

Learning Better & Learning More

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Outline Of Presentation

1. Understanding versus learning

- Examples: medicine, chess, flying

2. A simple model of human learning

3. Applications: Efficient student learning

- Attentional and sensory processing
- Comprehending and elaborating on information
- Rehearsing, storing and retrieving information

4. Summary takeaways

Learning

Acquisition of actions, knowledge or skills -
through experience, practice, study, or as a
result of being taught.

Understanding \neq Learning

Understanding

+

Storing in memory

+

Accessing from memory

(to assist judgments, actions, decisions)

=

Learning

Why Doctors Still Must Memorize Facts in a Digital Age

Dr. Gurpreet Dhaliwal, Wall Street Journal, March 2015

“The goal of education is to create an expert thinker.
Memorization is at the core of that endeavor.”



“Practicing medicine requires constant problem solving.

Just like in jazz, you can only ad lib when you start from a strong foundation.”

Dhaliwal, *Wall Street Journal*, March 2015

Quality and
Quantity of
Learning



Quality and
Speed of
Decision Making

Some Examples.....

"A real pleasure. . . . *Blink* brims with surprising insights about our world and ourselves." —Salon.com

#1 National Bestseller

WITH A NEW
AFTERWORD BY
THE AUTHOR

blink

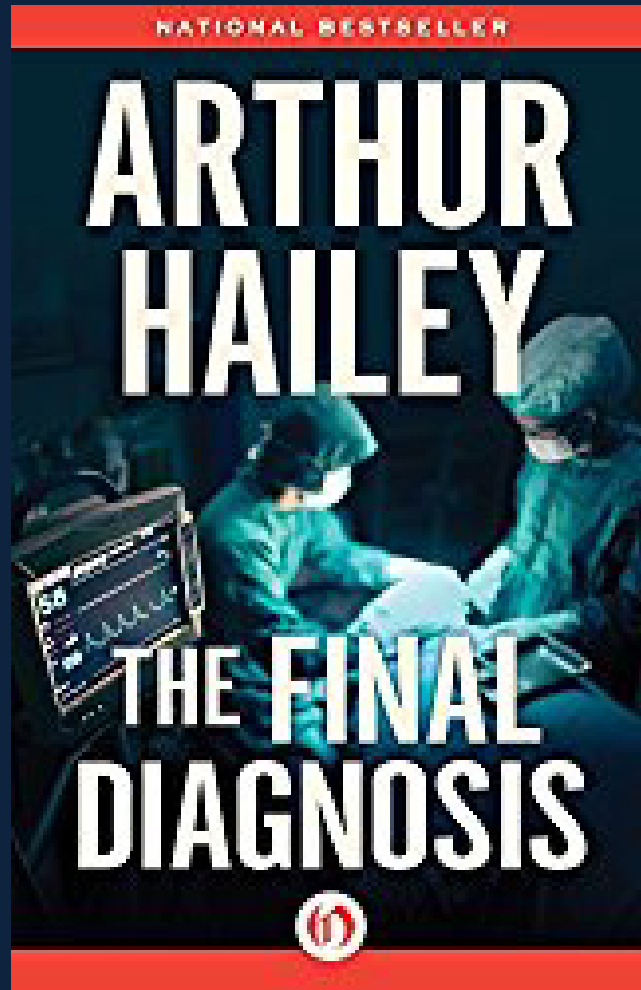
By the author of *THE TIPPING POINT*



The Power of Thinking
Without Thinking

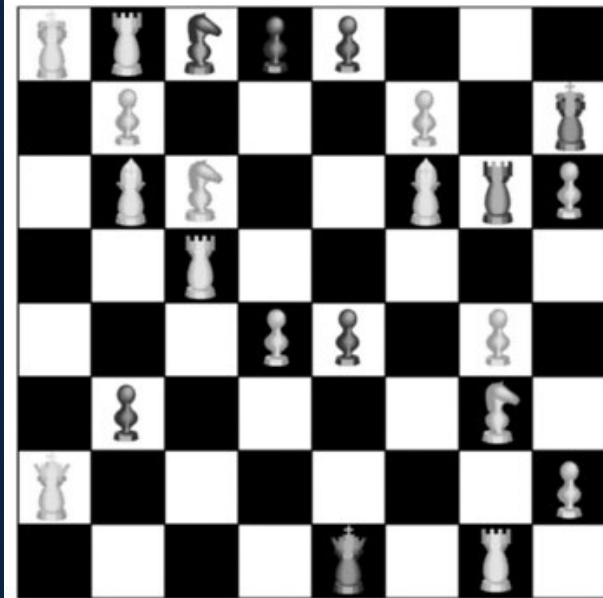
Malcolm Gladwell

Thin Slicing



*Making Complicated
Choices*

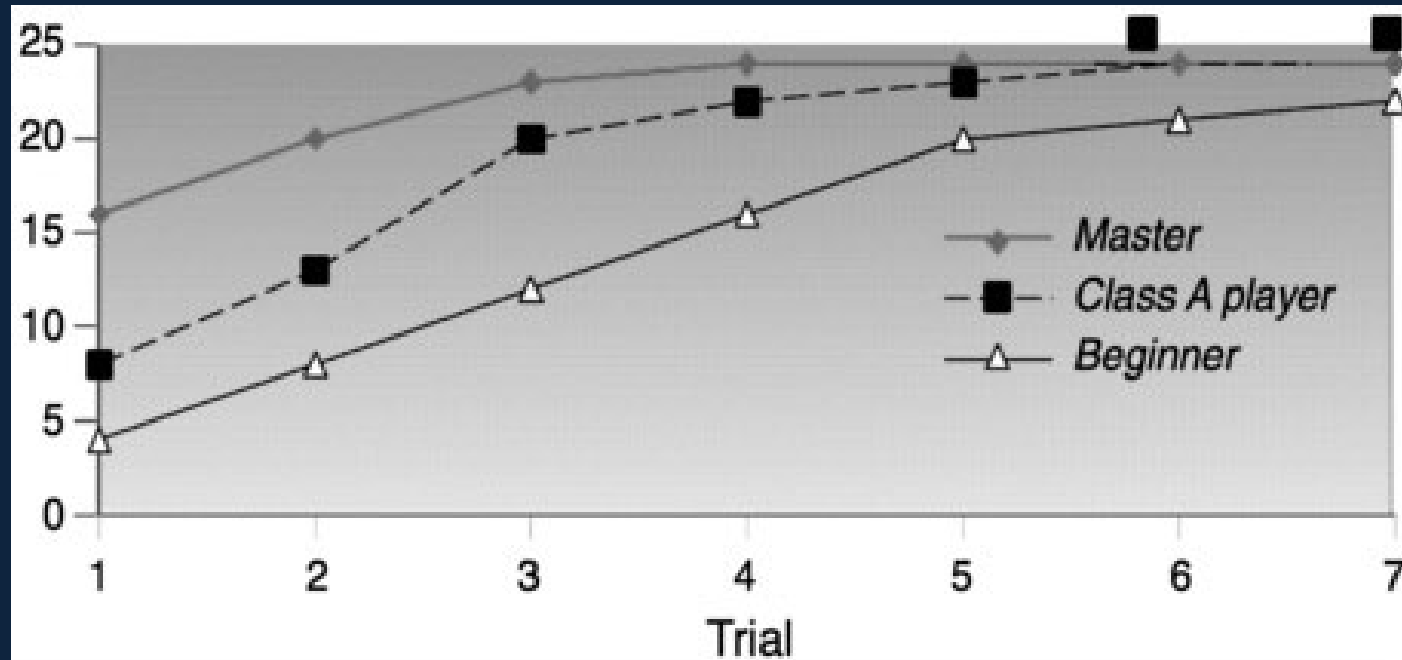
*Decision dilemma
between two
pathologists:
Dr. Joe Pearson
Kent O'Donnell*



*Chess board positions
used in memory
experiments.*

*SOURCE: Adapted from
Chase and Simon [1973].*

Chunking



Recall by chess players by level of expertise.

Novices recalled 4 positions after one trial.

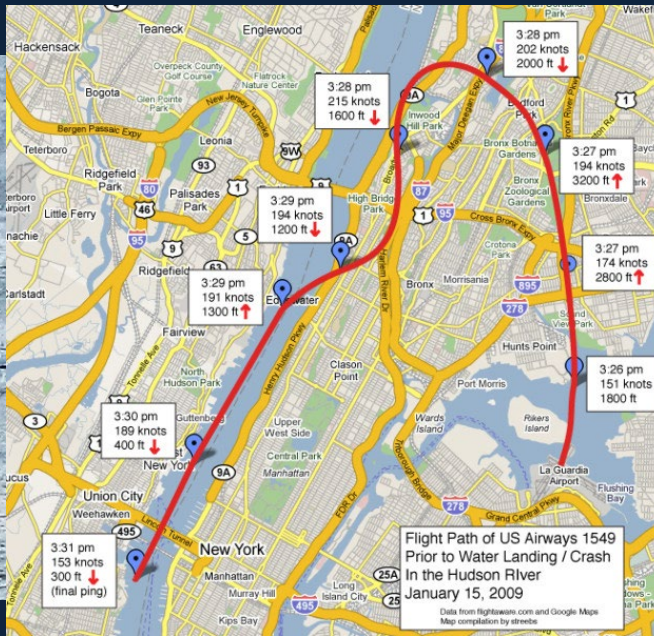
Experts recalled 18.

Reaction Time & Risky Choices

Captain Sully had to decide how to handle a crippled Airbus A320 carrying 150 passengers.

He rapidly evaluated 2 landing options in ~ 200 seconds.

And then went with a third option.

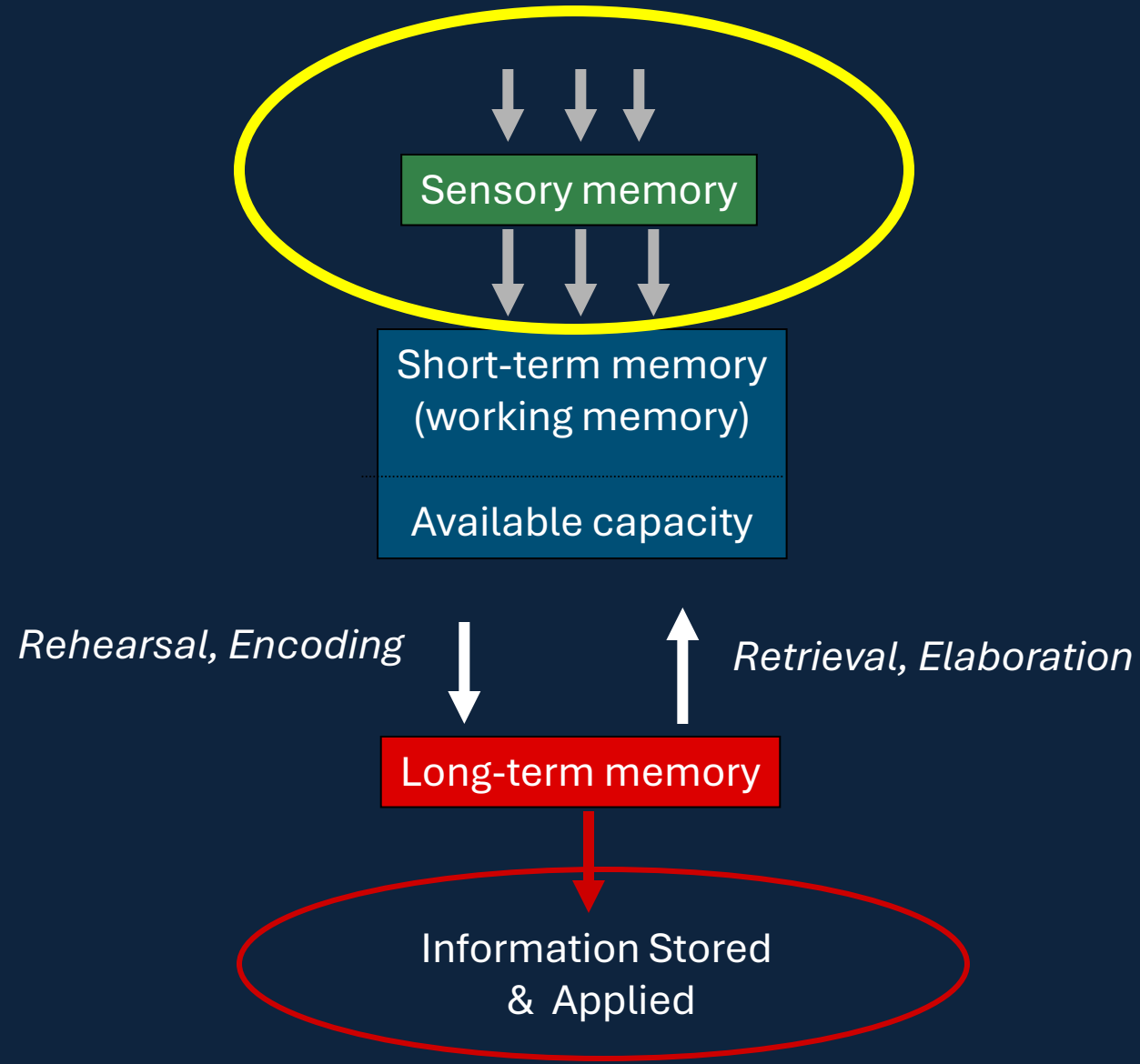


Experts have not only acquired knowledge,
but are also good at retrieving the knowledge
that is relevant to a particular task.

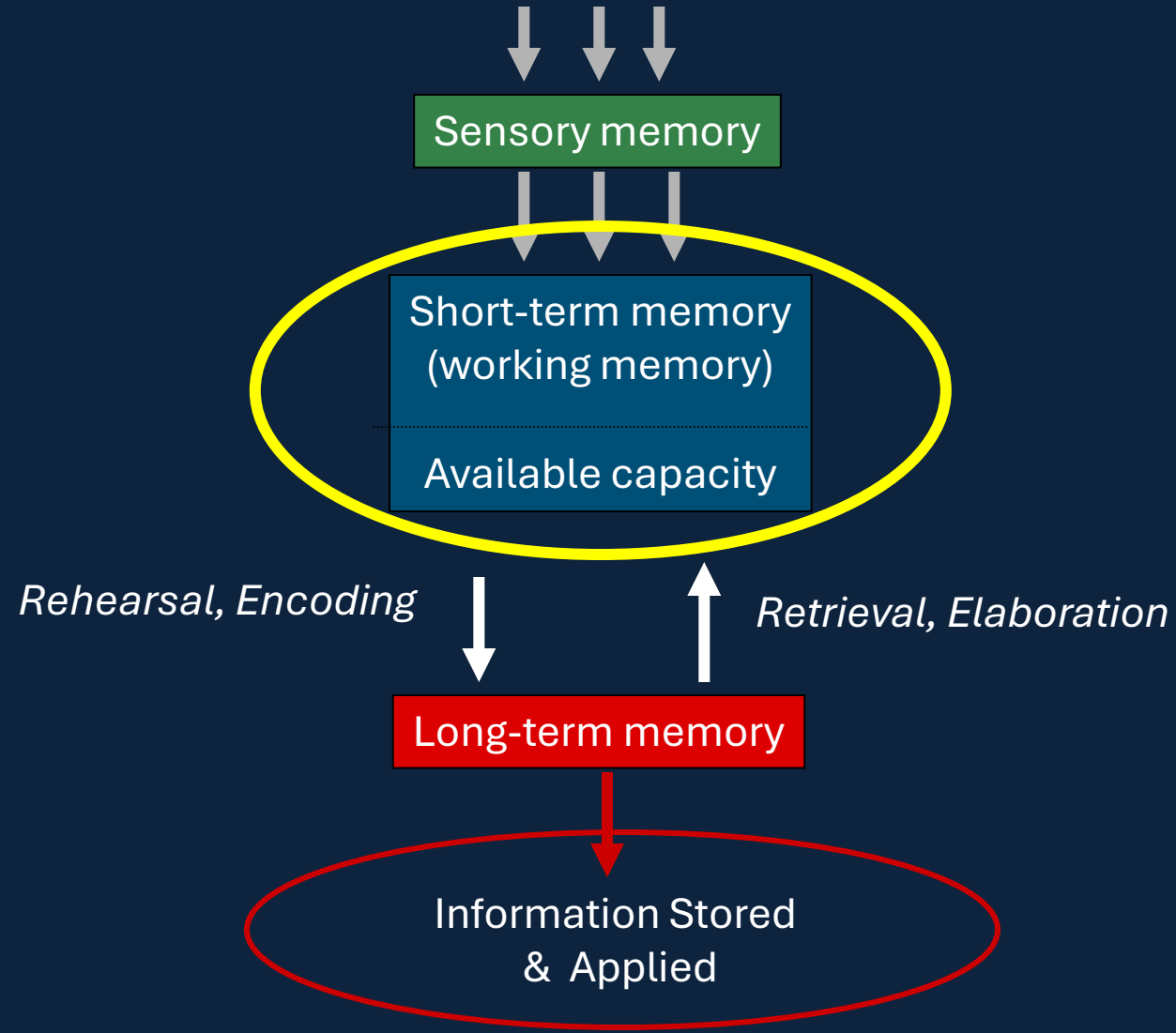
(Simon, 1980 – Nobel Prize Winner '78)

A Basic Model of Learning as a Framework

Information



Information



Information

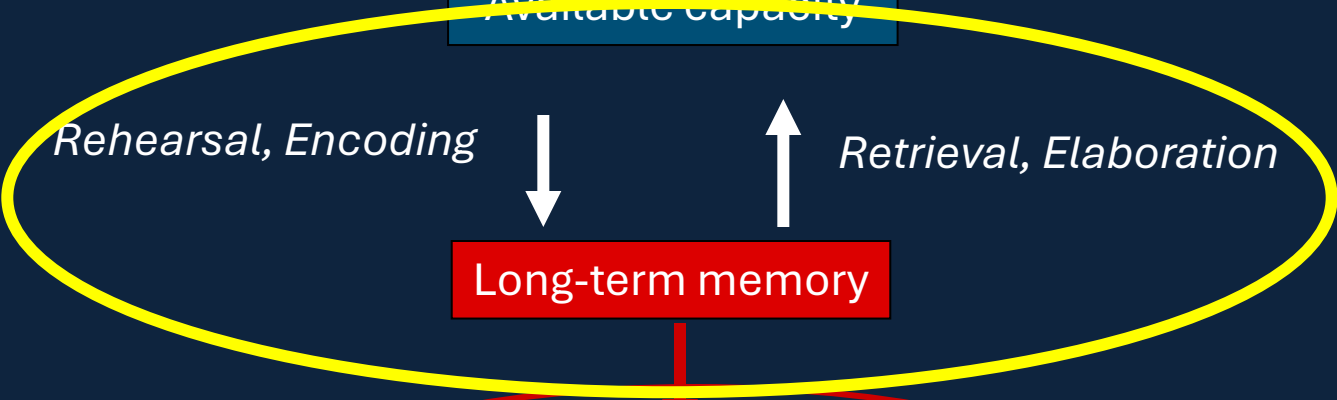


Sensory memory



Short-term memory
(working memory)

Available capacity



Long-term memory



Information Stored
& Applied

Summary

Understanding is the first but not the only step in the learning process

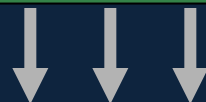
Implications for Learning

(with some supporting research)

Information



Sensory memory



Short-term memory
(working memory)

Available capacity

**Focus limited
attention capacity.
Clear out
distractions.**



Rehearsal, Encoding



Long-term memory

Retrieval, Elaboration

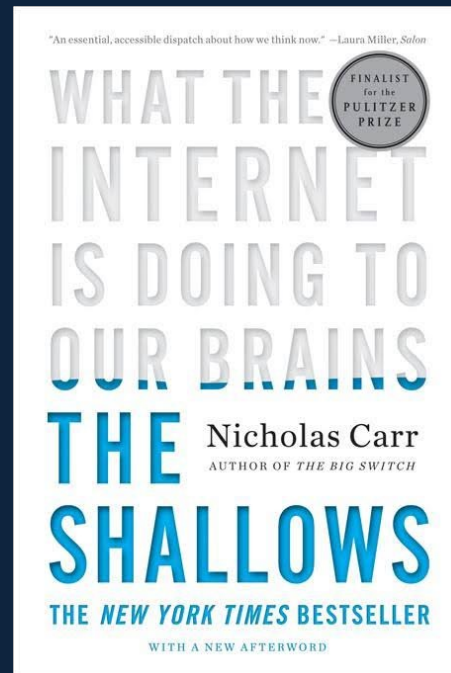
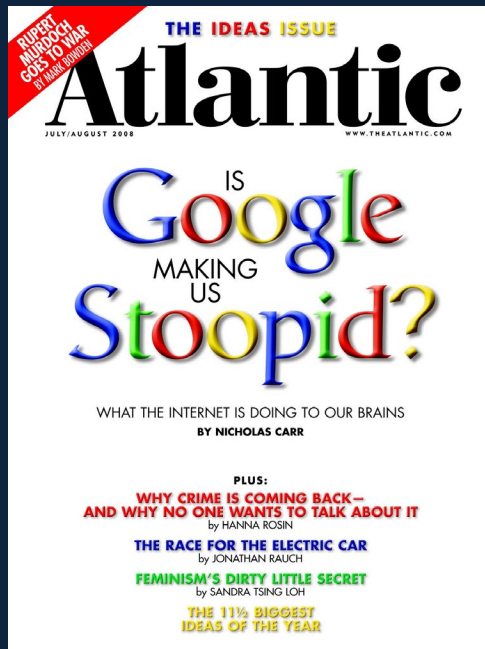


We have limited cognitive resources available to attend to, process, encode, and store information.

When focused on a single primary task, our attentional resources are used efficiently, and information is adequately processed, encoded, and stored.

When we add a secondary task, attention must be divided, and processing of incoming information becomes fragmented.

Encoding is disrupted, and this reduces the quantity and quality of information that is processed.



“Once I was a scuba diver in a sea of words.

Now I zip along the surface like a guy on a Jet Ski.”

Nick Carr in *The Shallows: What the Internet Is Doing to Our Brains*, 2010.

The Laptop and the Lecture: The Effects of Multitasking in Learning Environments

Journal of Computing in Higher Education
Fall 2003, Vol. 15(1), ?-?.

The Laptop and the Lecture: The Effects of Multitasking in Learning Environments

Helene Hembrooke and Geri Gay
Human Computer Interaction Laboratory
Cornell University

Recall and recognition are lower when the laptop was open during class

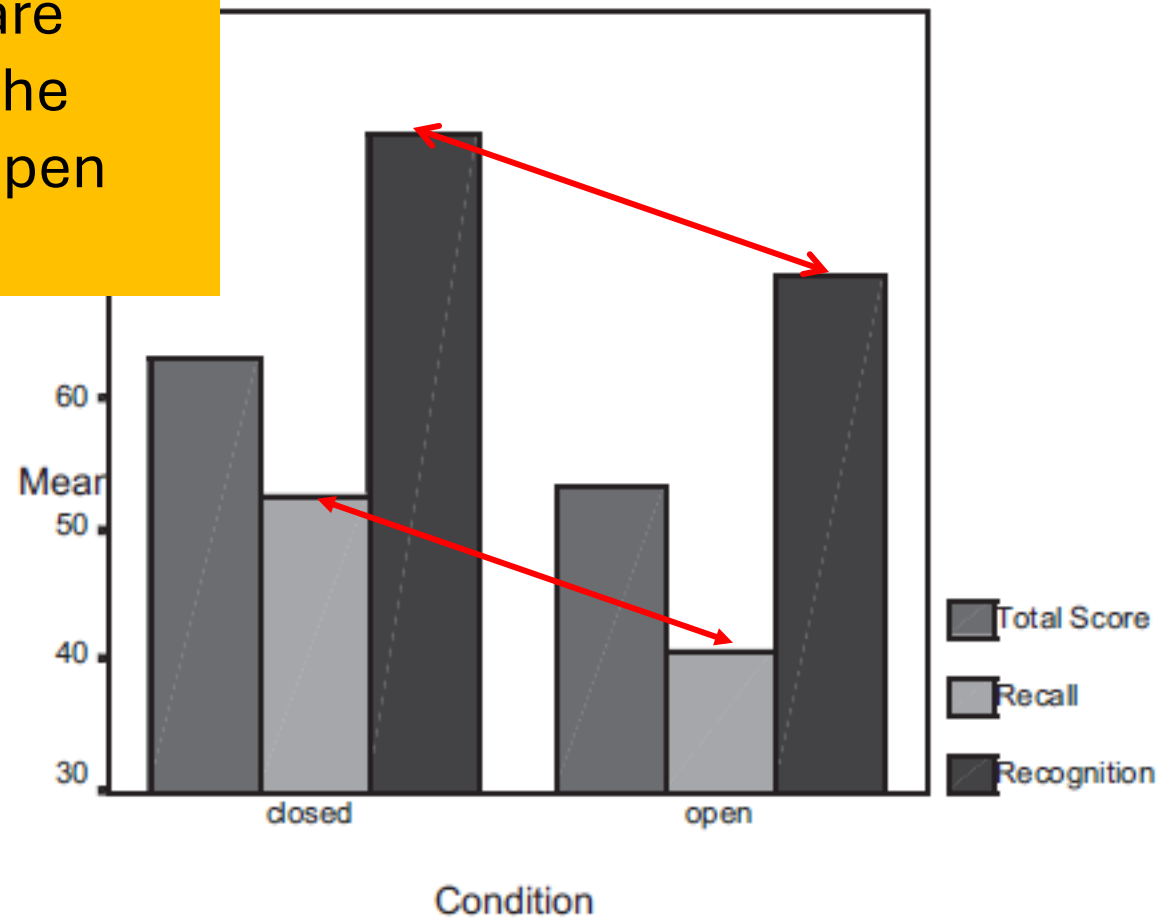


Figure 1. Mean total, recall, and recognition scores for open and closed laptop conditions



Contents lists available at SciVerse ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu



Laptop multitasking hinders classroom learning for both users and nearby peers

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^bYork University, Department of Psychology, 4700 Keele Street, Toronto, ON M3J 1P3, Canada

^cYork University, LaMarsh Centre for Child and Youth Research, 4700 Keele Street, Toronto, ON M3J 1P3, Canada

Laptops are commonplace in university classrooms. In light of cognitive psychology theory on costs associated with multitasking, we examined the effects of in-class laptop use on student learning in a simulated classroom. We found that participants who multitasked on a laptop during a lecture scored lower on a test compared to those who did not multitask, and participants who were in direct view of a multitasking peer scored lower on a test compared to those who were not. The results demonstrate that ~~multitasking on a laptop poses a significant distraction to both users and fellow students and can be detrimental to comprehension of lecture content.~~

The Impact of Listening to Music on Cognitive Performance

Arielle S. Dolegui, *Inquiries*,
2013, VOL. 5 NO. 09 | PG. 2/2

Independent variables

Type of music played at two different levels of intensity: high intensity and low intensity.

Dependent variable

Performance, which was measured in terms of accurate answers obtained in each of the tests.

Performance scores were significantly higher in silence (M= 12.94) than in all four music conditions, intensity levels, and types of music combined (M= 11.99), $t(31)= 2.21$, $p < .05$.

Confirms *Smith and Morris, 1977*.

By PETER STEVENSON / AP / July 24, 2006, 5:27 PM

Distractions Make Learning Harder



generic children kids watching tv television / AP / CBS

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Your parents were right: Don't study with the TV on.

Multitasking may be a necessity in today's fast-paced world, but new research shows distractions affect the way people learn, making the knowledge they gain harder to use later on.

The study, in Monday's Proceedings of the National Academy of Sciences, also provides a clue as to why it happens.

"What's new is that even if you can learn while distracted, it changes how you learn to make it less efficient and useful," said Russell A. Poldrack, a psychology professor at the University of California, Los Angeles.

My Explanations: One

During knowledge acquisition,
listening to music of any sort
takes away cognitive resources
and leads to learning deficits.

My Explanation: Two

When you read in silence, you are reading (print) and hearing yourself saying the words (auditory) and sometimes seeing images (visual). This creates multiple traces of information – and strengthens memory for it.

Listening to music of any sort while reading, disrupts auditory and visual coding and most likely only leads to coding of words.

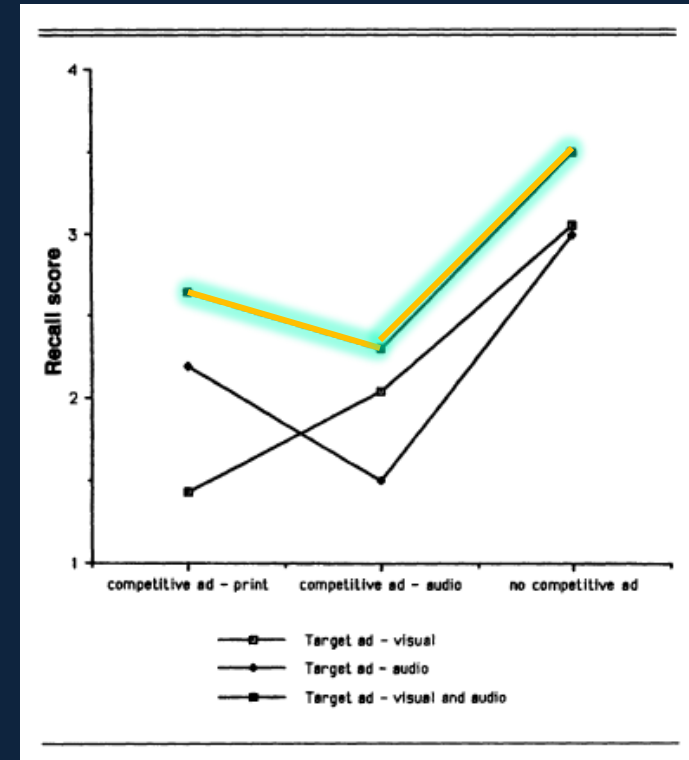
Support for this logic

H. RAO UNNAVA and DEEPAK SIRDESHMUKH

Some recent research has shown that the presence of competitive advertising undermines the recall of a marketer's advertising. The authors use the encoding variability hypothesis to develop two approaches to counter the detrimental effects of competitive advertising. In the first experiment, the use of varying ad executions is shown to help resist competitive advertising better than repeating the same executions. In the second experiment, changing the modality of target advertising to be different from the modality of competitive advertising is shown to reduce interference effects.

Reducing Competitive Ad Interference

One study from our paper in the
Journal of Marketing Research
(Unnava and Sirdeshmukh, 1994)



People remembered more – and forgot less - when they saw an ad in visual and print form (top line), rather than one form

A caveat

Listening to music can have other beneficial effects, but typically when learning tasks are not aimed at deep understanding and memorization.

Music has been found to increase creative and exploratory thinking – both in terms of number of innovative ideas generated, and innovativeness of ideas.

Listening to music can make mundane and routine tasks (such as coding data) more bearable.

Summary

Understanding is the first but not the only step in the learning process

Multi-tasking and tech tools can undermine learning comprehension

Information



Sensory memory



Short-term memory
(working memory)

Available capacity



Rehearsal, Encoding



Long-term memory

Retrieval, Elaboration



Information Stored

Keep a thread going (narrative)

Find connections to what you already know.

Avoid highlighting, the first time you are reading.

Take notes by hand rather than on a laptop

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

**John Dunlosky¹, Katherine A. Rawson¹, Elizabeth J. Marsh²,
Mitchell J. Nathan³, and Daniel T. Willingham⁴**

¹Department of Psychology, Kent State University; ²Department of Psychology and Neuroscience, Duke University;

³Department of Educational Psychology, Department of Curriculum & Instruction, and Department of Psychology, University of Wisconsin–Madison; and ⁴Department of Psychology, University of Virginia

Psychological Science in the
Public Interest

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Study examined multiple techniques

Table 1. Learning Techniques

Technique	Description
1. Elaborative interrogation	Generating an explanation for why an explicitly stated fact or concept is true
2. Self-explanation	Explaining how new information is related to known information, or explaining steps taken during problem solving
3. Summarization	Writing summaries (of various lengths) of to-be-learned texts
4. Highlighting/underlining	Marking potentially important portions of to-be-learned materials while reading
5. Keyword mnemonic	Using keywords and mental imagery to associate verbal materials
6. Imagery for text	Attempting to form mental images of text materials while reading or listening
7. Rereading	Restudying text material again after an initial reading
8. Practice testing	Self-testing or taking practice tests over to-be-learned material
9. Distributed practice	Implementing a schedule of practice that spreads out study activities over time
10. Interleaved practice	Implementing a schedule of practice that mixes different kinds of problems, or a schedule of study that mixes different kinds of material, within a single study session

Note. See text for a detailed description of each learning technique and relevant examples of their use.

Multiple studies confirm that highlighting is a poor learning aid

Table 4. Utility Assessment and Ratings of Generalizability for Each of the Learning Techniques

Technique	Utility	Learners	Materials	Criterion tasks	Issues for implementation	Educational contexts
Elaborative interrogation	Moderate	P-I	P	I	P	I
Self-explanation	Moderate	P-I	P	P-I	Q	I
Summarization	Low	Q	P-I	Q	Q	I
Highlighting	Low	Q	Q	N	P	N
The keyword mnemonic	Low	Q	Q	Q-I	Q	Q-I
Imagery use for text learning	Low	Q	Q	Q-I	P	I
Rereading	Low	I	P	Q-I	P	I
Practice testing	High	P-I	P	P	P	P
Distributed practice	High	P-I	P	P-I	P	P-I
Interleaved practice	Moderate	I	Q	P-I	P	P-I

Note: A positive (P) rating indicates that available evidence demonstrates efficacy of a learning technique with respect to a given variable or issue. A negative (N) rating indicates that a technique is largely ineffective for a given variable. A qualified (Q) rating indicates that the technique yielded positive effects under some conditions (or in some groups) but not others. An insufficient (I) rating indicates that there is insufficient evidence to support a definitive assessment for one or more factors for a given variable or issue.

Why Highlighting leads to Learning Deficits

- The task itself uses up mental resources.
 - Focuses attention on words and sentences, not the entire context.
- Reduces cognitive capacity for real-time elaboration of material
- *Is better used in a second or follow-up reading.*

One more suggestion: Try and take handwritten notes, and do as much in writing as possible



The screenshot shows the top portion of a journal article page. At the top, the journal title "Psychological SCIENCE" is displayed in white on a dark red background, with the subtitle "A Journal of the Association for Psychological Science" to its right. Below the title is a navigation bar with buttons for "Home", "OnlineFirst", "All Issues", "Subscribe", "RSS", and "Email Alerts". The main content area has a white background. A red link indicates a more recent version of the article was published on 06-04-2014. The article title "The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking" is prominently displayed. The authors are listed as Pam A. Mueller and Daniel M. Oppenheimer, with their respective affiliations: Princeton University and University of California, Los Angeles. A short bio for Pam A. Mueller is provided, including her email address. The "Author Contributions" section details the roles of both authors in the study.

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A [more recent version](#) of this article was published on [06-04-2014]

The Pen Is Mightier Than the Keyboard Advantages of Longhand Over Laptop Note Taking

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Author Contributions Both authors developed the study concept and design. Data collection was supervised by both authors. P. A. Mueller analyzed the data under the supervision of D. M. Oppenheimer. P. A. Mueller drafted the manuscript, and D. M. Oppenheimer revised the manuscript. Both authors approved the final version for submission.

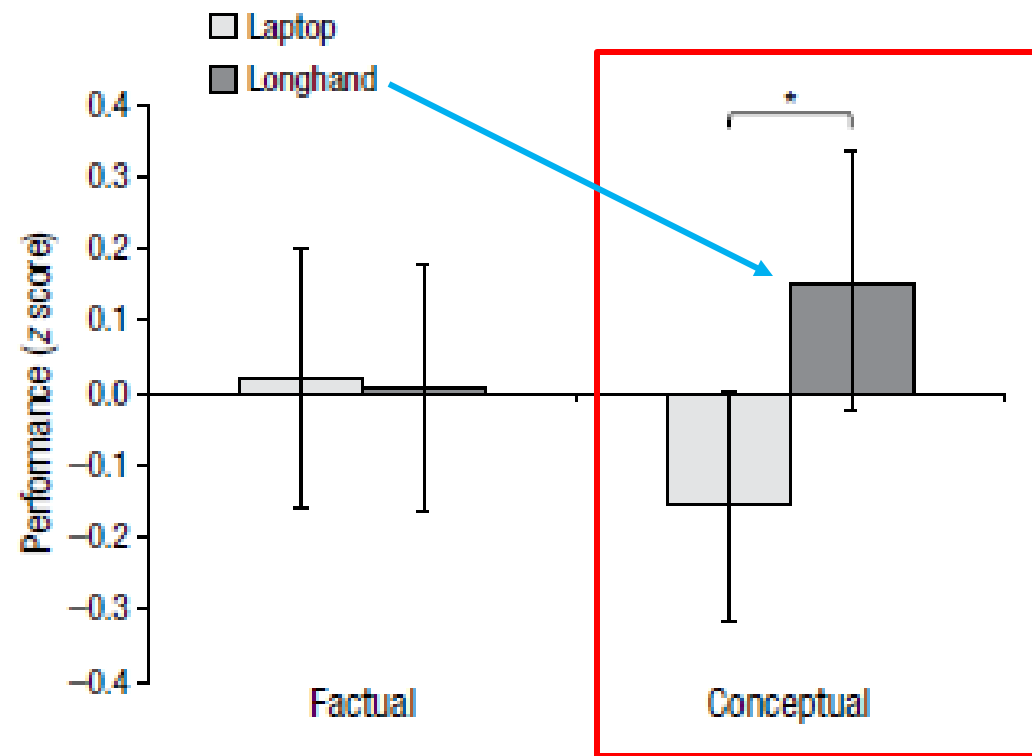


Fig. 1. Mean z-scored performance on factual-recall and conceptual-application questions as a function of note-taking condition (Study 1). The asterisk indicates a significant difference between conditions ($p < .05$). Error bars indicate standard errors of the mean.

Benefits of handwritten notes *

Students who took notes in longhand performed better at subsequent tests focused on conceptual questions.

Notes taken on laptops tended to be shallower; evidence of more elaboration & summarizing when taking notes by hand.

Notes on laptops tended to have more words, but were more verbatim.

** Dictated notes may have similar benefits, but I have no research on hand*

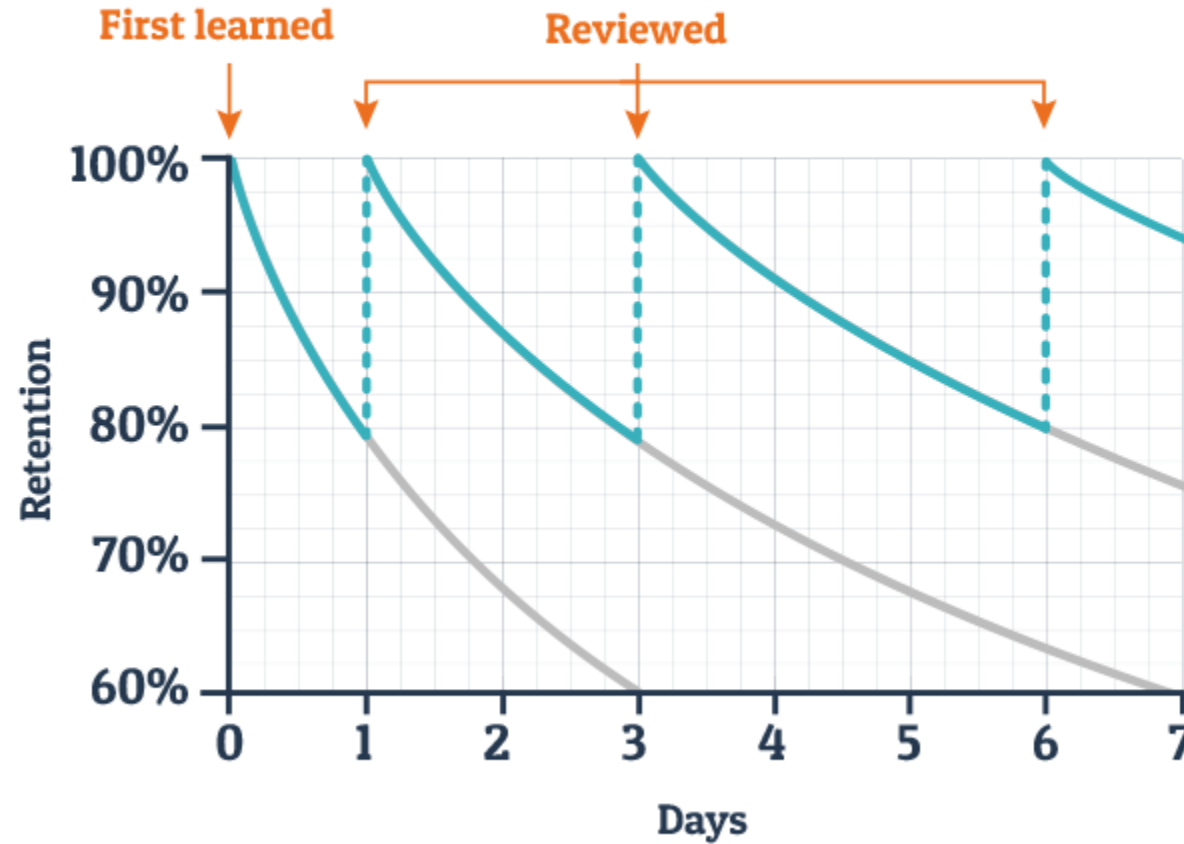
Summary

Understanding is the first but not the only step in the learning process

Multi-tasking and tech tools can undermine learning comprehension

Learning methods such as highlighting can adversely affect learning

Typical Forgetting Curve for Newly Learned Information



Multiple studies confirm that self-testing or interactive testing is a distinctly superior learning method.

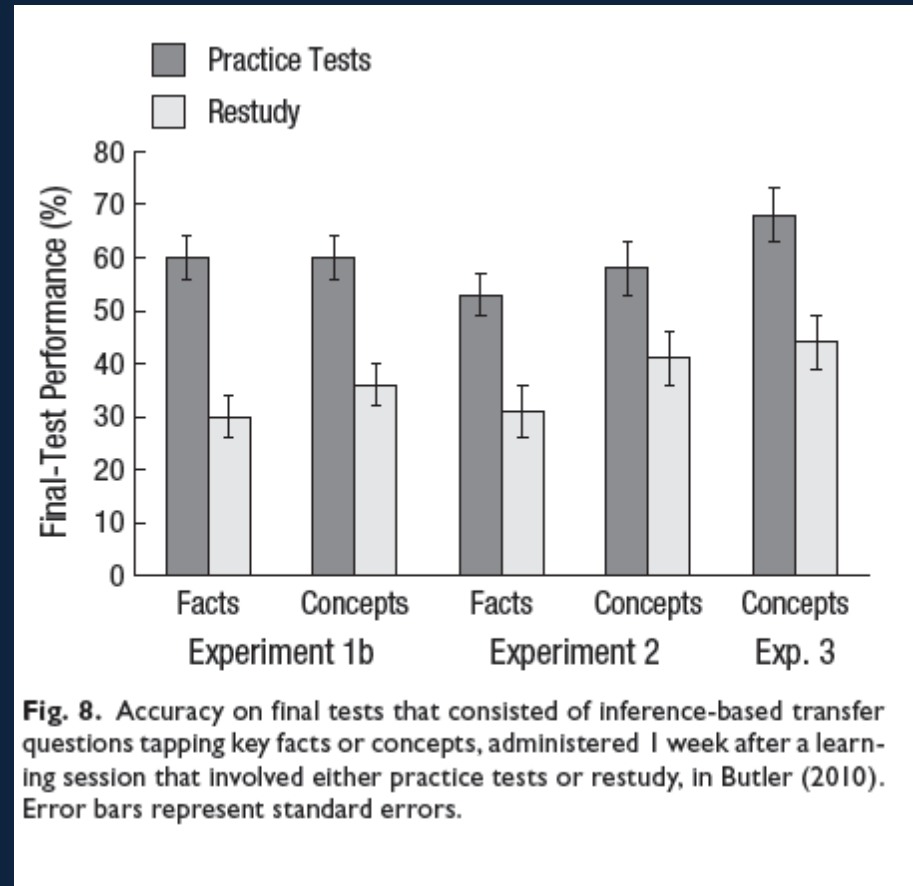


Fig. 8. Accuracy on final tests that consisted of inference-based transfer questions tapping key facts or concepts, administered 1 week after a learning session that involved either practice tests or restudy, in Butler (2010). Error bars represent standard errors.

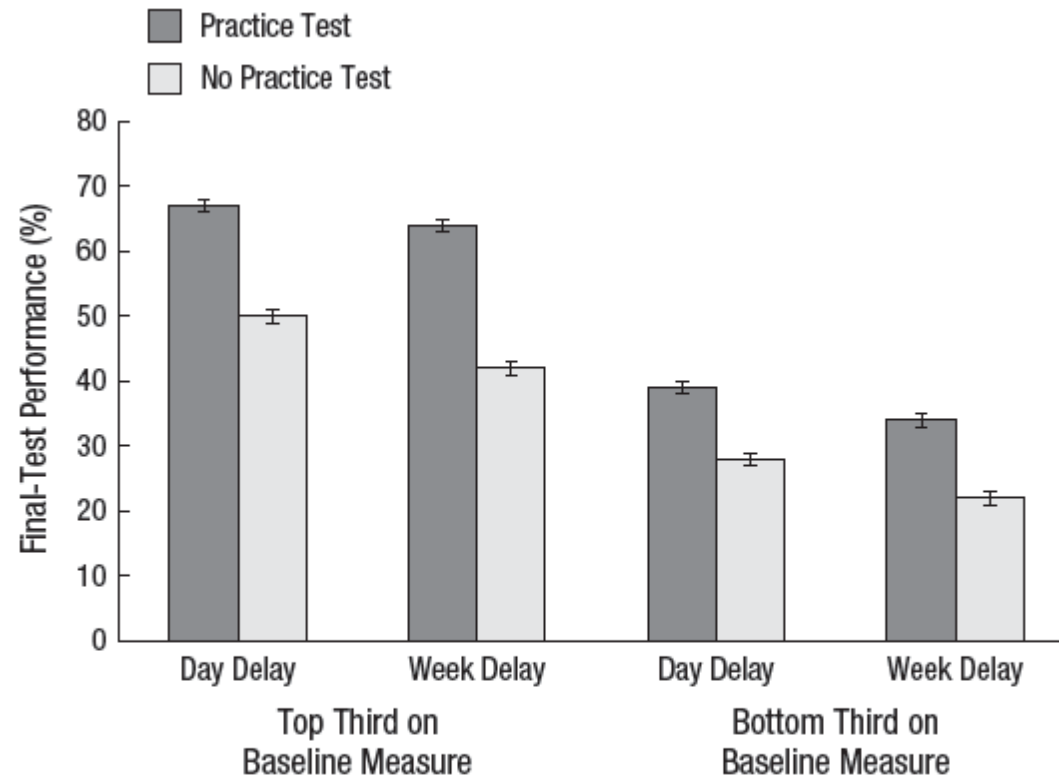


Fig. 7. Mean accuracy on a final test administered 1 day or 1 week after a learning session that either did or did not include a practice test, for the top and bottom thirds of scorers on a baseline measure of ability, in Spitzer (1939). Error bars represent standard errors.

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Multi-tasking and tech tools can undermine learning comprehension

Learning methods such as highlighting can adversely affect learning

Rehearsal and self-testing strengthen long-term memory

Information



Sensory memory



Short-term memory
(working memory)

Available capacity

“Partition” your learning –
marketing/operations/etc
Within marketing –
products/pricing/etc.



Rehearsal, Encoding




Retrieval, Elaboration

Long-term memory

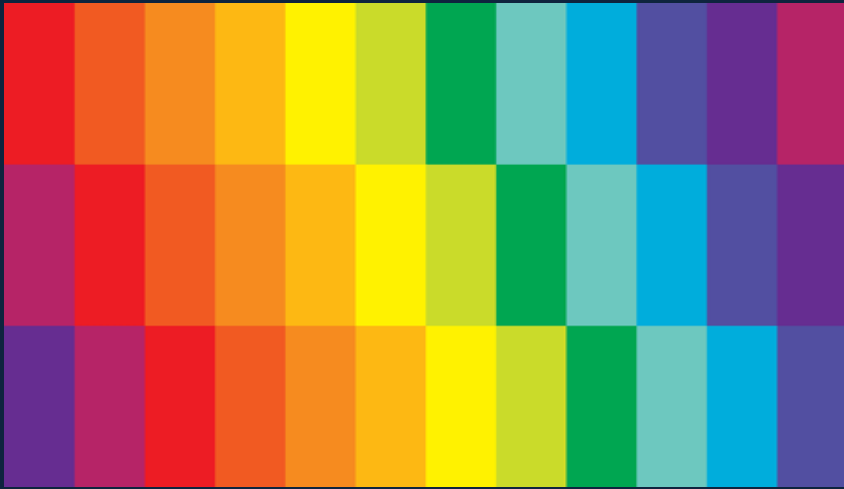


Information Stored

Your learning can end up
like a library of unsorted
and unclassified books



Instead –
compartmentalize your
learning.



Easier to scan memory for a match and make decisions,
when you organize your knowledge even as it is being created.



The Principle of Encoding Specificity

Recall is most effective when the conditions at the time of encoding match the conditions at the time of retrieval.

These conditions may refer to the context in which the information was encoded, the physical location or surroundings.

The Principle of Encoding Specificity

Some Implications

Taking an exam in the same classroom in which the material for the exam was learned positively correlates with performance on said exam (Multiple studies).

Other techniques: Take notes for each subject on different colored sheets, or different books, or with a different pen.

Summary

Understanding is the first but not the only step in the learning process

Multi-tasking and tech tools can undermine learning comprehension

Learning methods such as highlighting can adversely affect learning

Rehearsal and self-testing strengthen long-term memory

Partitioning learning and storing contextual cues helps retrieval

Stored Information



Recalled and Applied



Understand the task carefully

Look for a cue (or clue) that tells you what knowledge to access.

Use the cue to focus your search.

Integrate, apply, respond.

Summary

Understanding is the first and not the only step in the learning process

Multi-tasking and tech tools can undermine learning comprehension

Learning methods such as highlighting can adversely affect learning

Rehearsal and self-testing strengthen long-term memory

Partitioning learning and storing contextual cues helps retrieval

Cues in the task environment should help access stored knowledge