

# The Critical Importance of Retrieval for Learning

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Learning is often considered complete when a student can produce the correct answer to a question. In our research, students in one condition learned foreign language vocabulary words in the standard paradigm of repeated study-test trials. In three other conditions, once a student had correctly produced the vocabulary item, it was repeatedly studied but dropped from further testing, repeatedly tested but dropped from further study, or dropped from both study and test. Repeated studying after learning had no effect on delayed recall, but repeated testing produced a large positive effect. In addition, students' predictions of their performance were uncorrelated with actual performance. The results demonstrate the critical role of retrieval practice in consolidating learning and show that even university students seem unaware of this fact.

Ever since the pioneering work of Ebbinghaus (1), scientists have generally studied human learning and memory by presenting people with information to be learned in a study period and testing them on it in a test period to see what they retained. When this procedure occurs over many trials, an exponential learning curve is produced. The standard assumption in nearly all research is that learning occurs while people study and encode material. Therefore, additional study should increase learning. Retrieving information on a test, however, is sometimes considered a relatively neutral event that measures the learning that occurred during study but does not by itself produce learning. Over the years, researchers have occasionally argued that learning can occur during testing (2–6). However, the assumptions that repeated studying promotes learning and that testing represents a neutral event that merely measures learning still permeate contemporary memory research as well as contemporary educational practice, where tests are also considered purely as assessments of knowledge.

Our goal in the present research was to examine these long-standing assumptions regarding the effects of repeated studying and repeated testing on learning. Specifically, once information can be recalled from memory, what are the effects of repeated encoding (during study trials) or repeated retrieval (during test trials) on learning and long-term retention, assessed after a week delay? A second purpose of this research was to examine students' assessments of their own learning. After learning a set of materials under repeated study or repeated test conditions, we asked students to predict their future recall on the week-delayed final test. Our question was, would students show any insight into their own learning?

A final purpose of the experiment was to address another venerable issue in learning and

memory, concerning the relation between the speed with which something is learned and the rate at which it is forgotten. Is speed of learning correlated with long-term retention, and if so, is the correlation positive (processes that promote fast learning also slow forgetting and promote good retention) or negative (quick learning may be superficial and produce rapid forgetting)? Early research led to the conclusion that quick learning reduced the rate of forgetting and improved long-term retention (7), but later critics argued that, when forgetting is assessed more properly than in the early studies, no differences exist between forgetting rates for fast and slow learning conditions (8, 9). By any account, conditions that exhibit equivalent learning curves should produce equivalent retention after a delay (9).

Using foreign language vocabulary word pairs, we examined the contributions of repeated study and repeated testing to learning by comparing a standard learning condition to three dropout conditions. The standard method of measuring learning, used since Ebbinghaus's research (1), involves presenting subjects with information in a study

period, then testing them on it in a test period, then presenting it again, testing on it again, and so on. The dropout learning conditions of the present experiment differed from the standard learning condition in that, once an item was successfully recalled once on a test, it was either (i) dropped from study periods but still tested in one condition, (ii) dropped from test periods but still repeatedly studied in a second condition, or (iii) dropped altogether from both study and test periods in a third condition (Table 1).

Surprisingly, standard learning conditions and dropout conditions have seldom been compared in memory research, despite their critical importance to theories of learning and their practical importance to students (in using flash cards and other study methods). Dropout conditions were originally developed to remedy methodological problems that arise from repeated practice in the standard learning condition (10), but they can also be used to examine the effect of repeated practice in its own right, as we did in the present experiment. If learning happens exclusively during study periods and if tests are neutral assessments, then additional study trials should have a strong positive effect on learning, whereas additional test trials should produce no effect. Further, if repeated study or test practice after an item has been learned does indeed benefit long-term retention, this would contradict the conventional wisdom that students should drop material that they have learned from further practice in order to focus their effort on material they have not yet learned. Dropping learned facts may create the same long-term retention as occurs in standard conditions but in a shorter amount of time, or it may improve learning by allowing students to focus on items they have not yet recalled. This strategy is implicitly endorsed by contemporary theories of study-time allocation (11, 12) and is explicitly encouraged in many popular study guides (13).

**Table 1.** Conditions used in the experiment, average number of trials within each study or test period, and total number of trials in the learning phase in each condition.  $S_n$  indicates that only vocabulary pairs not recalled in the previous test period were studied in the current study period.  $T_n$  indicates that only pairs not recalled in the previous test period were tested in the current test period. Students in all conditions performed a 30-s distracter task that involved verifying multiplication problems after each study period.

Condition	Study (S) or test (T) period and number of trials per period								Total number of trials
	1	2	3	4	5	6	7	8	
ST	S 40	T 40	S 40	T 40	S 40	T 40	S 40	T 40	320
$S_nT$	S 40	T 40	$S_n$ 26.8	T 40	$S_n$ 8.0	T 40	$S_n$ 2.0	T 40	236.8
$ST_n$	S 40	T 40	S 40	$T_n$ 27.9	S 40	$T_n$ 11.8	S 40	$T_n$ 3.3	243.0
$S_nT_n$	S 40	T 40	$S_n$ 27.1	$T_n$ 27.1	$S_n$ 8.8	$T_n$ 8.8	$S_n$ 1.5	$T_n$ 1.5	154.8

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**Joacim Rocklöv**



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