Helping Students Achieve: Promising Practices and Strategies from Cognitive Science

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Evidence-based Education Reform

Does the strategy boost performance?

Does it help in the lab and in the classroom?

Does it help all students (K-12, college, all abilities)?

Lots of evidence available on how well strategies improve student achievement

Hattie's (2009) *Visible Learning*

Reviewed 138 factors (includes over 800 meta-analyses)

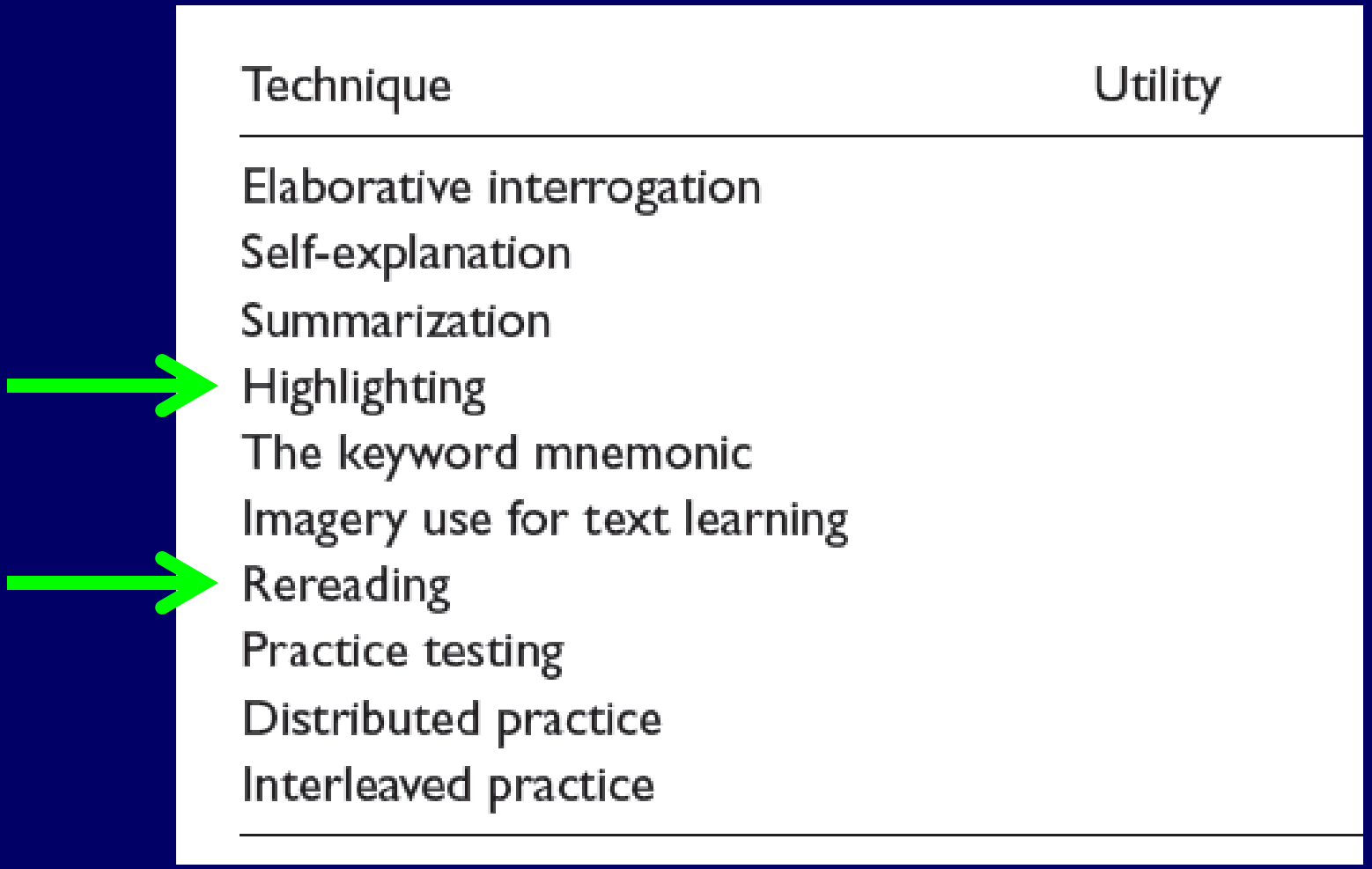
Minor influence:

Class size
Use of power point

Top 30 included:

Obtaining formative evaluation
Reciprocal teaching
Distributed practice
Metacognitive strategies
Study strategies

Which Study Skills Help Students?



Technique	Utility
Elaborative interrogation	
Self-explanation	
Summarization	
Highlighting	
The keyword mnemonic	
Imagery use for text learning	
Rereading	
Practice testing	
Distributed practice	
Interleaved practice	

From Table 4. Dunlosky, Rawson, Marsh, Nathan, & Willingham (2013). Improving Students' Learning with Effective Learning Techniques. *Psychological Science in the Public Interest*, *14*, 4-58.

Strategy	Percent reporting
Rereading notes or text book	83.6
Doing practice problems	42.9
Flashcards	40.1
Retrieval practice	10.7

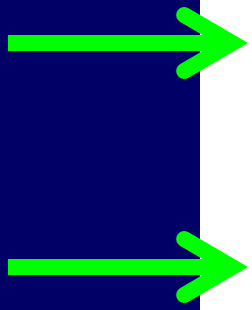
adapted from Karpicke et al. (2009), Table 1

Similar results from Kornell & Bjork (2007) and Hartwig & Dunlosky (2012)

Strategy	%
Rereading notes or text book	67
Test yourself/practice problems	72
Flashcards	54
Highlighting	53
Cram	53

adapted from Morehead, Rhodes, and DeLozier (2015)

Which Study Skills Can Help Students?



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Which Study Skills Can Help Students?

Technique	Utility
Elaborative interrogation	Moderate
Self-explanation	Moderate
Summarization	Low
Highlighting	Low
The keyword mnemonic	Low
Imagery use for text learning	Low
Rereading	Low
Practice testing	
Distributed practice	
Interleaved practice	Moderate

From Table 4. Dunlosky, Rawson, Marsh, Nathan, & Willingham (2013). Improving Students' Learning with Effective Learning Techniques. *Psychological Science in the Public Interest*, *14*, 4-58.

Talk Overview

1. Which Study Strategies Help Students?
2. Retrieval Practice
3. Distributed Practice
4. Successive Relearning

Talk Overview

For Each Strategy:

- Lab research
- Classroom implementation
- Under the Hood

Talk Overview

1. Which Study Strategies Help Students?
2. Retrieval Practice
3. Distributed Practice
4. Successive Relearning
5. A Few Tips for Exploring Your Innovations

Retrieval Practice

Aka: Test taking

Retrieval Practice

Practice tests:

- Multiple-choice tests
- Fill-in-the-blank tests
- Essay-style recall tests

Retrieval Practice

60 Swahili-English translations

e.g. zabibu - grapes

Initial study trial for all items

Karpicke (2009) *JEP:General*

Retrieval Practice

60 Swahili-English translations

e.g. zabibu - grapes

Initial study trial for all items

Then, either:

study – study – study – study

test – study – test – study

vumbi- ???

leso- ???

lozi- ???

nafaka- ???

ziwa- ???

pombe- ???

vumbi- dust

leso- scarf

lozi- almond

nafaka- corn

ziwa- lake

pombe- beer

Retrieval Practice

60 Swahili-English translations

e.g. zabibu - grapes

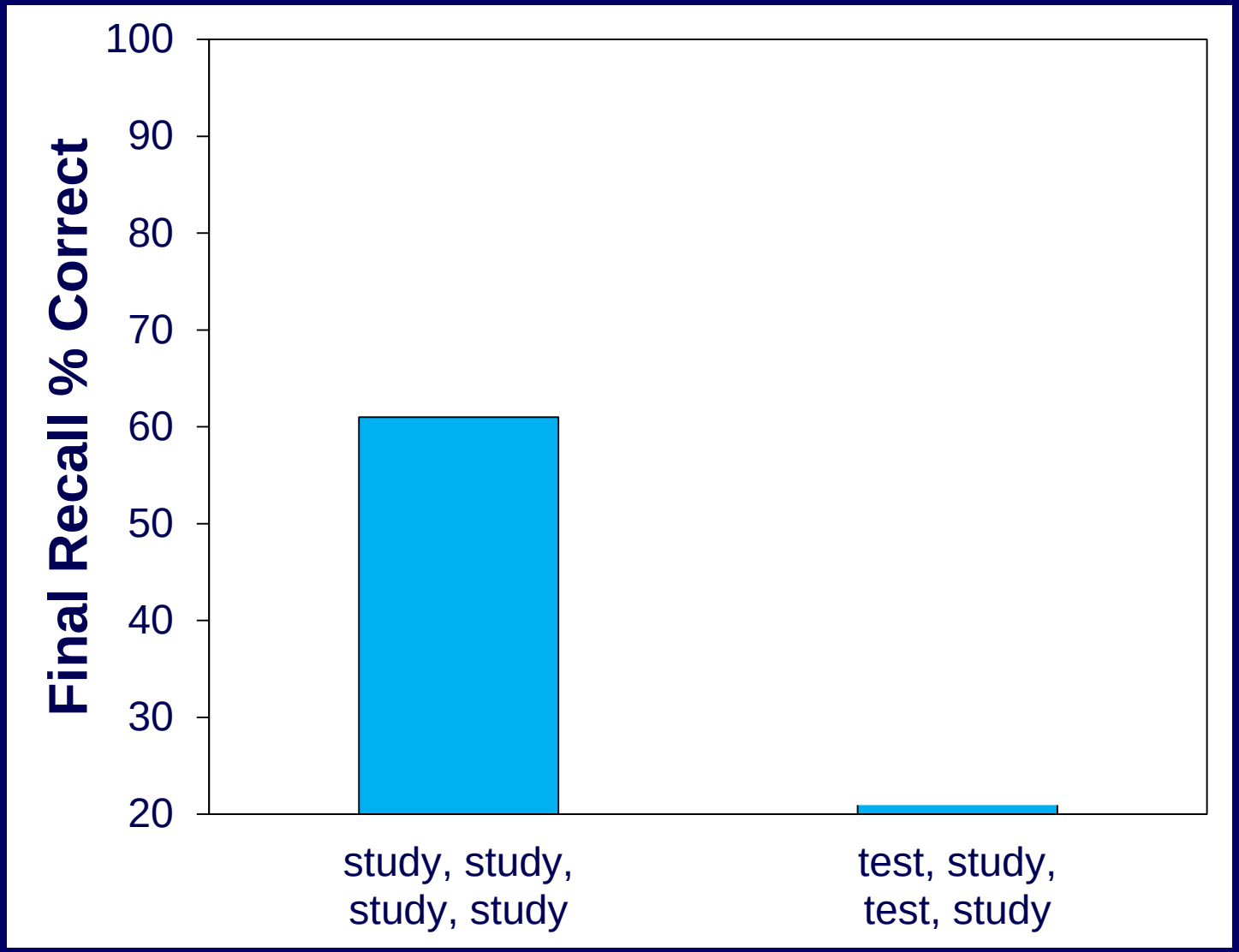
Initial study trial for all items

Then, either:

study – study – **study** – study

test – study – **test** – study

Then, a final recall test



Karpicke (2009) *JEP:General*

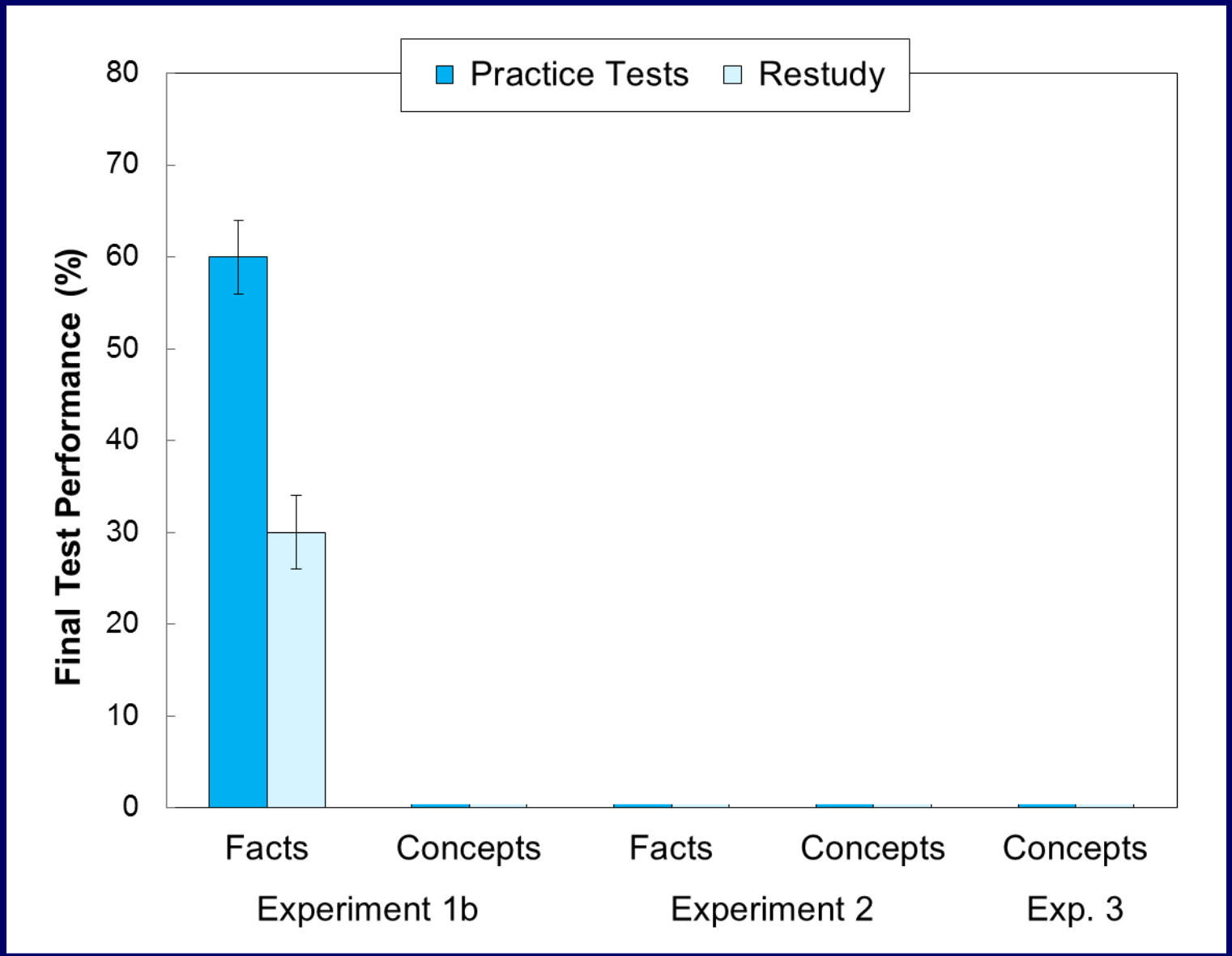
Retrieval Practice

Initial study ~1000 word texts

Then, test-restudy or restudy only for key facts and concepts

One week later – final test with NEW inference questions

Butler (2010) *JEP:LMC*


Practice Tests
Restudy
Final Test Performance (%)
80
70
60
50
40
30
20
10
0
Facts
Concepts
Facts
Concepts
Concepts
Experiment 1b
Experiment 2
Exp. 3

Retrieval Practice

Has multiple benefits!

Effective when:

- Followed by feedback
- Responses are (eventually) correct

Implementing

Flash cards

Note taking (e.g., Cornell notes)

Daily “reviews”

Peer Instruction

Implementing: Peer Instruction

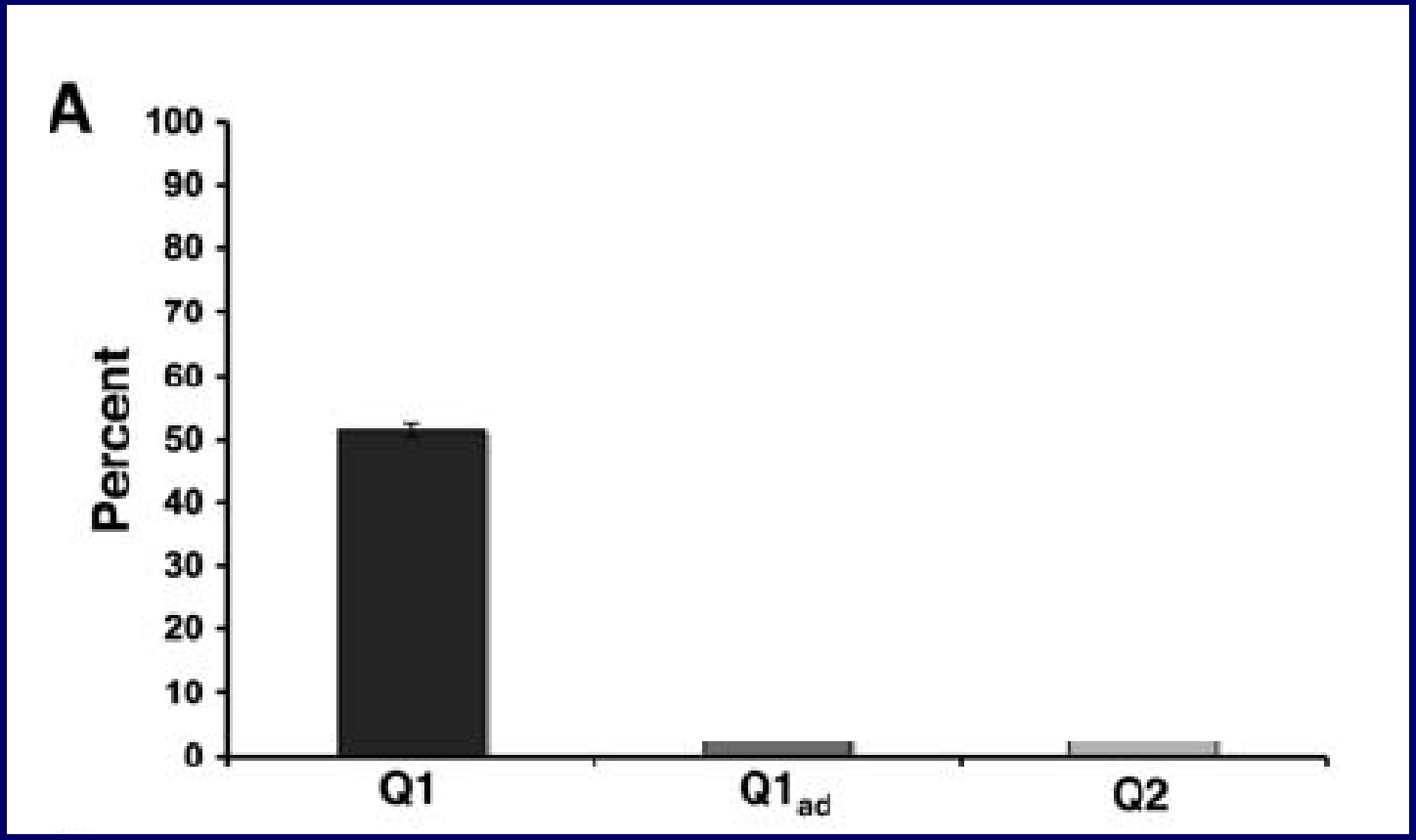
A Single Genetics Course

Multiple choice question followed by peer discussion

Same question and isomorphic question

Smith, Wood, Adams, Wieman, Knight, Guild, & Su (2009) *Science*

Implementing: Peer Instruction



Smith et al. (2009)

Under The Hood

A Single Genetics Course

Pre-instruction Test Critical

Was it peer instruction?

To know, a control is needed…

Smith et al. (2014)

Under The Hood

A Single Genetics Course

Pre-instruction Test Critical

Freeman et al. (2014). *PNAS*.

Smith et al. (2014)

What versus When

Retrieval practice: What to do.

Distributed practice: When to study.

Distributed Practice

Spreading out study (of the same content) across time

Distributed Practice

Session 1: Study relevant material

Session 2: Restudy the same material

Session 3: Restudy the same material

Session 4: Restudy the same material

Exam

versus Cramming

One Session the Night Before

Exam

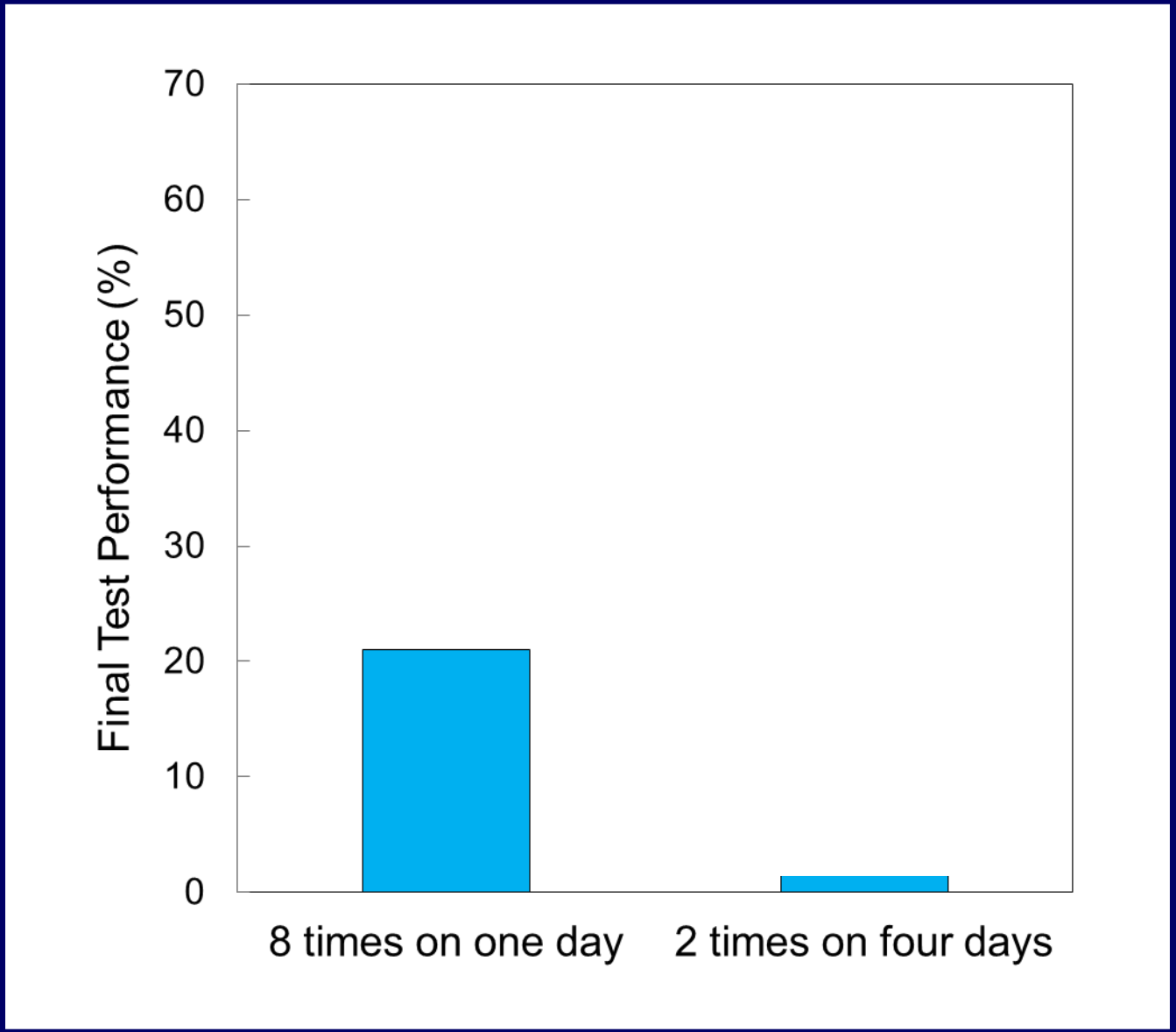
Distributed Practice

Initial study of vocabulary word pairs

Then, test-restudy trials:
eight on one day or two on four days

One day later – final test

Kornell (2009)



Kornell (2009)

Distributed Practice & Math

7th Graders

Learned to solve 4 problems:

- Solve linear equation
- Solve word problem w/proportions
- Graph an equation
- Determine slope of line

Rohrer, Dedrick, & Burgess (2014)

Distributed Practice & Math

9 weeks of (10) practice assignments

Assignment: Solve 12 problems

Massed in one assignment

OR

Distributed across assignments

Two week delay, surprise test

Rohrer et al. (2014)

Distributed Practice & Math

	Mean	*SD*
Distributed practice	.72	.30
Blocked practice	.38	.35

Rohrer, Dedrick, & Burgess (2014)

Under The Hood

Eight classes and 3 teachers

Two Groups of Four Classes

Used 4 Practice Problems so as to:

Counterbalance Problems to Distributed vs. Massed Practice

Rohrer et al. (2014)

Distributed Practice

Essential for long-term retention

Most effective when:

- Practice is distributed ACROSS sessions
- Distributed practice involves Effective Strategies

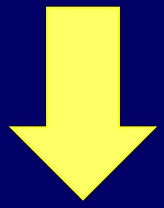
Implementing

Repeat problem types/content across class days

Repeat problem types in homework assignments across weeks

What: Retrieval Practice Until You Get it Right

When: Distributed Across Several Sessions



Successive Relearning

Successive Relearning

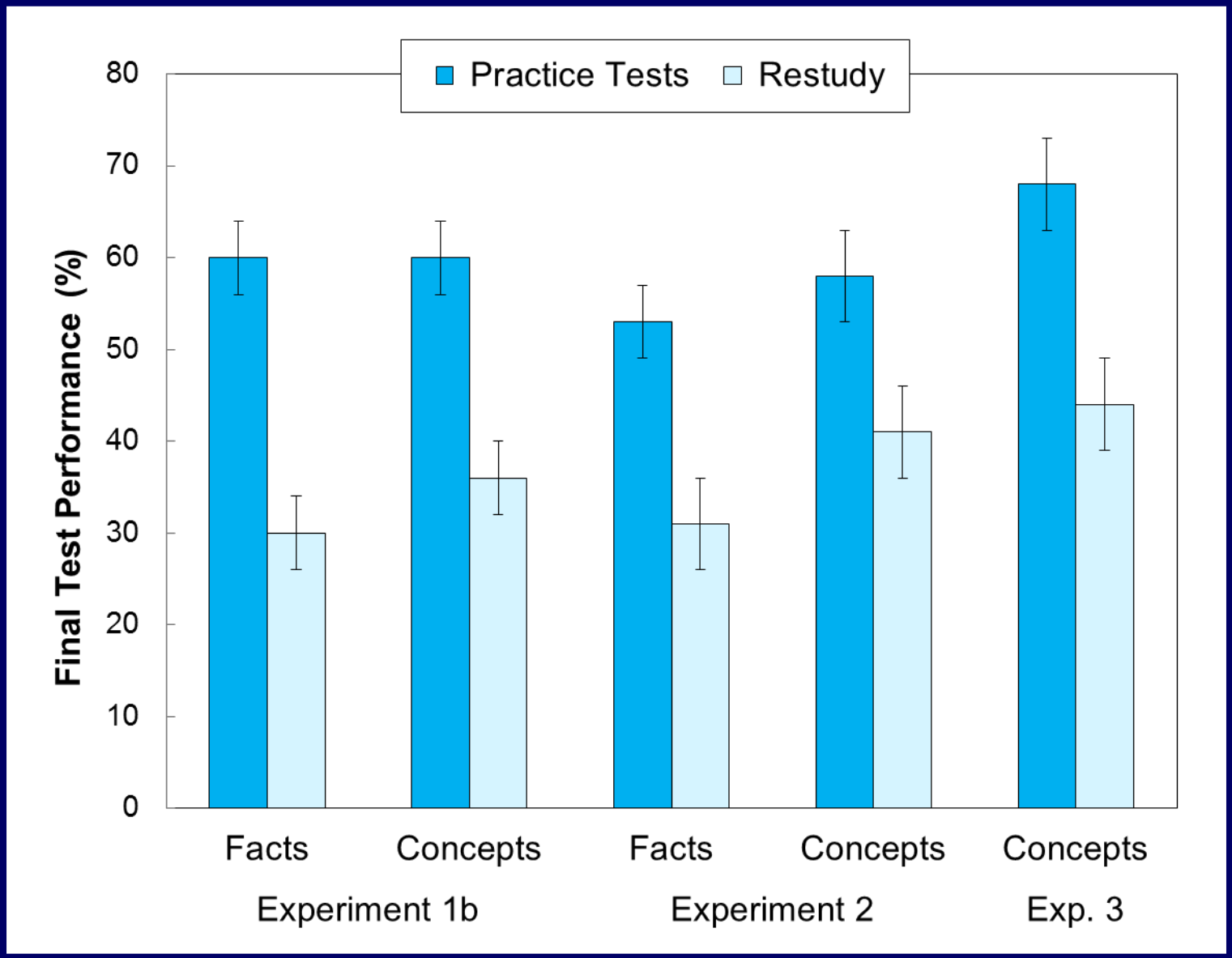
Session 1: Learn material to a specific criterion
(practice retrieval plus restudy until correct)

Session 2: Relearn the same material

Session 3: Relearn the same material

Session 4: Relearn the same material

Exam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Power of Successive Relearning: Paired-Associate Method

Swahili – English pairs (pombe – beer)

Session 1: 1 - 7 correct recalls

Relearning sessions: 1, 2, 3, or 4

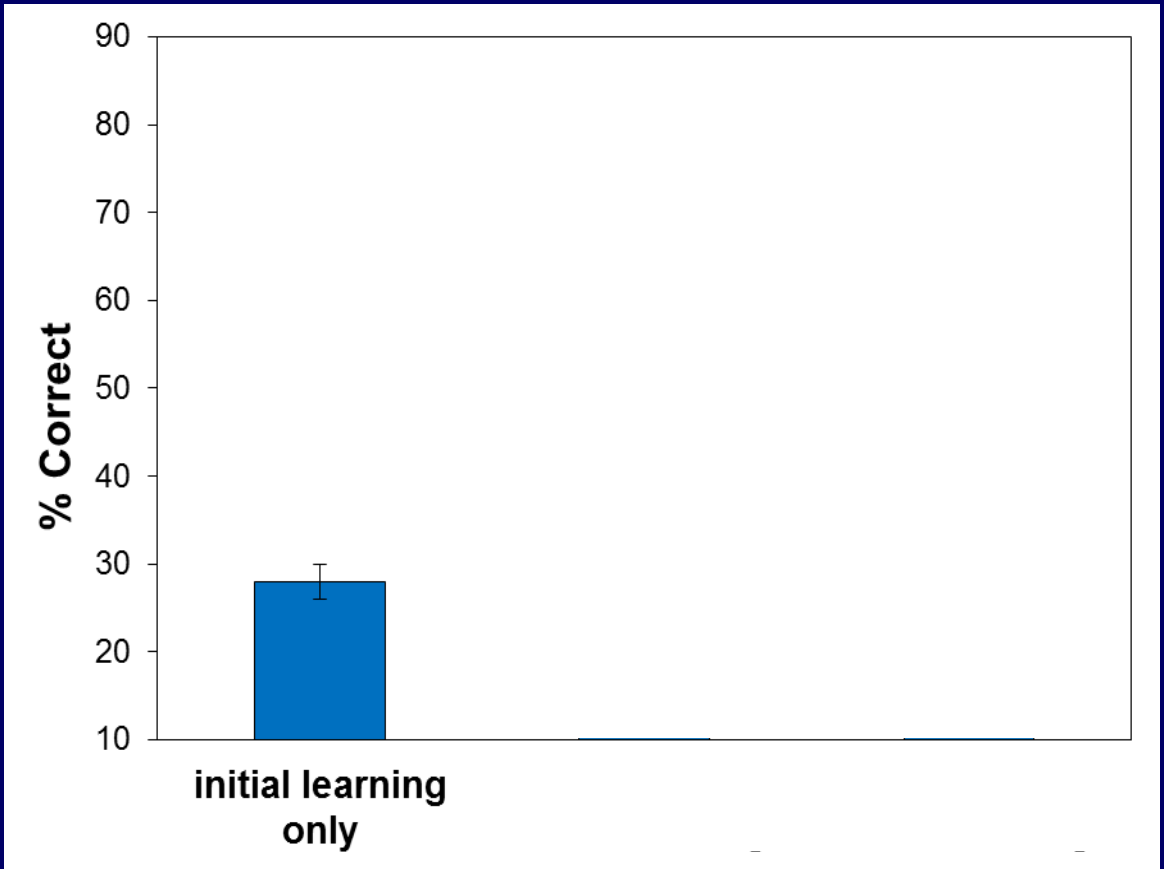
- Continue until 1 correct recall
- One week delay between each session

Relearning sessions begin with recall

Vaughn, Dunlosky, & Rawson (2016)

Retention After One Week

70 Swahili-English pairs (*pombe – beer*)



Retention After One Week

	Use of Practice Retrieval	
	Cram	Distributed
Two correct	22%	48%
Three correct	28%	68%
Four correct	28%	75%

Power of Successive Relearning: Introductory Psychology

Students in large section (400+) of Intro Psych

Instructor provided key concepts from 8 units

32 successive relearning, 32 baseline

For successive relearning:

Initial learning + 3 relearning sessions

Rawson, Dunlosky, Sciartelli (2013)

Practice Test

What is the self-serving bias?

When I think that my good behaviors are because I'm a good person but my bad behaviors are due to someone else.

Done with Answer

Feedback and Restudy

What is the self-serving bias?

Tendency to attribute positive outcomes to our own traits or characteristics but negative outcomes to factors beyond our control.

Finished Studying

Power of Successive Relearning: Introductory Psychology

Students in large section (400+) of Intro Psych

Instructor provided key concepts from 8 units

32 successive relearning, 32 baseline

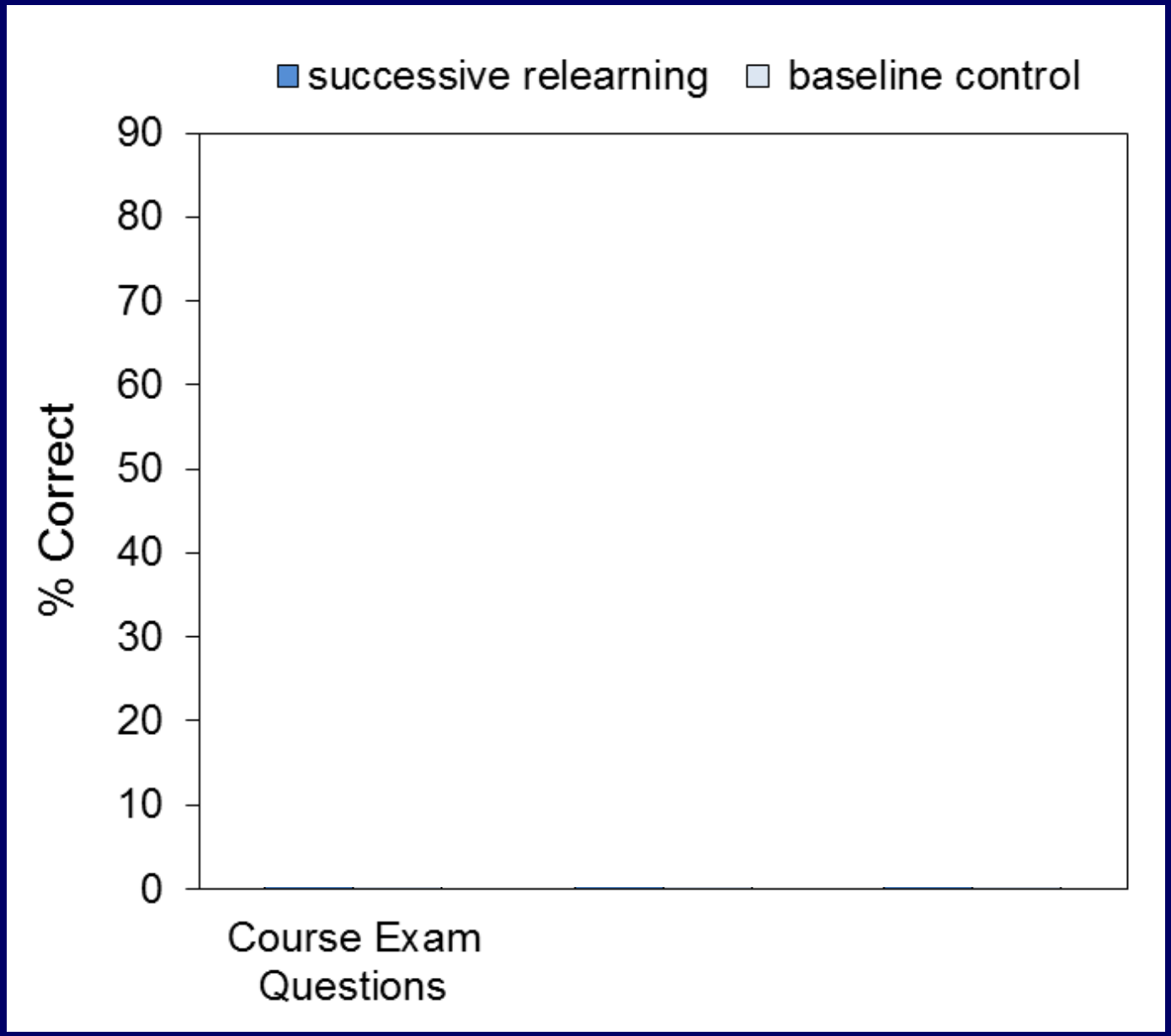
For successive relearning:

Initial learning + 3 relearning sessions

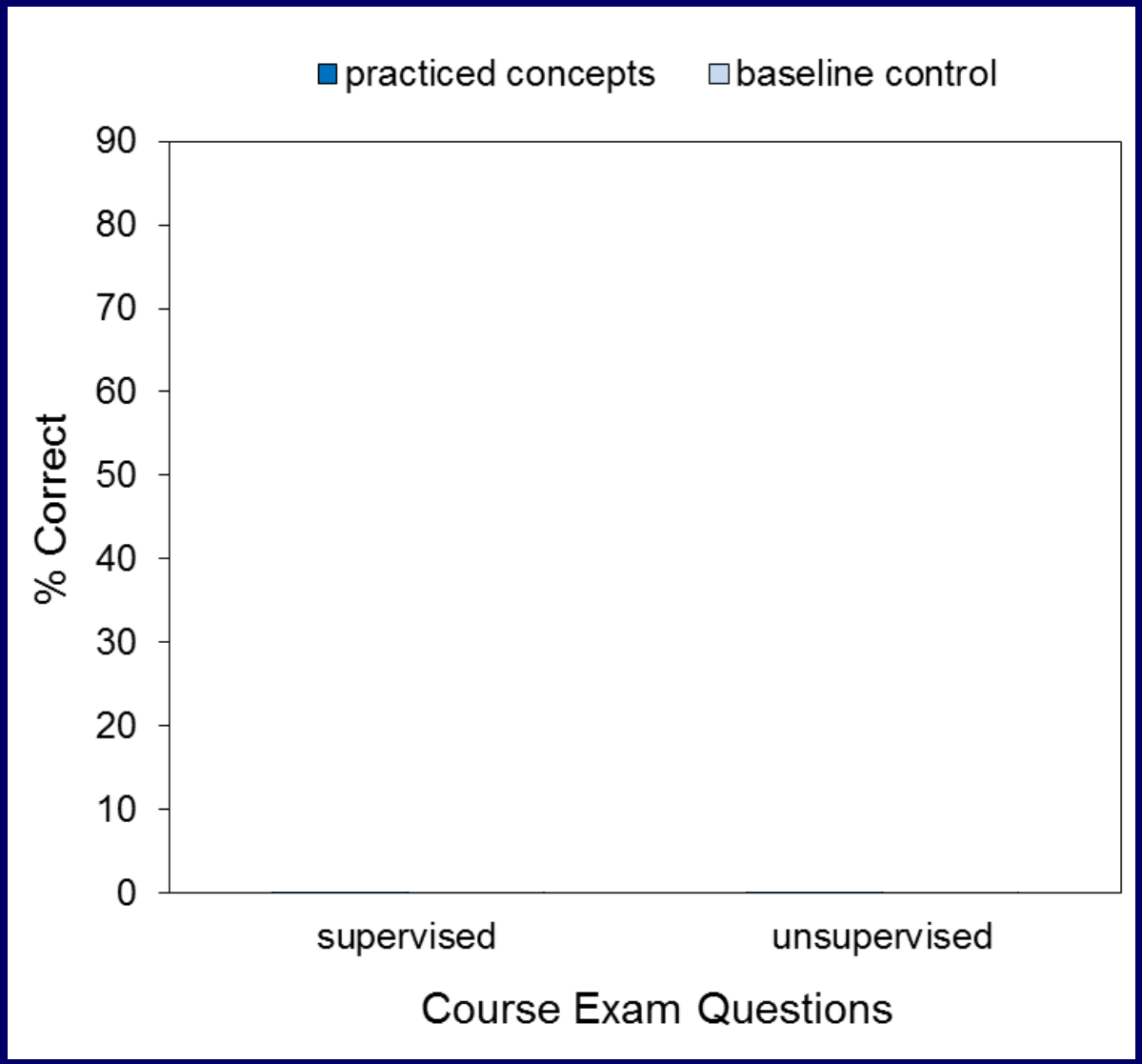
Sessions synchronized with class

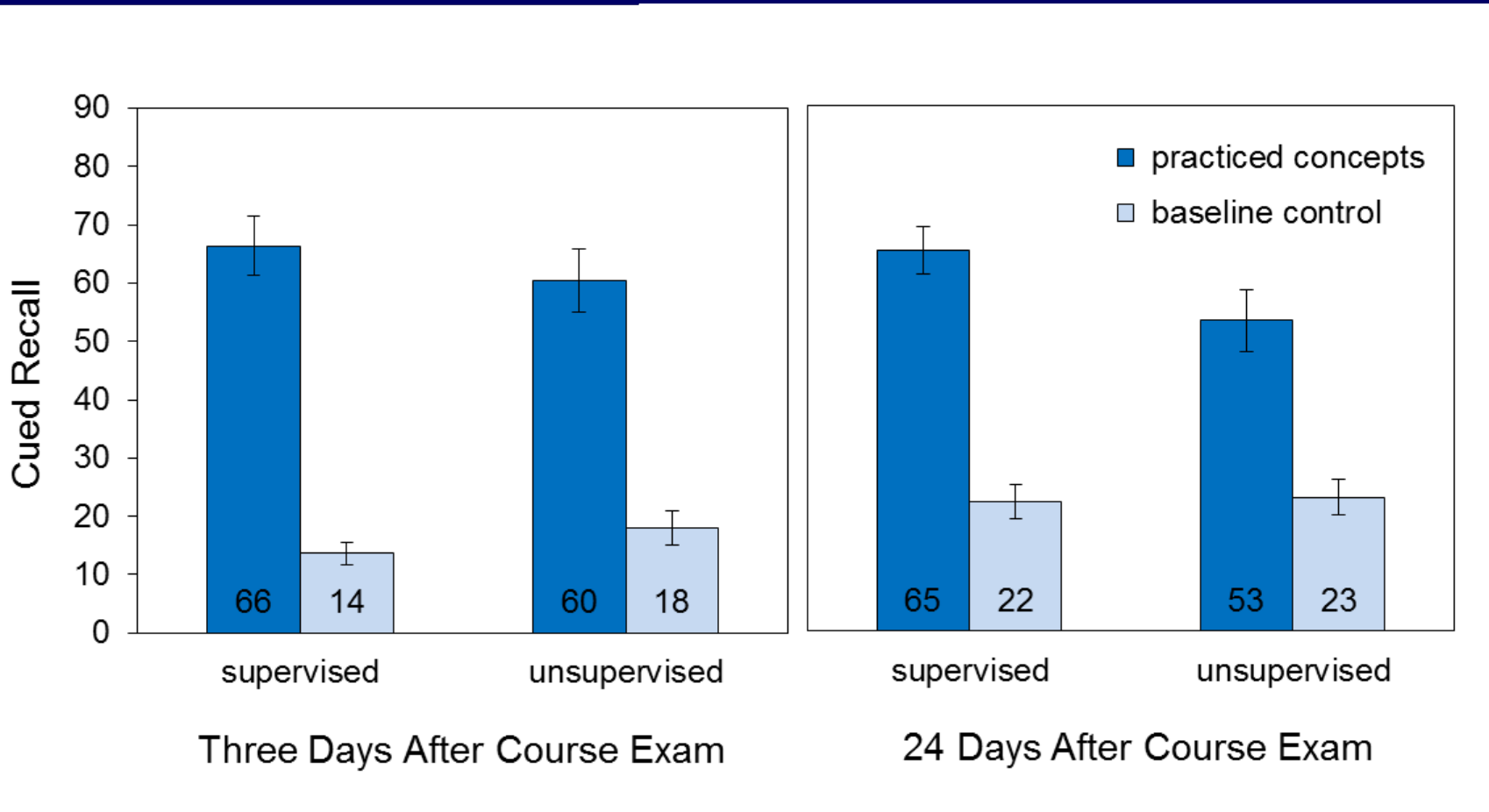
When casinos make such a big deal out of drawing attention to winners, they are taking advantage of the _____ as a way to encourage patrons to return regularly.

a. conservation heuristic
b. representativeness heuristic
c. availability heuristic
d. confirmation bias



Rawson, Dunlosky, Sciartelli (2013)


practiced concepts
baseline control
90
80
70
60
50
40
30
20
10
0
% Correct
supervised
unsupervised
Course Exam Questions


Cued Recall
90
80
70
60
50
40
30
20
10
0
66
14
60
18
65
22
53
23
practiced concepts
baseline control
supervised
unsupervised
supervised
unsupervised
Three Days After Course Exam
24 Days After Course Exam

Under The Hood

A Single Psychology Course

Within-participant manipulation:

Two sets of concepts

Each student was his/her own control

Rawson et al. (2014)

Successive Relearning

Essential for long-term retention

Relatively efficient: relearning requires (much) less time

Exploring Intervention Efficacy: A Few Tips

Use Pre- and Post-Intervention Tests When Possible

Use Within-Student Design When Possible

With 2 or More Classes Using Same Content:

- Begin After Exam 1 (use as baseline)
- Vary Intervention Across Subsequent Exams

	Ex 1	Ex 2	Ex 3
Class 1	Intervention	Control	
Class 2	Control	Intervention	

Baseline to establish classes are similar

Shadish, Cook, & Campbell (2002). *Experimental and Quasi-Experimental Design*. Houghton Mifflin, NY, NY.

Conclusions

Effective Study Strategies Can Improve Achievement

Strategies Can Be Implemented in the Classroom and Out-of-class Assignments

Evaluate Your Innovations in Your Own Classroom!

Thank You

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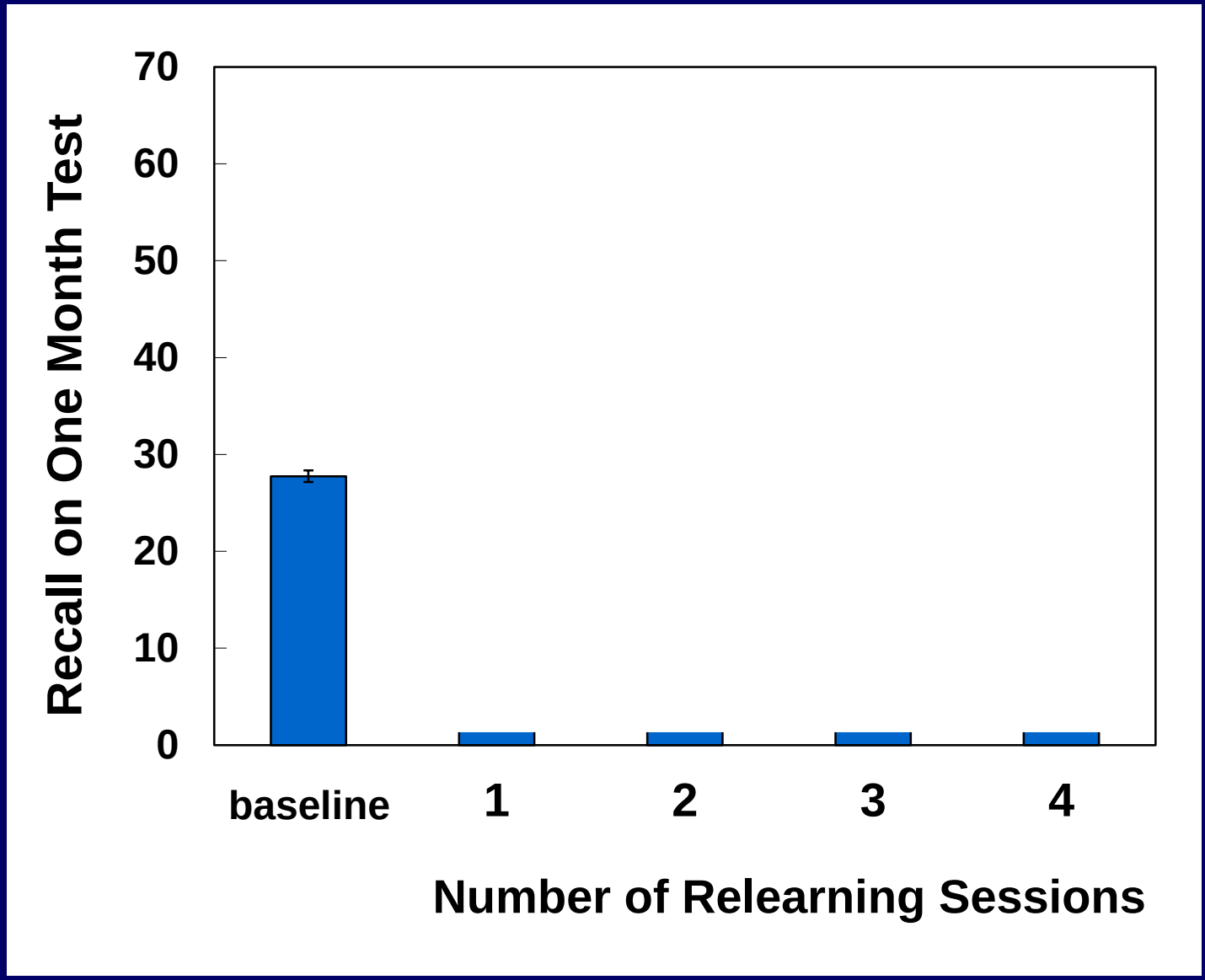
What About Younger Learners?

8th grade students, key concept definitions

Successive relearning vs. baseline control

Relearning: **1**, **2**, **3**, or **4** sessions

Final Test after **one month**



Rawson & Dunlosky (in preparation)

Retrieval Practice for Science

8th grade students

Content: Foundational concepts from genetics, evolution, and anatomy

Some material was targeted for in-class quizzes (multiple choice)

McDaniel et al. (2011)

Retrieval Practice for Science

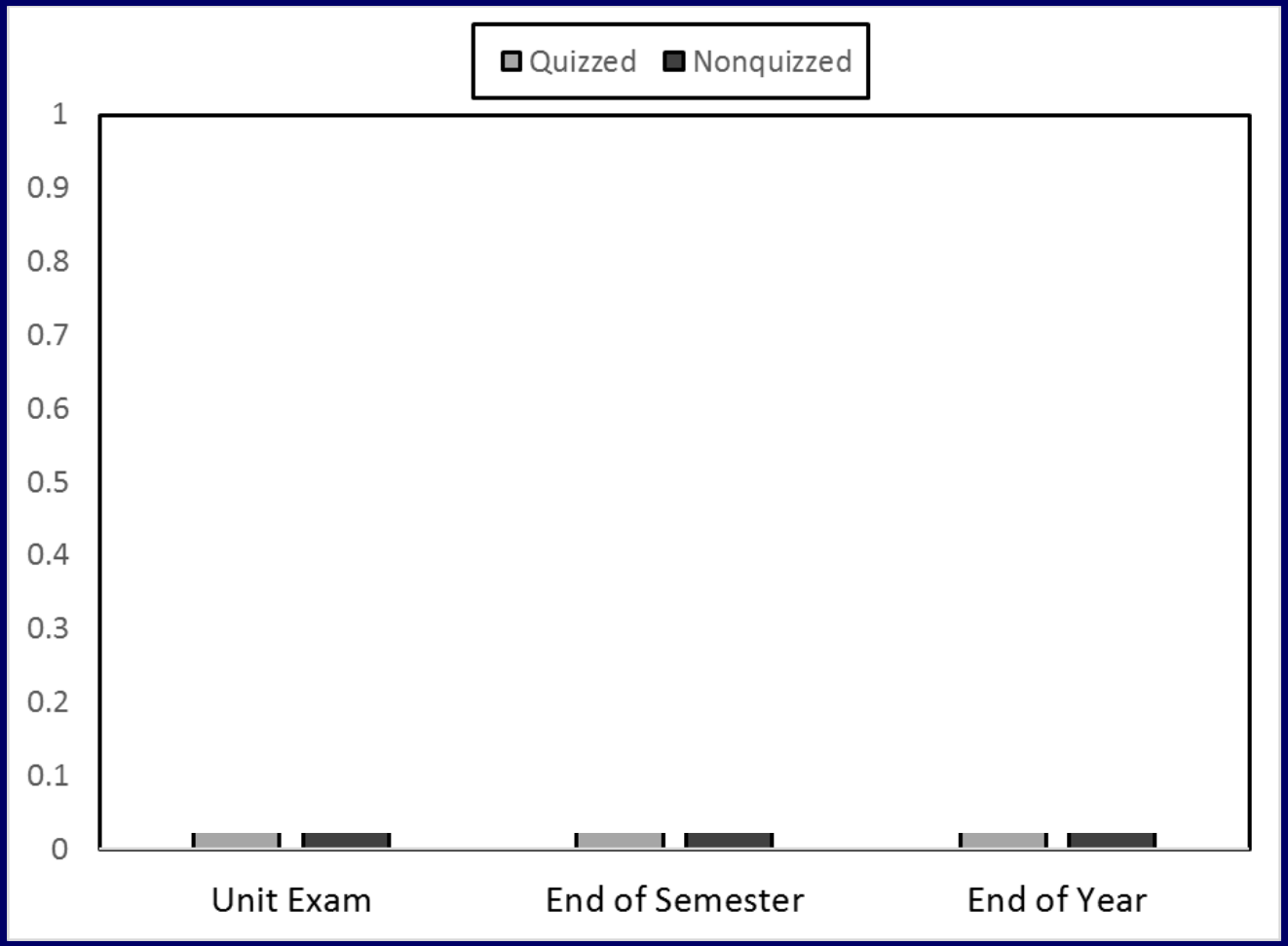
Class unit exam (50% of overall grade)

End of semester exams

End of the year exams

McDaniel et al. (2011)

Proportion Correct on Exam



McDaniel et al. (2011)