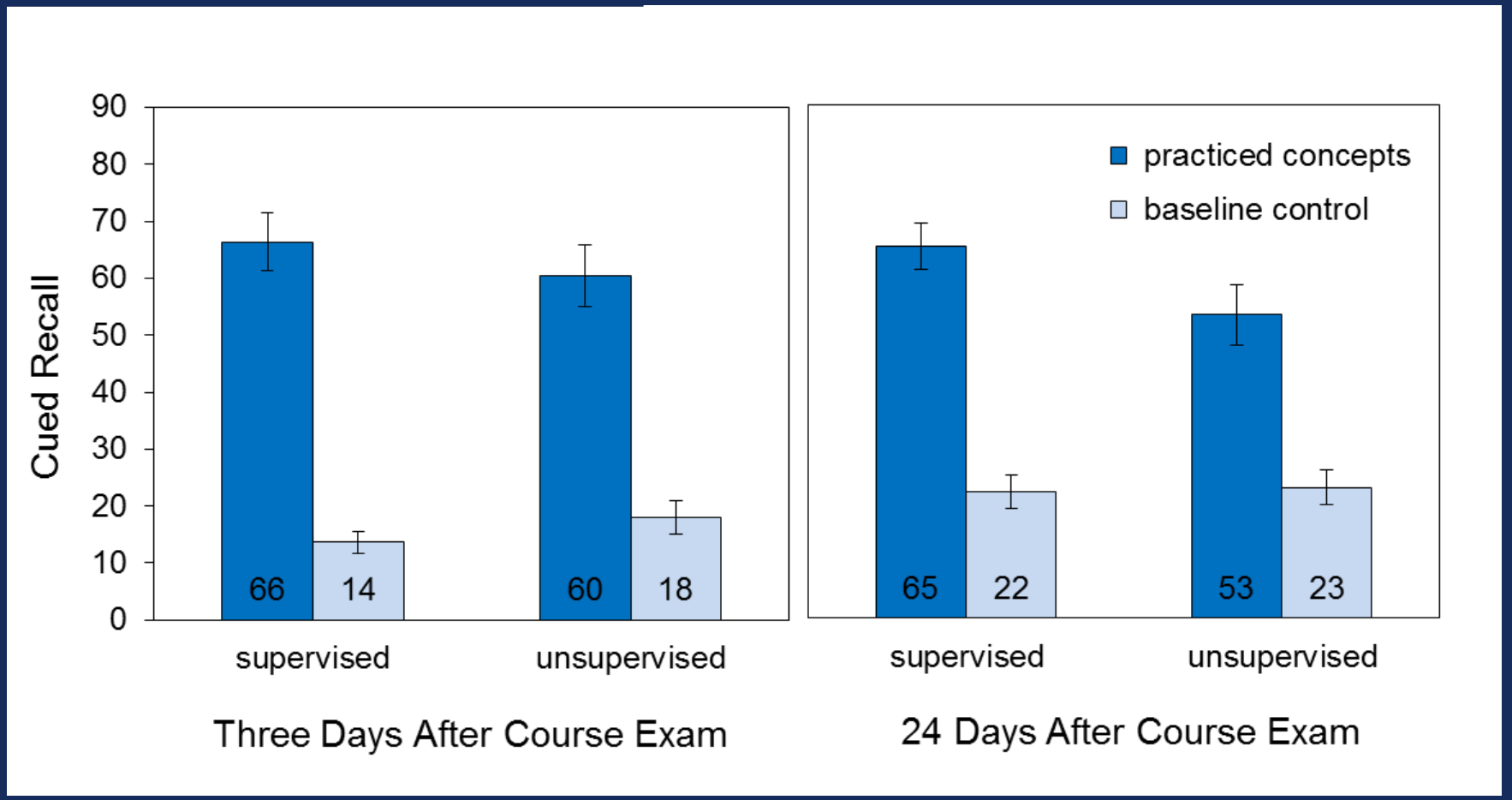
Figure 2. Performance on the final free recall test for the overt retrieval, covert retrieval, and no test conditions in Experiment 2. Error bars represent within-subject standard errors of the mean (Cousineau, 2005; Morey,



Rawson, Dunlosky, & Sciartelli (2013, *Educational Psychology Review*)

Combined Spaced, Test-driven Learning

Works with automated, unsupervised teaching



Rawson, Dunlosky, & Sciartelli (2013, *Educational Psychology Review*)

Dismiss the Hype:
Four Trendy Myths Not to Take Seriously

- *"Brain-Based Education"*
- *"Brain-Training" (e. g., Lumosity)*
- *"Study Skills" as cure-all*
- *"Learning Styles"*

Expecting too much from "**Study Skills**"

Reality:

Many students can benefit from instruction in "effective study techniques" (more to follow…)

But much mastery-related difficulty results from deficits of knowledge, not deficits of study skills

“Study Skills?”

Most significant contributor to knowledge acquisition is print exposure

Stanovich et al. (1995)

“Exposure to print was a significant predictor of vocabulary and declarative knowledge even after differences in working memory, general ability, and educational level were controlled. These results … suggest a more prominent role for exposure to print in theories of individual differences in knowledge acquisition…”

Differences in Print Exposure?

90%-ile 5th grade readers

vs.

10%-ile 5th grade readers

90th readers) have ***200 times more print exposure***

Difference increase as children get older

Serious Problem in Remedial Education

The "Matthew Effect"

"For everyone who has will be given more, and he will have an abundance. Whoever does not have, even what he has will be taken from him."
Matthew 25: 29

Good students benefit more from the same amount of instruction and practice: *the "cognitively rich get richer"*

Matthew Effect

Ritchie and Bates (2013, Psych. Science)

*"We tested the effects of mathematics and reading achievement **at age** 7 on attained SES by **age 42**…[emphasis added]*

" Mathematics and reading ability [at age 7] both had substantial positive associations with adult SES, above and beyond the effects of SES at birth, and with other important factors, such as intelligence."

The Myth of "Learning Styles?"

Hypothesis:

"Students with one learning style achieve the best educational outcome when given an instructional method that differs from the instructional method producing the best outcome for students with a different learning style. In other words, the instructional method that proves most effective for students with one learning style is not the most effective method for students with a different learning style."

Pashler et al. (2009)

What about "Learning Styles?"

Conclusion:

"… ample evidence that children and adults will, if asked, express preferences about how they prefer information to be presented to them…and that people differ in [their] aptitudes for different kinds of thinking and for processing different types of information. However, ***we found virtually no evidence for the interaction pattern mentioned above, [which is] a precondition for validating the educational applications of learning styles***."

Pashler et al. (2009)

What study/teaching techniques are effective?

aps
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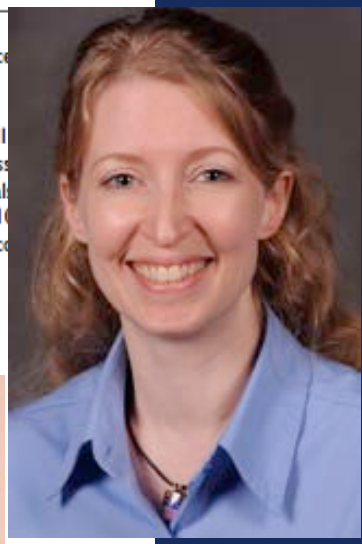
Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology



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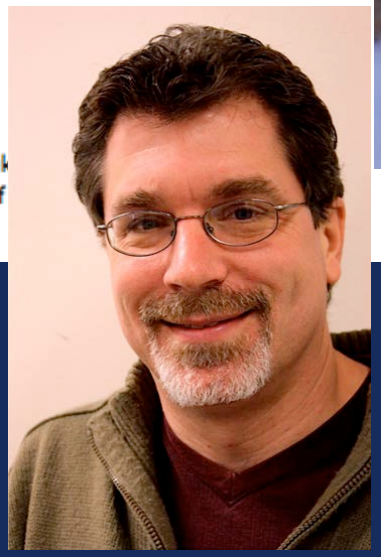

Techniques Examined

1. Elaborative interrogation	**6. Imagery for text**
	7. Rereading
2. Self-explanation	**8. Practice testing**
	9. Spaced practice
3. Summarization	
4. Highlighting/underlining	**10. Interleaved practice**
5. Keyword mnemonic	

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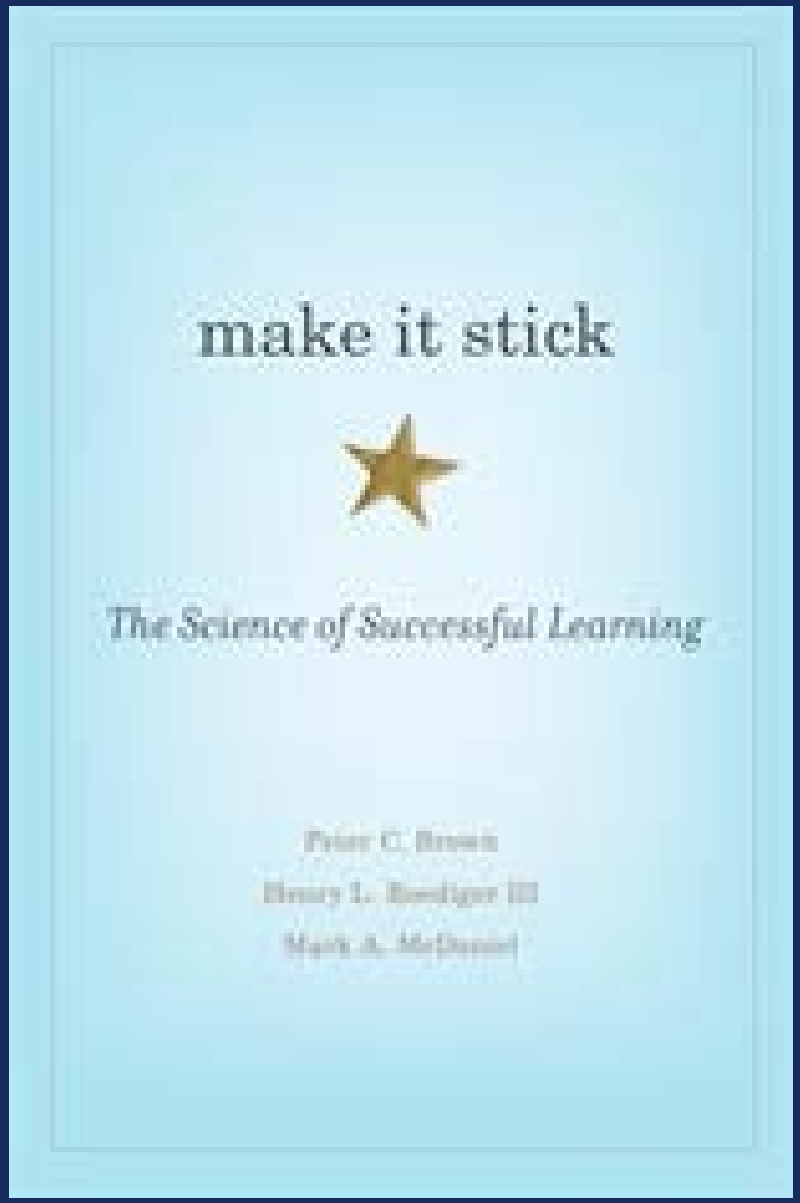
What do we tell students?



Specific Recommendations to Students

1. **Instead of taking notes, generate questions*
2. When you study, answer the questions **without looking at the answer**
3. Study from every class several times each week. Don't block subjects by day

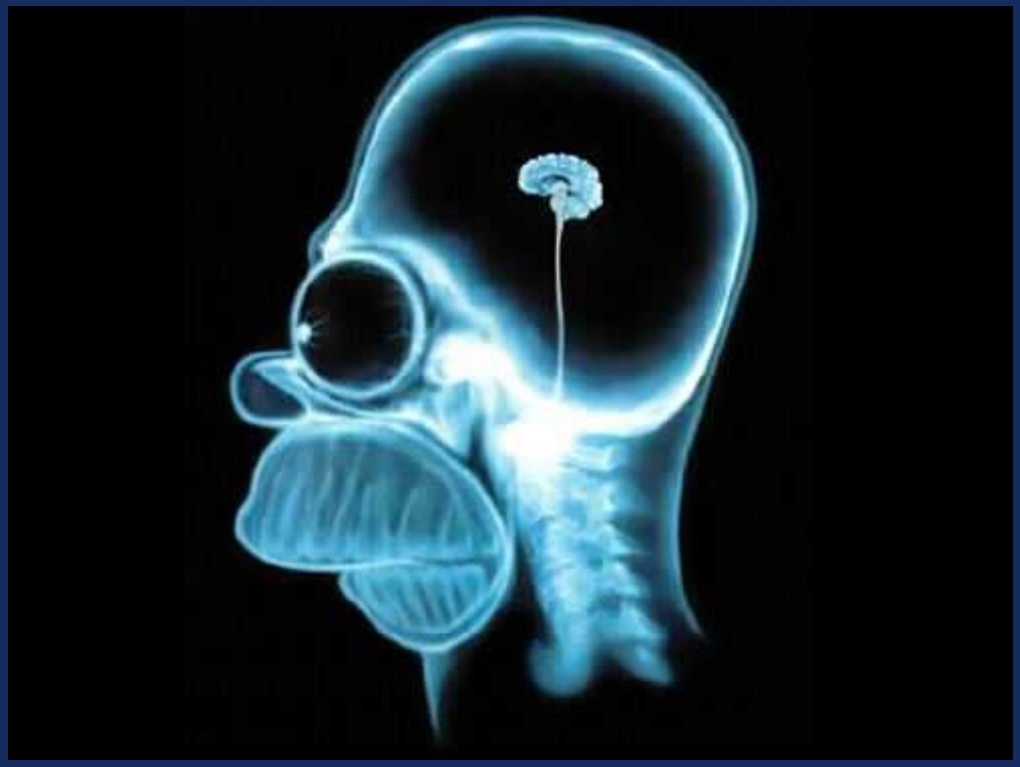
Specific Recommendations

4. Don’t take too many shortcuts (borrowing study guides, etc.)
5. Don’t test yourself right after studying
6. Don’t spend time on unnecessary activities (retyping notes, color-coding material, etc.)
7. Don’t cram for test.
8. Flashcards: It’s kinda complicated

Specific Recommendations

9. Educators: Frequent Quizzes, and *Comprehensive Final Exams should be non-negotiable.*

Thanks!



Questions, comments, handouts?

Email me: **Charles_Weaver@Baylor.edu**