How to Be a Better Student (using Cognitive Science!)

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How to be a better student
Spacing versus distributed learning

Information is better encoded when there is a longer delay between repetitions (*spaced practice*)

Cramming for a test (*massed practice*) is not a good strategy. Your time is more efficiently spent spacing student sessions over multiple days.
Spacing versus distributed learning

Fig. 1. Structure of a typical study of spacing effects on learning. Study episodes are separated by a varying gap, and the final study episode and test are separated by a fixed retention interval.

- Melton (1970)
- Two repetitions of words spaced apart with different numbers of words presented between them
- Also varied speed of presentation
Spacing versus distributed learning

- Bahrick et al. (1993)
- How long the spacing effect lasts
- Subjects studied foreign vocabulary words every 12, 28, or 56 days for up to 4 years; each subject had same number of repetitions
- Memory tested over next 5 years

Spacing versus distributed learning

Fig. 3. Performance on the final (a) recall and (b) recognition tests as a function of gap, for each of the four retention intervals. The plotted points show mean accuracy ± 1 SEM. The lines correspond to cubic spline fits to the data, with fixed points at gaps of 0 and 105 days.

“Although the interactive effects of gap and RI pose challenges for practical application, certain conclusions can nonetheless be drawn. If a person wishes to retain information for several years, a delayed review of at least several months seems likely to produce a highly favorable return on the time investment—potentially doubling the amount ultimately remembered compared with a less temporally distributed study schedule, with study time equated. Although this advice is in agreement with the earlier work of Bahrick (e.g., Bahrick et al., 1993), it is at odds with many conventional educational practices—for example, study of a single topic being confined within a given week of a course.”
Spacing versus distributed learning

- Why is spaced practice better?
- **Encoding variability:** Study sessions that are more distant in time are likely to occur in different contexts making for a richer representation of the memory
- Not just for episodic memory!
- Also improves retention of motor skills like typing, snowboarding, etc..
- but is it good for all types of learning?
Spacing versus distributed learning

Research Article

Learning Concepts and Categories

Is Spacing the “Enemy of Induction”?* 

Nate Kornell and Robert A. Bjork

University of California, Los Angeles

Spacing good for memory but might make it harder to detect commonalities if you are extracting a pattern from a set of examples.
Spacing versus distributed learning

Some items massed/some spaces MSSMMSSMMSSM

All paintings either space or massed depending on condition

Test: classify the painter of a novel Painting
Spacing versus distributed learning

Graphs showing the proportion correct over test blocks for spaced and massed learning conditions.

Bar chart illustrating actual and judged effectiveness with different conditions.
Spacing versus distributed learning

Test: recognition (have you seen this artist work in the study phase?)
Spacing versus distributed learning

Key points

• Spacing was not the enemy of induction it was previously assumed to be

• People misjudge which conditions they have remembered better. YOU DON’T UNDERSTAND HOW YOUR OWN MEMORY WORKS!
Spacing versus distributed learning

• Do people actually prefer to self-study in accord with the spacing effect?

• **NO!** Well, many students cram for tests. This may simply reflect poor time management rather than lack of understanding of spacing effect

• However, experiments show the people rate massed practice as a better way to learn a list (Simon & Bjork), and when given the option prefer massing their practice

• “massing provides a sense of ease, which learns assume will translate to good memory on a later test, whereas spacing is often as ‘desirable difficult’” (Kornell & Bjork, 2008)
Testing (and generation) effect

- Information is better remembered when it is generated by a subject than when it is presented to a subject.
- e.g., studying by generating the definitions of terms is more effective than reading the definitions of terms (flashcards).
- Maybe be related to *levels of processing*.
Testing (and generation) effect

Slameka & Graf (1978)

- Had subject study pairs of words in two ways:
  - Read: subjects saw two words that were related by a rule and were asked to read them (e.g., are the words synonyms?)
  - Generate: subject saw one word along with the first letters of another word, were asked to generate a word that has a specific relationship with the first word
    - e.g., opposite HOT-C____
Testing (and generation) effect

**Condition 1**  
**Read**
- king - crown
- horse-saddle
- lamp-shade

**Condition 2**  
**Generate**
- king - cr____
- horse-sa____
- lamp-sh____

**Cued Recall**
- king - _____
- horse-_____  
- lamp-______
Testing (and generation) effect

- Better able to recognize words they had generated than words they read
Testing (and generation) effect

- Retrieving information from memory results in stronger memories than repeated study opportunities

- e.g., preparing for a test by answering practice questions is more effective than re-reading or re-writing notes

Learning is typically identified with encoding or construction of knowledge, and retrieval is considered merely the assessment of learning that occurred in a prior experience. - Karpicke (2012)
Testing (and generation) effect

Karpicke & Roediger (2008)

- Compared whether studying or testing is better for memory
- Study Swahili-English word pairs (mashua - boat)
- After studying, given test (mashua - ?)
- Repeat the study and test sections but varied which words were included in study and test
Testing (and generation) effect

Karpicke & Roediger (2008)

- Conditions
  - **ST:** all word pairs were studied and testing in all sections until you got them all right
  - **SnT:** once you got a word correct in a test, it was dropped from later study blocks but was kept in later test blocks
  - **STn:** once you got a word correct in a test, it was dropped from later test blocks but kept in later study blocks
  - **SnTn:** once you got a word correct in a test, it was dropped from all later blocks.

Testing (and generation) effect

Karpicke & Roediger (2008)

Learned Equally well. One week Later....

Testing (and generation) effect

Roediger & Karpicke (2006)

- Students read educational text and recalled under three conditions
  - **SSSS:** repeated study over four sessions
  - **SSSR:** three study period one retrieval period
  - **SRRR:** one study three retrievals

Testing (and generation) effect

Fig. 2. Mean proportion of idea units recalled on the final test after a 5-min or 1-week retention interval as a function of learning condition (SSSS, SSST, or STTT) in Experiment 2. The labels for the learning conditions indicate the order of study (S) and test (T) periods. Error bars represent standard errors of the means.

Testing (and generation) effect

Karpicke & Blunt (2011)

- Measured whether testing would benefit the learning of scientific concepts
- Included several comparison conditions that differed in the depth of processing.
- **Concept mapping**: an elaborative study method where you organize material and encode relationships among concepts.
Testing (and generation) effect

Karpicke & Blunt (2011)

Testing (and generation) effect

Karpicke & Blunt (2011)

Once again, people were bad at predicting what would help them learn!!
Take home message

- Two very important things you can do to improve memory: space and test!
- In every case people’s *intuitions* about how your memory works is different than what really works to improve your memory.
- Next time you say “I learn better like this” catch yourself... is that really true or is that just your feeling?