The Impact of Taking Breaks on Learning and Memory

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There may be a variety of reasons for preferring a mid-August start date for public schools over a September start date, but a concern over exam performance following the Christmas break cannot be one of them. In fact there is substantial evidence from the experimental psychological literature, as well as from what might be called common sense, that a break prior to exams would have an improving effect. In this brief report I will summarize some of the basic research on the relevant issues and also make it clear that people intuitively understand the importance of taking breaks and do so in everyday life.

I. What the spacing effect is and the range of its empirical support

While there has not been a focused study in the psychological literature on test outcomes in the two ways of configuring the school year, there is an enormous literature on what has been termed the spacing effect. The spacing effect has to do with the quality of learning and retention that occurs when learning episodes are interrupted by breaks rather than being presented more or less contiguously. The spacing effect is relevant here because the winter break is an interruption and one can fairly ask whether the sequence [instruction, review, exam, winter break] is not more reasonable than the sequence [instruction, winter break, review, exams]. The first sequence is an example of what would be termed *massed* presentation because the review follows closely upon the instruction and prior to the break. The second sequence, that which would result from a September start date, represents the *spaced* presentation because the break interrupts the instruction and review.

A. Original discovery of the spacing effect

Psychological research on the spacing effect in memory retention began with the very first published study on memory. It is a curious fact that although people have been aware that they have memories for at least several thousand years, it was only in 1885 that Ebbinghaus conducted the first systematic study on learning and forgetting. And one of the first things that Ebbinghaus noticed was that by placing breaks—on the order of days—between study episodes, his retention was greatly improved. In fact, Ebbinghaus regards this as a commonsense notion of the 19th century:

> With this result, found here for only very limited conditions, the method naturally employed in practice agrees. The school-boy doesn't force himself to learn his vocabularies and rules altogether at night, but knows that he must impress them again in the morning. A teacher distributes his class lesson not indifferently over the period at his disposal, but reserves in advance a part of it for one or more reviews (Ebbinghaus, 1885).

What Ebbinghaus is recommending here is a break prior to review and it is no accident that this comes at the dawn of memory research – taking breaks during study and prior to review produces profound effects.

In the intervening century there have been a number of studies on the spacing effect. Some 300 studies existed by 1992. These studies cover a range of issues and

experimental procedures but they all converge on the finding that spaced presentation is superior to massed presentation for memory retention. I will discuss a few of these studies in order to get a sense of how experimental psychologists have approached the issue of retention under different learning protocols.

B. Spacing effects operate on both short and long time scales

A typical laboratory study is illustrated by the learning of French vocabulary (Bloom & Shuell, 1981). In this study subjects were exposed to 30 minutes of instruction. One group of high school students received their 30 minutes all at once, while another group of high school students received 10 minutes on 3 consecutive days. Psychologists are typically interested in two kinds of recall, immediate and delayed, and so two exams were given. The two groups performed identically on the test given immediately following the final period of instruction. However, 4 days later, the group receiving the spaced instruction performed 35% better than the students receiving massed instruction. This sort of result is typical in the memory literature. Differences are often revealed only after a palpable opportunity for forgetting has been offered. This is obviously of enormous importance for education theorists since we desire students to know things in the long run, not just for tests taken during their courses.

Laboratory experiments are often limited by the resources available to researchers and by the exigencies of academic life. It is both costly and unwise to conduct large-scale longitudinal studies on memory retention: costly because it is difficult to keep track of people and unwise because researchers are expected to publish if they desire to retain their jobs. However there is one notable study in the literature that examined the spacing effect over the time scale of years. Bahrick et al. (1993) conducted a language learning study over a 5 year period. In this study the students experienced breaks between learning episodes as large as 2 months. These researchers found that long term learning was best when the learning episodes were most widely spaced, recognizing that learning under these conditions is not particularly easy and requires greater effort. The effects here were quite large: learning at intervals of 2 months produced four times greater retention after a 5 year period than learning at intervals of 2 weeks.

C. Spacing effects are independent of motivational state

It is of considerable interest to see how the practice effect holds up under real life learning conditions. By "real life" I mean learning material that must in fact be learned by people who are under considerable pressure to do the learning. No better examples of this exist than the cadets in the United States Air Force Academy who do poorly on their mathematics placement exams and are placed into the pre-calculus curriculum. Revak (1997) studied an entire class of 375 cadets who were so placed using experienced Air Force instructors who administered either massed homework or spaced homework to their classes. Over the course of a semester these students were given homework assignments over the lecture given that day (massed presentation) or a mixture of homework problems over lectures given days or weeks previously (spaced presentation). All of the students completed the exact same homework problems, the only difference being when they received their problems. Revak found that on 4 of 6 achievement measures those receiving spaced homework outperformed those who did the homework for a particular lecture immediately following that lecture. These results were independent of the students' measured mathematics ability and level of math anxiety.

At the opposite end of the motivational spectrum we have a study conducted at Texas A&M by Smith and Rothkopf (1984). They paid 25 volunteers to listen to 8 hours of statistics. These students had no compelling reason to learn statistics and were not punished or rewarded on the basis of their performance. They received their stipend regardless of outcome as mandated by ethics committees at such institutions. Smith and Rothkopf (1984) presented an 8 hour videotaped statistics course to students either on a single day or spaced over 4 days in two hour sessions. Following normal procedure two tests were given, with one immediately following instruction and one 5 days later. And again, typical of laboratory experiments, there was no retention benefit at immediate testing. However, following 5 days, the spaced presentation showed a 10% advantage in recall. The real issue, of course, is how much learning is retained in the long run and it is exactly this kind of data that is difficult to come by. Nevertheless, it is important to understand that spacing effects are so robust they, unlike most things in life, do not depend upon the motivation or ability of the learner. In fact multiple experimental attempts to eliminate the advantages of spacing have proved futile (Shaughnessy 1976; Jensen & Freund 1981).

D. Spacing effects are important for skill learning as well as for fact learning

Although school learning is the principal issue here, spacing effects may be most profound in the learning of skills such as golf, tennis, or a musical instrument. Controlled studies on skill acquisition are rare but Dail and Christina (1984) did find spacing effects in golf putting where it is possible to experience palpable improvement with minimal practice. Golf novices not only reached higher level of skill when their instruction was distributed over time, but also had the sense that they were doing a better job of learning.

In everyday life it is in the domain of skill acquisition where we can exert the most personal control. In school learning the pace and instruction protocols are set by the teacher. This is true whether you are paying for the lessons or whether they are provided by the state. Yet when we desire to learn how to play golf or a musical instrument we can set up our own schedules. When we buy, say, a package of golf lessons, we do not desire them to be given one after another on a single day. We want them spaced out. And this is true even if we do not anticipate regular practice. We will simply get more out of the lessons if they are not massed.

II. Psychological issues related to breaks in study

So far I have been focused principally on the reality of the spacing effect and have not dealt directly with the underlying psychological causation. I believe that there are at least three separate reasons why the spacing effect operates and why it might be particularly relevant to the issues raised by the winter break.

A. Consolidation. There is more than one memory system in the human mind. The materials learned and recalled in a school setting are examples of declarative knowledge. And although we are consciously aware of this information, the processes that allow us to retrieve this information are not conscious and operate much as learning skills. The process of encoding, storage, and retrieval are patently time dependent and benefit from what is commonly known as consolidation. It takes time to digest material because the underlying biochemistry and neural reconfiguration occur in a biological organism. We are not computers into which information is downloaded.

Information, even in the case of rote facts, must become part of our body if it is to be retrieved.

B. Familiarity Bias. How do we know when we know something? This aspect of metacognition has been studied in some detail by Koriat and it appears that there are two governing principles: speed and amount. We judge the extent of our learning by the rate and amount of the material that comes to mind when we try to recall it. Unfortunately, these are heuristics and do not reveal how well we in fact do understand something. That is ultimately determined by independent testing. When we review material immediately upon learning it, everything is familiar and we experience a rapid rush of recall. This can lead to shallow processing because there is no goal to think more deeply. The benefit of a break is obvious here. Following a substantial break we lose the feeling of familiarity and the feeling of knowing. If we are studying for an exam it forces us to review more deeply because we are not lulled into complacency by an erroneous sense of competence.

C. Release of Mental Set. In every learning situation there is a mental set, a framework for understanding. You may have a picture in your mind or some way of thinking about the material that gives it organization. One of the major findings of cognitive psychology is that all of our knowledge is embedded in a web of understandings and this web is continuously being updated and modified. A break allows us to review material with a new mental set. Anybody who has ever tried to solve a difficult crossword puzzle has experienced this phenomenon. There are inevitably moments when a clue leads to the same unproductive associations. If the puzzle is going to be solved the solver must come up with new associations, a new mental set. There is no straightforward way to do this and often the only thing to be done is simply to put the puzzle down for awhile and try again later. The amazing thing about the human mind is how effective this strategy often turns out to be. Introspectively it appears that after a break new associations arise spontaneously. In fact, we are experiencing the perspective of a new mental set. Some of the best advice is often to sleep on a difficult problem, whether moral, mathematical, or a recreational puzzle.

In summary we have looked at some of the psychological literature on why breaks are not bad things for learning. And while it is admittedly painful to pick up a lesson after a break, learning is not impaired but is mostly probably improved. The pain is in fact the pain of focusing attention and putting the thinking cap on. Yet the benefits of breaks in learning are undeniable and there is no question that a fresh mind learns better.

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