

COGNITION IN ACTION

LECTURE TWO: MEMORY IN THE REAL-WORLD I

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MEMORY IN THE REAL-WORLD

- Memory: - a vital cognitive mechanism
 - Allows us to function appropriately in the real-world
- Being able to **remember** is one aspect of memory
- However, we are also interested in mechanisms behind how/why we **forget** and the impact this has in real-world settings
 - Can be trivial – e.g., forgetting a phone number
 - Or critical – e.g., forgetting emergency procedure when noticing a faulty system in a nuclear power plant

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REAL-LIFE EXAMPLES OF MEMORY FAILURES

- 1915: railroad switchman in Scotland forgot train was moved to an active track - two trains travelled on same piece of track and crashed.
 - Over 200 people killed (Rolt, 1978; Reason 2008).
- 1996: mechanics forgot to put safety caps on oxygen generators loaded onto a flight.
 - Ramp agent also forgot to check content of the cargo.
 - During flight, a generator engaged, causing a fire.
 - The plane crashed, killing over 100 (Langewiesche, 1998)

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MEMORY IN THE REAL-WORLD

- Success/failure of memory has major impact on safety.
- If we can understand mechanisms and functions of memory, we could avoid disaster.
- Could also improve productivity in organisational settings and learning in educational settings.
- Applied research, and with evidence from brain damaged patients, suggests memory is multi-faceted.
- This makes designing a general model difficult.
 - It needs to be broken down into constituent parts.

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TO ILLUSTRATE....



- Pilot's memory should contain representation of various **skills required** to fly an aeroplane.
 - Memories for how a task should be done – E.g., landing procedure
 - This would use LTM
- But on a given flight, pilot also keeps internal record of info related to **that particular flight**.
 - e.g., current location, instructions from air traffic controller, next steps in flight plan, weather conditions, etc.
 - This would involve STM

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WORKING MEMORY



- Seen as *workbench* of consciousness:
 - Used to evaluate, transform, and compare mental representations.
- Demanding tasks overload WM:
 - E.g., during landing, pilot may be simultaneously implementing instructions from air traffic control, receiving new instructions, and converse with co-pilot.
- Safety of passengers depends on pilots ability to combine various processing and short term storage operations involved.

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WM AND INTERFERENCE

- **Code interference:** Verbal-phonetic and visual-spatial code function cooperatively rather than competitively
 - E.g., both activated in parallel by pictures of objects.

Word

BIKE

Picture



- Advantage of cooperation = the two codes do not compete for the same limited processing resources.

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WM AND INTERFERENCE



- Irrelevant input from general environment disrupts performance:
 - Salamé and Baddeley (1989): music with lyrics disrupts verbal WM, while similar music without lyrics does not.
 - Tremblay and Jones (2001): To-be-ignored speech disrupts performance on verbal tasks.
- Suggests that to improve memory:
 - Irrelevant environmental info (e.g., sound) and
 - Concurrent tasks that amplify code interference should be minimised.

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WM AND INTERFERENCE

- Display format code enters system through different modalities also needs to be considered:

		Display Format Code	
Modality	Auditory	Verbal Speech	Spatial Sound localization
	Visual	Print	Pictures

- = optimum combination of code to modality.
- Practical importance when considering how instructions are provided.

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WM AND INTERFERENCE

- Non-rehearsed info **decays** from STM.
- Amount of information it can hold = limited.
- What could this mean for pilot coming into land?
 - E.g., length of navigational info from air traffic control needs to be concise.
- “Chunking”: Capacity overcome by organisation and rules.
 - Lofus et al. (1979): pilots’ memory of air traffic control info was better when parsed in to 2 chunks (27 84) than as four separate digits (2 7 8 4).



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INTERFERENCE IN MEMORY

- One of the primary functions of the executive control within WM is to deal with interference (Anderson, 2003).

PROACTIVE: Prior info interferes with new info.

- Effects are pronounced when little time between series of memory tasks (Hopkin, 1980); when engaged in another task and for Ps with low WM capacity (Kane & Engle, 2000).
- Lofus et al. (1979): need at least 10 second delay in-between verbal material being presented in exchange between pilots and air-traffic controllers to avoid subsequent material from disrupting memory for previous info.

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INTERFERENCE IN MEMORY

RETROACTIVE: New info interferes with old info.

- E.g., after using a new number we cannot remember old one.
- Has an impact on verbal info (Anderson, 2003); visual info (Davies et al., 1979); and spatial info (Hole, 1996).

- Items in WM can be forgotten due to *similarity* with other items
 - E.g., if air-traffic controller needs to deal with fleet of aircrafts having similar identification codes (Fowler, 1980).

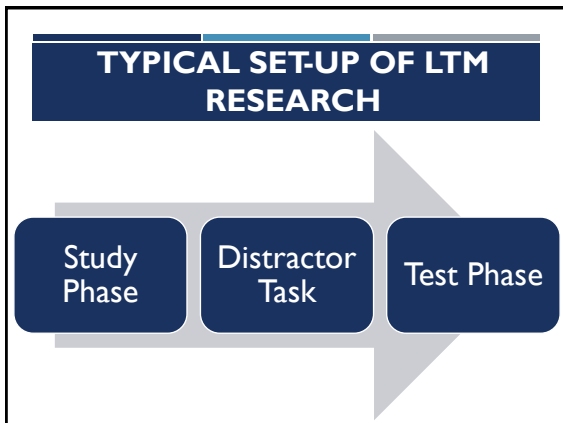
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LONG-TERM MEMORY IN THE REAL-WORLD



- Responsible for *all* info we could wish to retain/use
- Lots of information
 - Reflects complexity of world and our behaviour within it
 - Not just to remember a sequence of numbers!
- Made of separate memory systems due to fragmentation of different memory types

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STUDY PHASE EXAMPLE

- Two minutes to study the following list of words:
 - Cat
 - Table
 - Lorry
 - Door
 - Tree
 - Etc

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DISTRACTOR TASK

- To stop participants practicing
 - Could be a puzzle
 - A listing task
 - Decision making task
 - Anything not related to the stimuli
- Amount of time should be standardised for all



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TEST PHASE EXAMPLE

- Participants tested on memory for stimuli presented in study phase, either through:

Recall	Recognition
• Bringing fact to their own mind	• Identifying information from a choice presented

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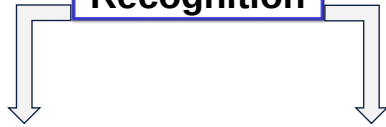
TEST PHASE: RECALL....

PLEASE
WRITE
DOWN AS
MANY
WORDS AS
YOU CAN
REMEMBER
FROM THE
STUDY
PHASE....

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TEST PHASE: RECOGNITION

Recognition



Target

TABLE

Was this in the study phase?

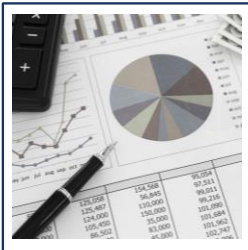
Distractor

HAMMER

Was this in the study phase?

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TYPE OF DATA PRODUCED



- Recall: Add all correct responses and work out % based on how many items there were in total.
 - E.g., 10 items in study phase; participant correctly identified 6 =
 - 60% accuracy
- Recognition: Add all correct responses
 - **HOWEVER** – must also consider items participants claim were there but were in fact not.....

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SIGNAL DETECTION THEORY (SDT)

Perceiver's response

		"Yes"	"No"
Stimulus	Present	Hit	Miss
	Absent	False alarm	Correct rejection

• (Green & Swets, 1966; Macmillan & Creelman, 2005).

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SIGNAL DETECTION

- Perfect performance: No misses or FAs.
- But, not always easy to distinguish signal from noise.
- Target detection latencies also taken into consideration.
 - Can be critical in real-life scenarios
- Premise of signal detection:
 - When a stimulus or signal occurs, it creates a neural response.

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WHAT IS SIGNAL DETECTION?

- Neural noise constantly fluctuates, so brain must decide if neural activity reflects noise alone or also a signal.
- When a stimulus is difficult to detect, cognitive factors become critical.
- However, there will always be a trade-off between hits and FAs
- We must consider number of times a person claims to detect a target when it is not there (FA rate), just as much as correct detection of a target that is present (Hit rate).
- WHY?.....

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SIGNAL DETECTION

- Detection ability is calculated as a probability from the hit and false alarm rates:
 - 20 signals presented, 5 hits & 15 misses = $5/20 = 0.25$
Hit rate
 - 10 noise trials, 1/2 were "yes" response = $5/10 = 0.50$
FA rate
- By combining hit & FA it produces an index of **response criterion** placement.....
 - Observers willingness to respond affirmatively.

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SIGNAL DETECTION

- It determines observers response characteristic
 - Conservative
 - Liberal
- Low hit & false alarm rates =
 - More *conservative* in response.
- High hit & false alarm rates =
 - More *liberal* in response.
- Reduction in hit rate but steady/increase FA rate = observer is not good at distinguishing between two types of events.

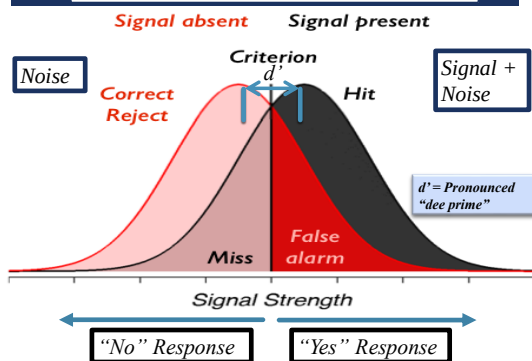
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SIGNAL DETECTION THEORY

- The detectability of the signal depends on the difference between the means of the noise plus signal and the noise alone distributions.
- This is known as **d' (d prime) – the index of sensitivity.**
 - The greater the overlap between the distributions, the lower the d value and the more difficult it is to discriminate signal from noise.

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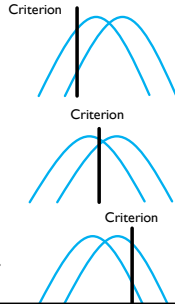
SIGNAL DETECTION THEORY (SDT)



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SHIFTING THE RESPONSE CRITERION

- People may set themselves specific criterion levels during detection decision scenarios.
- Only when that threshold is reached will a person decide to respond “yes” to the possibility of a signal.
- Notice there is no way of setting the criterion to achieve only hits & no FAs.



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FORGETTING: ADAPTIVE AND NECESSARY MECHANISM?



- Does our mind actively remove unwanted, irrelevant or distracting information from conscious awareness?
- Depends on the type of memory?
- Experimental lab and applied research examines emotional/traumatic memories and everyday/mundane memories.
- Aim to discover if difference exists in mechanisms used.

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MECHANISMS OF FORGETTING



- Memories enable us to function in a complex social world.
- But, we are continuously bombarded with constantly changing information
 - So, memories need to be regularly updated.
- We must forget old/irrelevant info that may be competing for recollection with new info we wish to recall.

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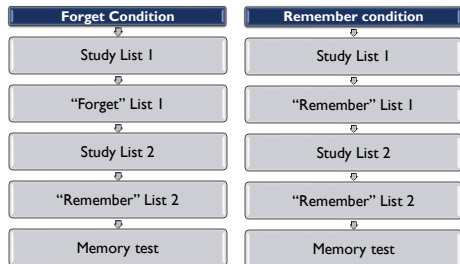
MECHANISMS OF FORGETTING



- When trying to locate where we parked the car at the supermarket, it is beneficial to forget other details about the car (e.g., where we parked last week) and concentrate on trying to remember where we parked it on the current occasion.

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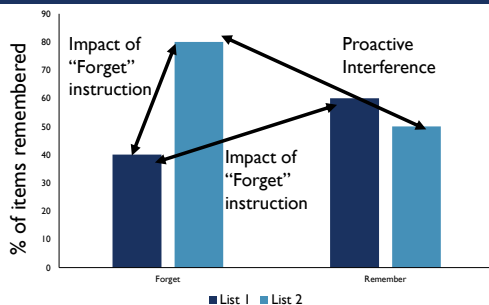
CONSCIOUS DIRECTED FORGETTING



What effect does "Forget" List 1 items have on the memory test?

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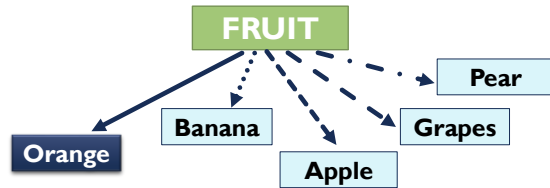
DIRECTED FORGETTING: TYPICAL FINDINGS



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INVESTIGATING MEMORY

- Can be difficult to retrieve specific memory due to retrieval being dependent on **cues** that facilitate access to the correct item.
- Spreading activation model: activation of cue spreads to the representation of the memory the person is trying to retrieve.



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UNCONSCIOUS FORGETTING

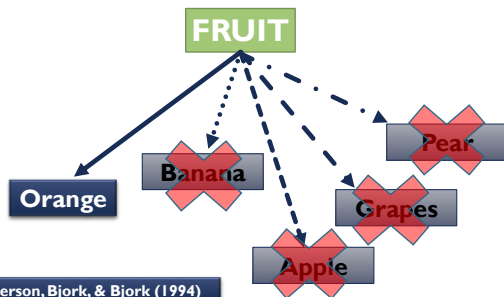
■ Retrieval-induced Forgetting (RIF):

- Retrieving an item from memory (e.g., Orange) from a specific category cue (e.g., Fruit), can later impair retrieval of another item sharing the same category (e.g., Pear), but not the retrieval of an item from an unrelated category (e.g., Vehicle-Car).
- Happens due to cues for recall being insufficiently specified – general cues activate the target memory (Rp+) in addition to all other memories related to that cue (Rp-).
- Unwanted information competes for retrieval with the target item.
 - These are then forgotten so that the target item can be retrieved.

Anderson, Bjork, & Bjork (1994)

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COMPETITION FOR RETRIEVAL

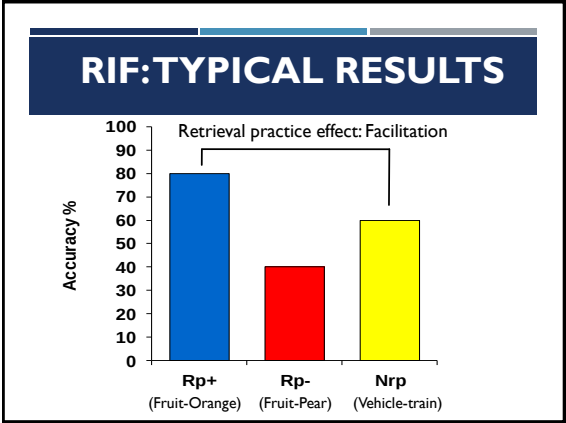


Anderson, Bjork, & Bjork (1994)

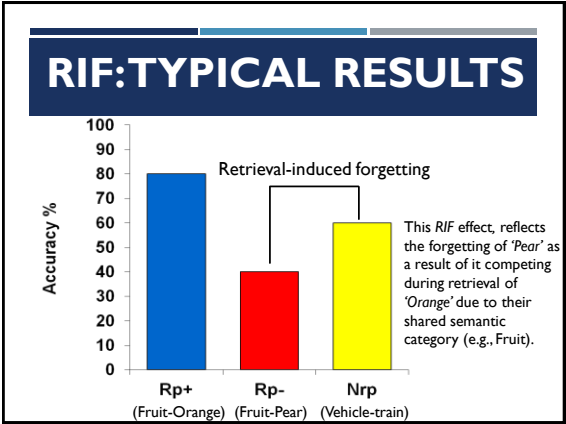
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Typical Retrieval-practice paradigm		
Study	Fruit_ orange	Vehicle_ car
	Fruit_ banana	Vehicle_ train
	Fruit_ pear	Vehicle_ bicycle
	Fruit_ apple	Vehicle_ airplane
Retrieval practice	Fruit_ or _____	
	Fruit_ ba _____	
Test	Rp+	Fruit_ or _____
		Fruit_ ba _____
	Rp-	Fruit_ pe _____
		Fruit_ ap _____
		Vehicle_ ca _____
		Vehicle_ tr _____
		Vehicle_ bi _____
		Vehicle_ ai _____
Nrp		

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Hundreds of published studies focusing on prevalence, dynamics, and boundary conditions of RIF

(See Anderson, 2003; Storm & Levy, 2012, for reviews).

- Empirical evidence has revealed RIF emerges with:
 - semantic material (e.g., Anderson, 2003),
 - episodic material (e.g., Racsmany & Conway, 2006),
 - factual information (e.g., Anderson & Bell, 2001),
 - phonological information (e.g., Bajo et al., 2006),
 - text passages (e.g., Little et al., 2011),
 - visuo-spatial material (e.g., Ciranni & Shimamura, 1999),
 - arithmetic facts (e.g., Phenix & Campbell, 2004),
 - EWT memory (e.g., Saunders & MacLeod, 2002),
 - mental imagery (e.g., Saunders et al., 2009),
 - creative problem solving (e.g., Storm et al., 2011),
 - autobiographical memory (e.g., Storm & Jobe, 2012),
 - social contexts (e.g., Storm et al., 2005)
 - actions (e.g., Reppa et al., 2013).
 - Images (e.g., Reppa et al., 2020)

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THEORETICAL ACCOUNTS OF RIF

Inhibitory Theory:

- Retrieval practice leads to reduced activation of Rp- items.
- During retrieval practice, Rp- items compete with Rp+ items, and to allow efficient retrieval practice of target Rp+ items the memory representation of the Rp- items is actively inhibited or suppressed (e.g., Anderson et al., 1994; Anderson & Spellman, 1995).
- This inhibition of Rp- items is expressed in their lower accuracy in the later test phase, compared with items whose category was never practiced (Nrp items).

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THEORETICAL ACCOUNTS OF RIF

Non-inhibitory Theories:

- Do not support idea RIF emerges from inhibition of competing items during practice.
- Instead, propose other mechanisms:
 - Associative blocking (Butler, et al., 2001; MacLeod, et al., 2003)
 - Encoding specificity (Perfect, et al., 2004).
- Suggest RIF occurs because memory of practiced items is strengthened by retrieval practice and blocks retrieval of weaker non-practiced memories.
- Context-based account (e.g., Jonker, Seli, & MacLeod, 2013)
 - RIF is entirely contextual effect.
 - Occurs when context between study and practice changes, and context of practice phase is activated during the test phase.

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LEARNING AND MEMORY: CONSIDERATIONS FOR EDUCATION

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MEMORY AND LEARNING: SKILLED PERFORMANCE



- From learning a task we infer a change in processing structures that represents that learning.
- Even without verbal report of the learning
- E.g., controlling a pushbike
- For a memory model we need to be concerned with the type(s) of memory involved in performing different tasks.
- These are implicit and procedural memories.
 - They relate to unconscious memories.

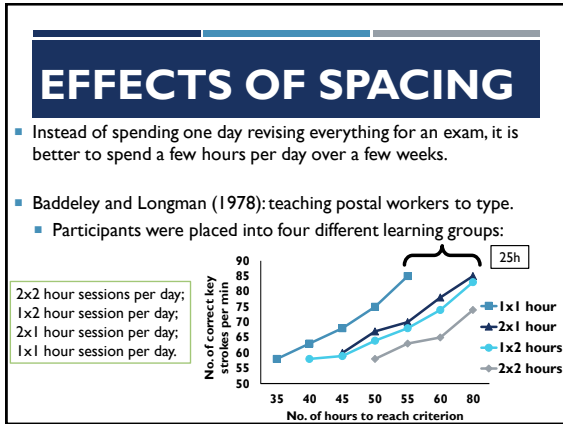
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MEMORY STRATEGIES FOR LEARNING

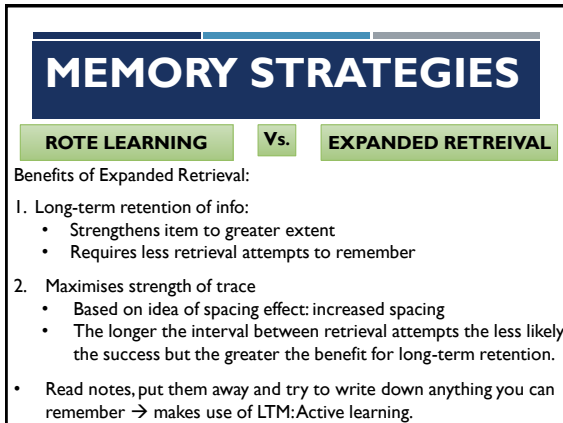


- McDougall & Gruneberg (2002):
 - Notes made before writing essay in exam: indicator of memory strategy.
 - No notes: indication of no memory strategy
 - Ps who wrote down researchers names at beginning performed better than those who did not → provides a cue.
- Effects of spaced revision:
 - Memory for info is much better if it is practiced over a spaced amount of time than massed in to one session.
- If spending X number of hours learning material, better to learn it spread out over hours rather than learn it all at once

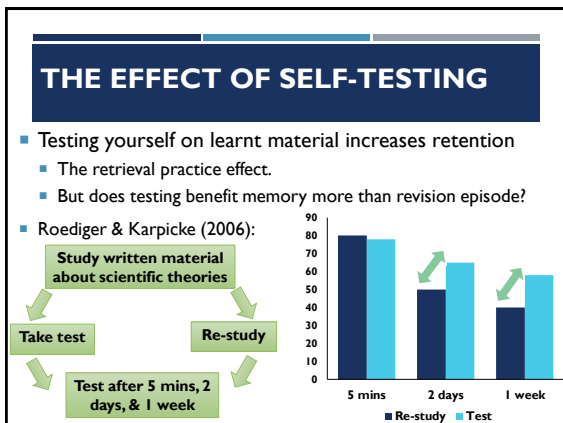
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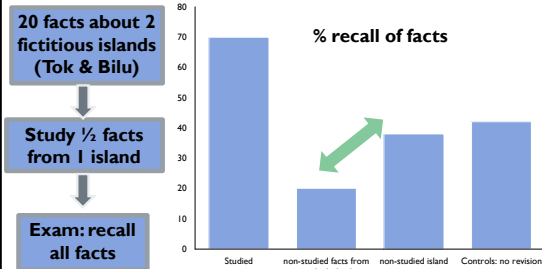
MEMORY STRATEGIES AND EXAMS

- Selective Revision: Macrae & MacLeod (1999)
 - Can be useful to save time and resources.
 - However, success of this depends on assumption that revised material will appear in exam.
 - If it does, then performance in exam should be good:
 - Retrieval practice effect - facilitation
 - However, what if revised material does not come up?
 - Would performance be as bad as not having revised at all
 - Or could it be even worse
 - Retrieval-induced forgetting effect.

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RESEARCH EXAMPLE IN EDUCATION: MACRAE AND MACLEOD (1999)

Ps told they were to take a geography exam



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MEMORY STRATEGIES AND EXAMS

- What can be done if RIF occurs in an exam?
 - Integration of information protects memories from RIF.
 - Make connections across materials
 - Work out what constitutes these connections during revision (not during the exam – too late).
 - Compose structures for mock essays.
 - Make any links explicit between items.
- If info is forgotten, the cues provided by the retrieval of other info, or related connections, should help cue related but forgotten info.
 - Make use of sub-headings.

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HOW CAN EXAM PERFORMANCE BE IMPROVED?

- Distributed studying (as opposed to mass/crammed studying)
- Integration of information
- Retrieval of material: especially expanded and elaborative practice
- Administering self-tests
- Having an understanding of material, not just learn in parrot fashion
- Make use of memory strategies
- Answer specifics of exam question (not just broad topic area)
 - Say why what you have said applies to the question.
