

Why Taking Exams after Winter Break is best for Students: What the Experts Say

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The Spacing Effect

Reviews of material with longer time elapsed between the first and second review (spaced) yield more learning than reviews with less time elapsed between the first and second review (massed). Review of material increases long-term memory best when there is more time between introduction and review of material.

- There is no shortage of evidence supporting this phenomenon. The spacing effect is widely recognized in the psychological community.
- Application for teaching
 - Review several weeks after introducing material to enhance long-term memory and thereby content mastery.
- Application to exams after break
 - **It would actually be better for exams to be taken after a break than before, given that there was a review before the exams, because of the spacing effect.**

Highlights from Selected Articles on Spacing Effect

“Synthesis of Research on Reviews and Tests” by Frank Dempster

Brief summary from page 74

- With total study time equated, two or more opportunities to study the same material are much more effective than a single opportunity
- Achievement following two massed study opportunities often is only slightly higher than following a single study opportunity
- Spaced reviews yield significantly better learning than do massed reviews
- The effectiveness of spaced review, relative to massed review, tends to increase as frequency of review increases
- Tests promote learning, especially if the material to be learned is first tested relatively soon after its introduction
- Spaced tests are more effective than massed tests, especially if the inter-test intervals are of an expanding nature
- Frequent spaced testing results in higher levels of achievement than does relatively infrequent testing
- The use of cumulative questions on tests is one of the keys to effective learning

Significant quotes from the article:

- “an opportunity to review previously presented material may affect not only the quantity of what is learned but also the quality” p 71
- “Much more effective are reviews that are spread out or distributed over lengthier periods of time. This phenomenon –known as the “spacing effect” – is one of the most robust and dependable phenomena yet documented by psychologists. In fact, two spaced presentations are often twice as effective as two massed [occurring close in time] presentations.” p. 72
- In a study of vocabulary learning, retention tests were given to students who studied vocabulary at 30 day intervals, 24 hour intervals and all in one day. All students had a high level of initial learning. “On the retention test, however, only the subjects who had received reviews at 30-day intervals remembered a respectable number of definitions.” p 72
- “The spacing effect also is remarkable in the scope of its application: with students of all ages and ability levels, in all sorts of situations, and with a wide variety of materials and procedures.” p 72
- “As with reviews, however, the most effective tests are those that come at spaced intervals, especially if the intervals are of expanding nature.” p 72
- “Massed repetitions, because there is not much time between them, tend to inspire a false sense of knowing or confidence. Thus, they receive relatively little [mental] attention... Spaced repetitions, on the other hand, are likely to encourage exactly the kinds of constructive mental processes, founded on effort and concentration, that teachers hope to foster.” p73
- “research suggests that spaced repetitions can foster time-on-task and help students develop and sustain positive attitudes toward school and learning.” p 75
- “the reconstruction hypothesis...[suggests] that spaced repetitions encourage highly constructive thinking.” p 75
- “spaced repetitions require the student to engage in active, conscious processing, whereas a massed repetition or a single presentation tends to evoke shallow, effortless processing—which though it involves ‘no pain,’ results in little or ‘no gain.’” p 75

“Spacing Effects in Recognition Memory: When Meaning Matters” by Riccardo Russo and Nicola Mammarella

- “Numerous studies have shown that repeated items are better remembered if their second occurrence is experienced after a certain lag from the first occurrence (i.e., spaced presentation), compared to a condition where the second occurrence of an item immediately follows the first one (i.e., massed presentation). This spacing effect is a robust phenomenon that has been observed in different explicit memory tasks like free recall, recognition, cued-recall, and frequency estimation.” p. 49

- “In the nonword condition a reliable spacing effect was observed. This finding extends to verbal material previous observations of reliable spacing effects in cued memory tasks with unfamiliar pictorial material.” p. 56.

“The Spacing Effect Depends on an Encoding Deficit, Retrieval, and Time in Working Memory: Evidence from Once-presented Words” by Kelly Braun and David Rubin

- “The spacing effect is one of the oldest and best studies effects in memory research. The spacing effect can be of great practical importance because the improvement of spaced over massed practice can be large and, unlike other mnemonic aids, it can be implemented without additional study time or training.” p. 37.

“Maintenance of Foreign Language Vocabulary and the Spacing Effect” by Harry, Lorraine, Audrey & Phyllis Bahrck

- “The spacing effect was one of the earliest research topics investigated by experimental psychologists, and interest in the effect as sustained more than 300 investigations during the past century.” p. 316
- “Other investigators have discussed the spacing effect as a prime example of the failure of educators to apply the results of psychological research.” p. 321
- “The present investigation shows that extended retrieval practice of foreign language vocabulary yields very large retention benefits over a 5-year period following the termination of practice and that these benefits are greatest when the intervals between retrieval sessions are 2 months, or possibly longer.

“The Acquisition and Retention of Knowledge: Exploring Mutual Benefits to Memory Research and the Educational Setting” by Moshe Naveh-Benjamin

- “the spacing effect, is established in laboratory memory research. It is one of the most reliable phenomena in human experimental psychology and refers to the fact that when we compare the effects of two presentations of the same verbal material that are separated (spaced) temporally to a case where these presentations are contiguous in time (massed), long-term recall of learned material is better if the learning episodes were spaced rather than massed.” p. 298
- “These empirical generalizations, if applied, have important implications for education, suggesting that students should space their study episodes on a given subject rather than do all their studying in one sitting.” p. 299

“Time and the Production of Classroom Learning: Discerning Implications from Basic Research” by Frank Dempster

- “Articles... imply that improvements in learning can best be achieved by the proper distribution of time, and implication derived from the spacing effect, and more

effective use of time, and implication derived from the variable coding hypothesis.”
pp. 2-3

- “educational policy, including policy recommendations, is often informed more by social and political considerations than by the results of scientific research.” p. 3
- “To date, the spacing effect still attracts considerable research attention. Its appeal hinges largely on three factors. First, the spacing effect is uncommonly reliable... Second, it is remarkably robust. In many cases, two spaced presentations are about twice as effective as two massed presentations, and the difference between them increases as the frequency of the repetition increases... Third, it is truly ubiquitous in scope. It has been observed in virtually every standard experimental paradigm... With these characteristics, it is little wonder that the spacing effect is thought to involve some fundamental mechanisms of learning.” p. 9
- “In conclusion, it is important to point out that the spacing effect is just one of a family of similar phenomena, all of which have implications for the distribution of time in the classroom.”

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Psychology of Learning Leading up to the Spacing Effect

Consolidation Theory (1880/1964)

- After a rehearsal (lesson) a period of preservation occurs
- The longer this period is allowed to continue the more consolidated the memory trace (stronger the memory in long-term)
- 1885- (republished in 1964) Hermann Ebbinghaus, Ph.D., found that the rate of forgetting is slowed when a period of sleep occurs between studying and taking a test
 - Precursor to the spacing effect
- Application to teaching
 - Allow students time to process a lesson
- Application to exams after break
 - The longer the student has to process information, the more likely it will remain in long-term memory and thus will not be forgotten directly after the test- case against cramming
- References:
 - Bower, G.H. (1981). *Theories of Learning*. Prentice-Hall: New Jersey
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Behaviorism (1950's)

- B.F. Skinner, Ph.D., Pre-cursor was Ivan Pavlov, Ph.D.- This theory of learning maintains that reinforcement/repetition (stimulus-response) is key to learning.
- Application to teaching
 - Practice in form of question and answer sessions/review, start from simple to complex so that student is reinforced by having correct responses which amounts to positive reinforcement
- Application to exams after break
 - Repetition can never be bad- only reinforces learning (review after winter break)
- References:
 - Bower, G.H. (1981). *Theories of Learning*. Prentice-Hall: New Jersey
 - Estes, W. K. (1962). Learning Theory. *Annual Review of Psychology*. 13 pp. 107-144.
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Stimulus Sampling Theory (1950's)

- W. K. Estes, Ph.D.- Particular stimulus-response is learned on a single trial; however, the overall learning process is a continuous one consisting of the accumulation of discrete stimulus-response pairings. The more pairings created, the stronger the memory.
- Application to teaching
 - The learning process is gradual and cumulative- the more review the better the retention
- Application to exams after break
 - Again, the review before the exam strengthens the memory
- References:
 - Bower, G.H. (1981). *Theories of Learning*. Prentice-Hall: New Jersey
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Information Processing Theory (1956)

- George A Miller, Ph.D. – 2 theoretical ideas that are fundamental to cognitive psychology
 - Chunking- short-term memory can only hold 5-6 chunks of information where a chunk is any meaningful unit (digits, words, faces, etc).
 - TOTE (Test-operate-test-exit) a goal is tested to see if it has been achieved and if not an operation is performed to achieve the goal; this cycle is repeated until the goal is achieved or abandoned. Miller suggested that TOTE (Test-operate-test-exit) should replace Stimulus-Response
- Application to teaching
 - Short term memory is limited so must teach to achieve long term memory
- Application to exams after break
 - Relying on short term memory- simply cramming before an exam is not conducive to content mastery
- References:
 - Bower, G.H. (1981). *Theories of Learning*. Prentice-Hall: New Jersey
 - Estes, W. K. (1962). Learning Theory. *Annual Review of Psychology*. 13 pp. 107-144.
 - Theory Into Practice at Psychology.org tip.psychology.org/miller.html

Dual Store Theory (1960s)

- R. Atkinson, Ph.D. & R. Shiffrin, Ph.D. (1968)- there are two types of memory stores in the brain, the short-term store and the long-term store, and rehearsal serves the purpose of increasing the strength built up upon in a long-term store both by increasing the length of stay in short-term store (during which time a trace is built up in long-term store) and by giving coding and other strategies time to operate
- Application for teaching
 - Review strengthens long-term memory of a subject
- Application to exams after break
 - Yet another opportunity to review before the test helps to solidify the subject material in long-term memory
- References:
 - Porter, L. (1976). Rehearsal span versus memory span: What does this comparison tell us about verbal memory? *British Journal of Psychology* 67(4) pp. 521-528.
 - Estes, W. K. (1962). Learning Theory. *Annual Review of Psychology*. 13 pp. 107-144.

Spacing Effect (1970s)

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