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Understanding and supporting cognition in the classroom

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Interactive bit: Identifying children with working memory problems

A brief recap…

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- Working memory is a system for maintaining information online for brief period of time
- It is very closely associated with learning at all ages

Characteristics of children with poor working memory

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- Poor academic progress

More than 80% of children with poor working memory fail to achieve expected levels of attainment in either reading or maths, typically both (Gathercole & Alloway, 2008)

Characteristics of children with poor working memory

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- Poor academic progress
- Reserved in groups

Ross (6 years) is a reserved and quiet child who tends not to volunteer responses and rarely answers direct questions, particularly in the whole-class situation. He sometimes becomes more vocal when working in small groups although he isn't necessarily discussing the task in hand.

Characteristics of children with poor working memory

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- Poor academic progress
- Reserved in groups
- Difficulties in following instructions

"Put your sheets on the green table, arrow cards in the packet, put your pencil away and come and sit on the carpet."

John (6 years) moved his sheets as requested, but failed to do anything else. When he realized that the rest of the class was seated on the carpet, he went and joined them, leaving his arrow cards and pencil on the table.

Characteristics of children with poor working memory

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- Poor academic progress
- Reserved in groups
- Difficulties in following instructions
- Loses track in complex tasks

When the teacher wrote on the board Monday 11th November and, underneath, The Market, which was the title of the piece of work, Nathan lost his place in the laborious attempt to copy the words down letter by letter, writing moNemarket.

Characteristics of children with poor working memory

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- Poor academic progress
- Reserved in groups
- Difficulties in following instructions
- Loses track in complex tasks
- Problems when activities involve processing and storage

Ruby's teacher wrote sequences of numbers on the white board that had some numbers missing. She read aloud the numbers, and asked the class what numbers had been missed out. In each case, there was more than one number missing. In each case, Ruby was unable to name the missing numbers.

Characteristics of children with poor working memory

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- Poor academic progress
- Reserved in groups
- Difficulties in following instructions
- Loses track in complex tasks
- Problems when activities involve processing and storage
- Place-keeping difficulties

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Characteristics of children with poor working memory

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- Poor academic progress
- Reserved in groups
- Difficulties in following instructions
- Loses track in complex tasks
- Problems when activities involve processing and storage
- Place-keeping difficulties
- Teachers say: short attention span and highly distractible

"he's in a world of his own"

"he doesn't listen to a word I say"

"she's always day-dreaming"

"with him, it's in one ear and out of the other"

For each child, decide:

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- what (if any) do you consider to be the possible major underlying problems faced by this child?
- whether this child shows any of the warning signs associated with working memory impairments?

Adam

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Adam is a 10-year old boy. He is viewed by his teacher as experiencing many problems within the classroom, and on occasions can be a disruptive influence due to his high level of distractibility. He often appears restless and fidgety, and on several occasions has broken classroom equipment. His work is of a low average standard, with its quality varying considerably from day to day. His teacher is as yet unsure whether he will attain Level 4 in Key Stage 2 National Curriculum assessments in English, maths and science, although she feels sure that he has the abilities to do so.

Andrew

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Andrew is a 6-year old boy with a pleasant and cheery personality. He is well-behaved and popular in his class. Andrew's IQ is within the normal range, with a higher Performance IQ (105) than Verbal IQ (95). His academic performance is poor in both numeracy and literacy, and is in the lowest ability group in literacy. He frequently becomes frustrated by the difficulties that he experiences, particularly in writing. Andrew does not often participate in class discussions, and often seems to be unable to respond even after he has raised his hand in response to a question by the teacher at 'carpet time'.

Olivia

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Olivia is a 7-year old child with an outgoing personality who is well-liked by her classmates. Her IQ is in the high average range (113). She has a mature and responsible attitude and is often chosen by her teacher to run errands. She has been placed in high-ability groups in both literacy and numeracy, and often helps out less able children within the group, occasionally misguiding them. At times she is forgetful, and can appear to be distracted from work by her own thoughts. The teacher often enlists her help in organizing classroom activities such as putting out art materials.

Alice

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Alice is aged 9 years. She is a timid girl with a close friendship with one other child. She was identified by her school as having special educational needs (School Action stage) one year ago due to her difficulties in developing literacy skills. Despite good comprehension of language, her word recognition skills are very poor and she struggles to extract meaning from text. Her hand-writing is messy, and her spelling is very inaccurate. Alice has made reasonable progress in maths where she copes with the demands of a mid-range ability group.

Jonathon

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At 8 years, Jonathon struggles to meet the language demands of the classroom despite appearing to be a bright and focused child. His spoken language is not markedly impaired, but is characterized by some degree of phonological immaturity. His progress in reading is very poor and he has struggled with many aspects of maths. In both areas, he receives twice-weekly support from a special needs assistant in school. The severity of his learning difficulties is reflected by his School Action Plus special needs status.

Charlotte

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Charlotte is a 6-year old girl who has established a small and supportive group of friends in her two years at school. In class activities, however, she often appears withdrawn, and frequently drifts away from activities without completing them. Her teacher says that she often seems to be in a world of her own. She is working in low ability groups in the classroom.

Are there ways of supporting working memory in class?

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- Two main approaches:
  - Working memory training
  - Structured classroom support

1. Classroom support (Gathercole and Elliot)

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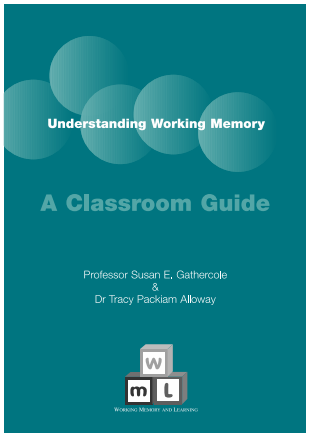
Children with poor working memory struggle to learn because of memory overload in activities designed to promote learning.

One approach is to minimise learning difficulties by preventing working memory overload.

For more information:

https://www.mrc-cbu.cam.ac.uk/wp-content/uploads/2013/01/WM-classroom-guide.pdf



Classroom support: Principles

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- **Familiarity with the warning signs of WM failure**
  - Incomplete recall
  - Failing to follow instructions
  - Losing track of place
  - Abandoning the task

Classroom support: Principles

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- Be aware of the warning signs of working memory failure
- **Reduce amount of information to be stored**

Examples of heavy WM loads

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- Remembering such sequences as
  - Three or more numbers (e.g., *5, 9, 2, 6)*
  - Three or more unrelated words (e.g., *cat, lion, kangaroo*)
- Writing lengthy sentences containing some arbitrary content
  - (e.g., *To blow up parliament, Guy Fawkes had 36 barrels of gunpowder*)
- Following lengthy instructions
  - (e.g., *Put your sheets on the green table, arrow cards in the packet, put your pencil away, and come and sit on the carpet*);
- Keeping track of the place reached in the course of multi-level tasks
  - e.g., writing a sentence either from memory or copying from the board

Classroom support: Principles

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- Be aware of the warning signs of working memory failure
- Reduce amount of information to be stored
- **Reduce difficulty of processing**

Classroom support: Principles

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- Be aware of the warning signs of working memory failure
- Reduce amount of information to be stored
- Reduce difficulty of processing
- **Enable the child to access key information**

Classroom support: Principles

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- Be aware of the warning signs of working memory failure
- Reduce amount of information to be stored
- Reduce difficulty of processing
- Enable the child to access key information
- **Encourage the use of memory aids**

Classroom support: Principles

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- Be aware of the warning signs of working memory failure
- Reduce amount of information to be stored
- Reduce difficulty of processing
- Enable the child to access key information
- Encourage the use of memory aids
- **Help the child to use strategies**

What teachers say about the intervention ….

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- “Their self esteem has improved as well because they’re not failing anymore. They are now actually succeeding so self-confidence has hugely improved.”
- “ I find, especially with the ones that struggle more, that they’re quite excited when they remember what they’ve got to do and when they’re working they seem to be enjoying it a lot more.”
- “I am now aware of working memory as a special need and feel increasingly aware of these pupils and the strategies needed to support them. I can now identify pupils with working memory problems myself.”
- “I understand how important it is to repeat information and explain things again and again to these pupils to support them. You can’t simply provide information once and move straight on or expect children to have taken it on board.”
- “We have been discussing whether we need to consider more widely all the other children in the school as well. It’s become a way of teaching for us now more than anything, and we now need to disseminate it to all the other staff so it becomes part of their teaching. We’re hoping to make this quality teaching and a school strategy.”

Overview

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- Variability in cognitive abilities – like working memory – will greatly impact upon an individuals capacity to engage with new material in any learning setting.

- If the amount of information exceeds an individuals working memory capacity then they will be unlikely to complete any of the desired tasks, and any new learning will be limited.

- When designing and delivering new material it is critical to keep working memory demands low (wherever possible) otherwise learners will find it difficult to engage with the deeper content of the material.

Long-term Memory

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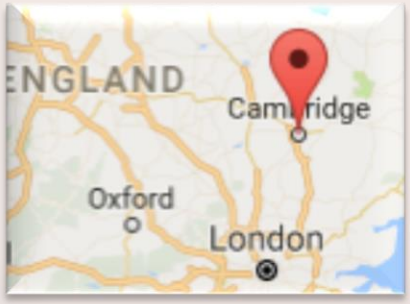
Explicit memory

Facts
(Semantic)



Events
(Episodic)

Implicit memory

Skills
(Habit)

Conditioning
Priming

Squire & Zola-Morgan (1991). Biological Psychology

Learning of new information

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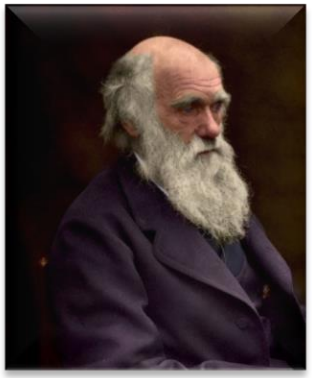

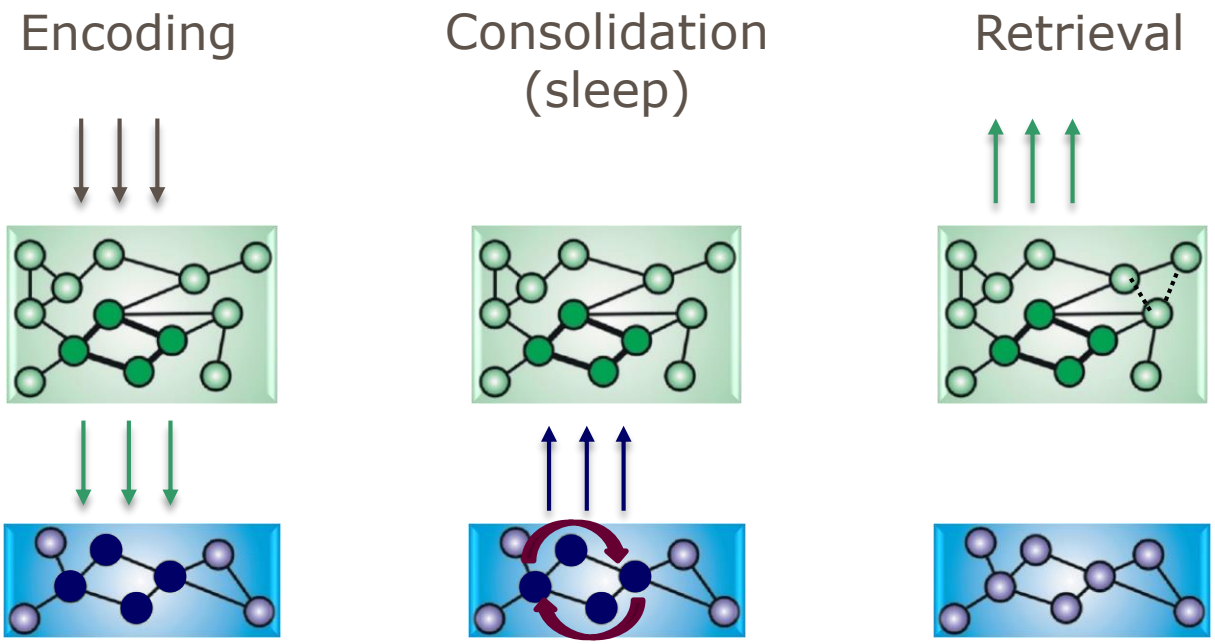

Feld, G.B & Born J (2017). Current Opinion in Neurobiology

Learning of new information

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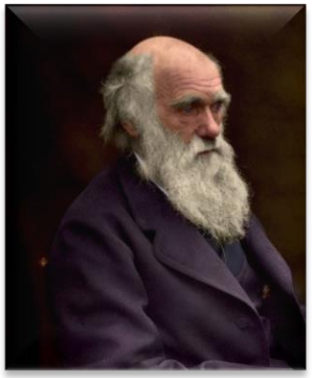
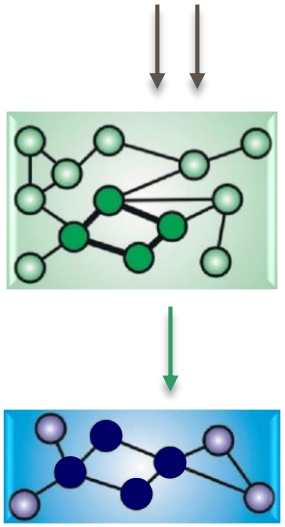
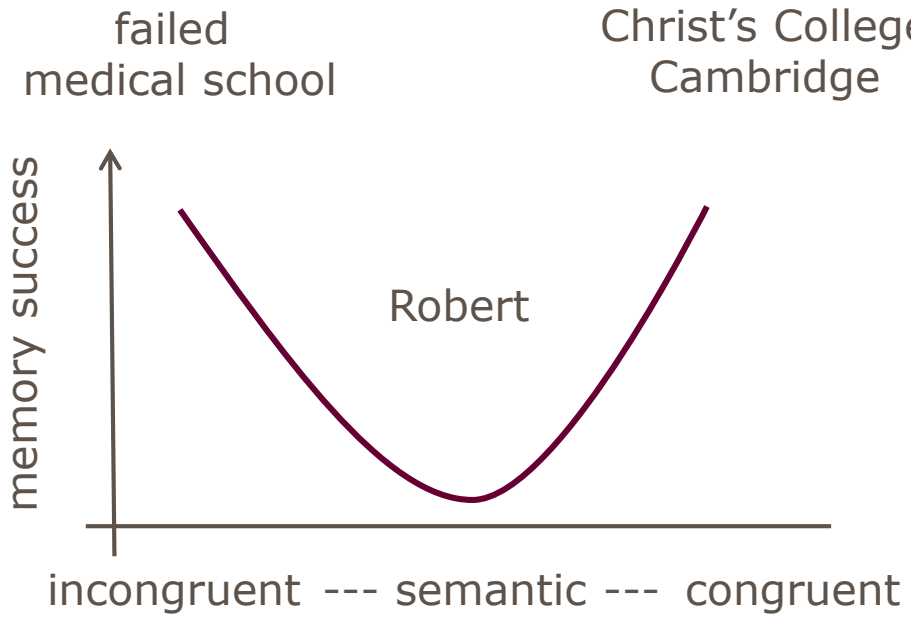


Encoding



Neocortex
(semantic)

Hippocampus
(episodic)



Greve et al (2017). Journal of Memory and Language

Memory processes and principles

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Storage

Encoding →  → Retrieval

Level of Processing

Cue-dependency
Encoding specificity
Context dependency

Rehearsal
Organization

IV. Learning techniques

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1. Spaced Practice

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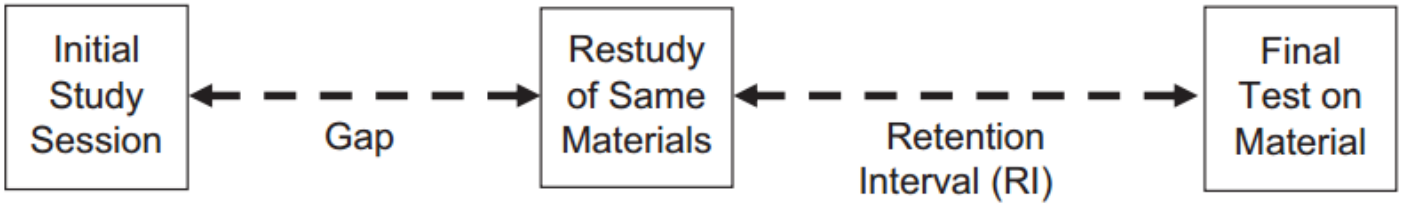
Study the material in several sessions spread out over a long period of time, rather than repeatedly learn material in a short period of time.

Studying five hours spread out over two weeks is much more effective than five hours all at once.

1. Spaced Practice: evidence



optimal gap increases as test delay increased

optimal gap between study sessions is about 5-10% of the study-test delay

Cepeda et al. (2008) Psychological Science

1. Spaced Practice: how to do it

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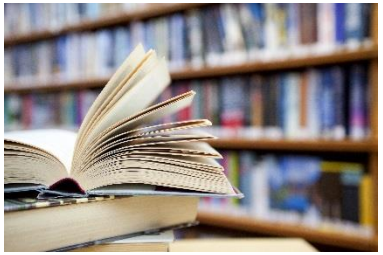
Lesson

Break

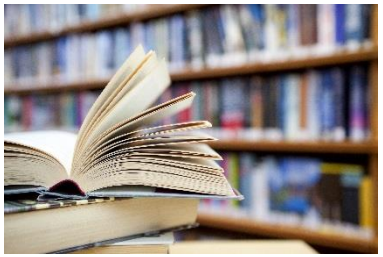
Review



and even older lessons

but also from older lessons

from most recent class



Benjamin, A. S., & Tullis, J. (2010). Cognitive Psychology

2. Interleaving

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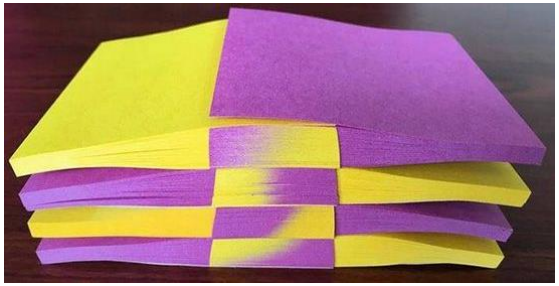
Instead of practicing one skill at a time ("AAABBBCCC"), interleaving mixes practice on several related skills together (for example, "ABCABCABC").



switch between ideas during a study session
go back over the ideas again in different orders

2. Interleaving: evidence

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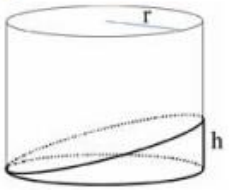
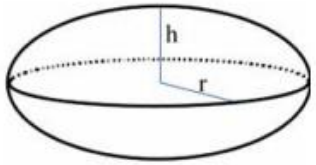
of maths problems

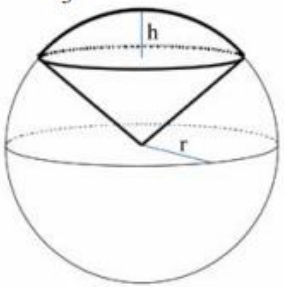
A **wedge** is the boldfaced portion of the tube.
Its bottom is a circle, and its top is a slanted oval.
Its volume equals $\frac{r^2 h \pi}{2}$



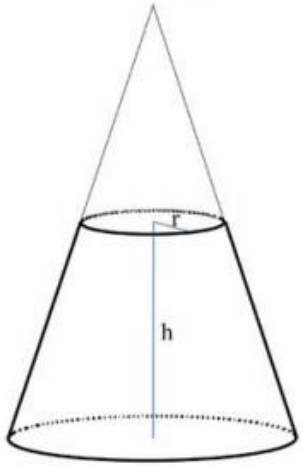
A **spheroid** is similar to a sphere.
But its height has been squeezed or stretched.
Its volume equals $\frac{4 r^2 h \pi}{3}$



A **spherical cone** is the boldfaced part of the sphere.
Its bottom is at the center of the sphere.
The rim of the cone is on the surface of the sphere.
Its volume equals $\frac{2 r^2 h \pi}{3}$



A **half cone** is the bottom half of a cone.
Both its top and bottom are circles.
Its volume equals $\frac{7 r^2 h \pi}{3}$



Mixer: A B C D, D B A C …

Blocker: A A A A, B B B B …

Rohrer & Kelli (2007). Instr Science

2. Interleaving: evidence

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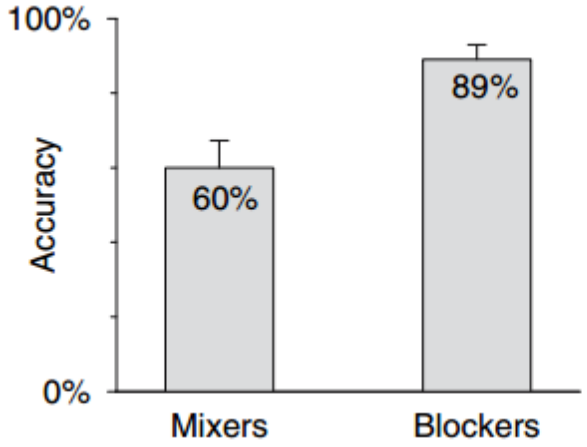
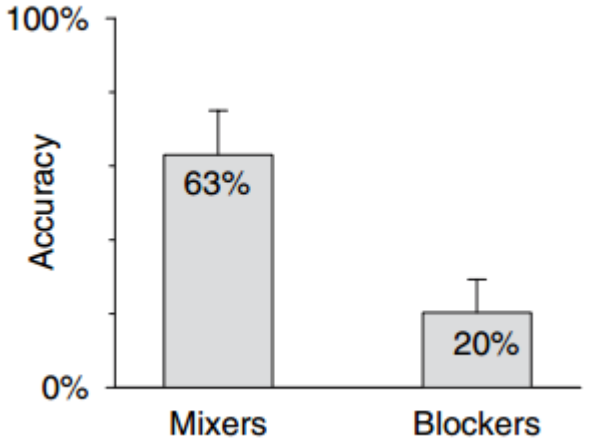
practice session performance



test session performance



Mixer: A B C D, D B A D …

Blocker: A A A A, B B B B …

Rohrer & Kelli (2007). Instr Science

2. Interleaving: how to do it

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Mix it up!

Don’t switch too often, or spend too little time on any one idea.

Feels harder than studying the same thing for a long time.

Some familiarity with subject materials is needed (or, the materials should be quickly or easily understood)

3. Retrieval Practice

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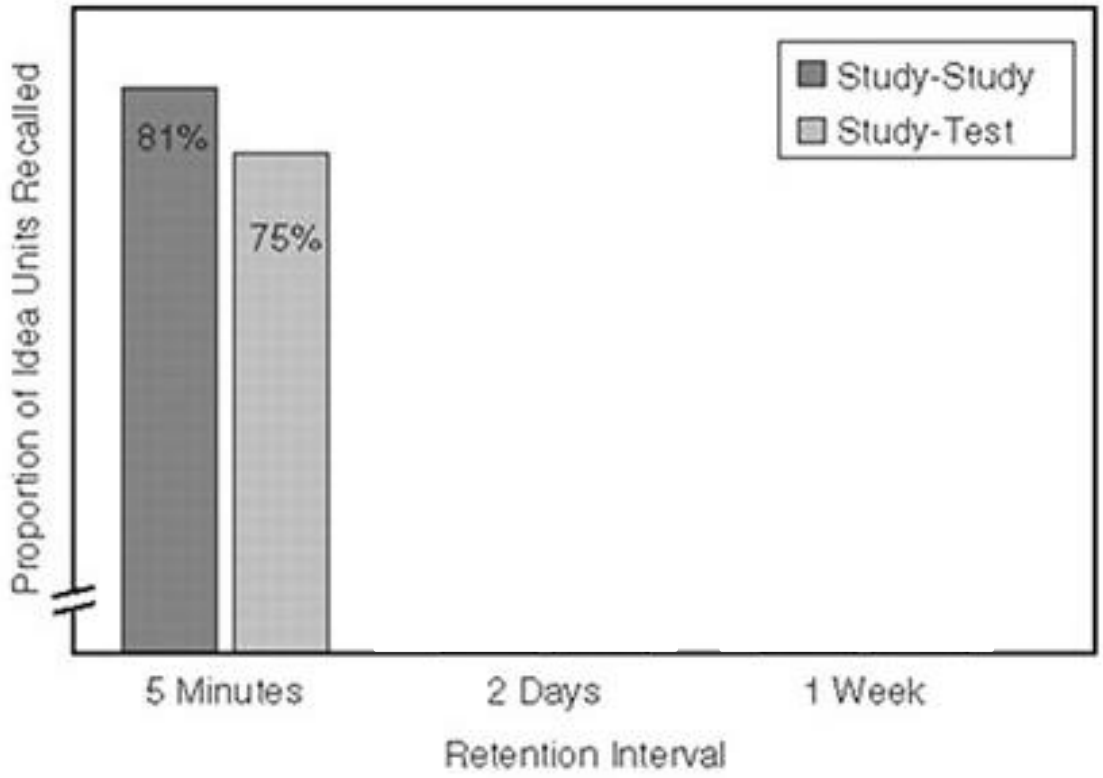
Devote some of the learning period to retrieving the to-be-remembered information through testing it with proper feedback.

answering questions is strengthening memory
active learning > passive learning

3. Retrieval Practice: evidence



Roediger & Karpicke (2006). Perspectives on Psychological Science

3. Retrieval Practice: how to do it

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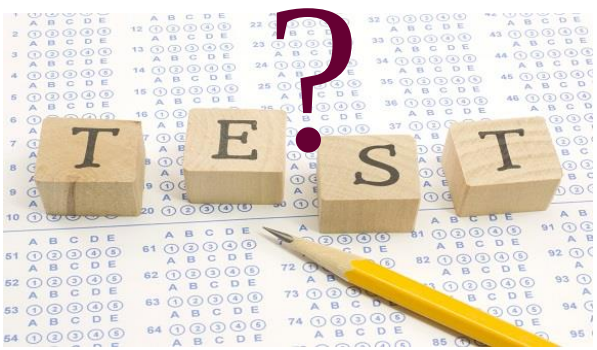
learning opportunity

flash cards



feedback

practice questions

actively think about material

complex questions

4. Elaboration

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Use strategies that enhance the information of the learning material and increases their relation to other information the learner already knows.

encoding the original content
in a different but related way

4. Elaboration: how to do it

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make sure it is accurate

ask questions about how/why things work

in life, make connections to material

apply material to your experiences

link two different ideas together

ANY mental construction:
inference, example, analogy,
detail, image, overall summary

McDaniel, M. A., & Donnelly, C. M. (1996). Journal of Educational Psychology

5. Curiosity

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Gruber et al. (2014). Neuron

6. Intention to learn

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Mandler (1967)

7. Interference

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Interference occurs when old and new information overlap which has a negative influence on remembering old or learning the new information.

cat - tree
jelly - moss
book - tractor

cat - glass
jelly - time
book - revolver

Underwood & Postman (1960). Psychological Review

Sleep

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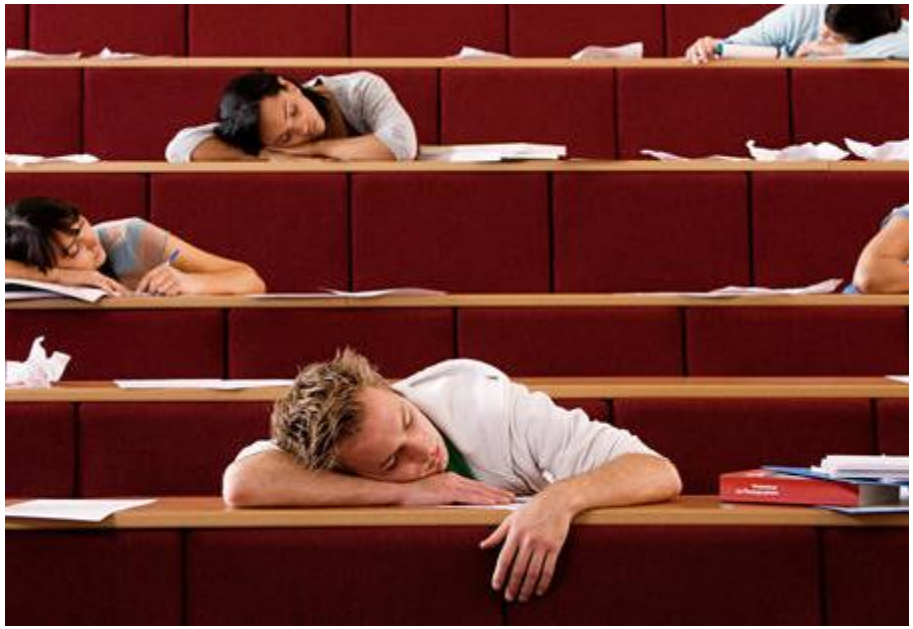

Diekelmann & Born. (2010). Nature Review

Final Summary:

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- Different types of memory have different functional roles, and underlying neural processes.

- The different types of memory are important at different stages of the learning process:
  - In class – working memory limits can constrain learning
  - Consolidation allows for 'episodes' to enter into semantic memory, such that they are durable and can be generalised.

- Reducing working memory demands during learning has been shown to improve long term outcomes – especially for those who might have lower working memory capacity.

- Spacing learning properly, allowing for 'deep processing', and plenty of sleep have all been shown to enhance this consolidation process.

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