授業で応用する“記憶力とその根本原理”についての再考
A Review of the Fundamental Psychology of Memory and its Application in the Classroom

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One of the first people to consider the subject of memory was Plato, in the fourth century B. C. He proposed what is known as the wax tablet hopothesis. According to Plato's theory, impressions are recorded in the mind in the same way that lines are etched in wax. With time the impression wears away, leaving a smooth surface once more. This Plato saw as the process of forgetting.

Since Plato, a wide variety of hypotheses on memory have been offered and evidence from many different sources suggest that, for all practical purposes, our memory is virtually unlimited. So why do we appear to forget?

One of the earliest theories of forgetting was Freud's hypothesis that forgetting is a result of repression. A period that has painful or anxiety-promoting associations is unconsciously repressed. If we cannot remember it, then we do not have to face up to its associations. However, although repression may sometimes occur, it only accounts for a very small amount of our failure to recall.

According to the decay theory, the memory trace itself gradually fades with time. Thus, if memory were encoded in changes in protein throughout the brain, then decay would take place as some of the proteins returned to their original state. As the decay progressed, the memory would become become fainter and harder to retrieve. Although there is some evidence for decay, especially in short-term memory, it is now thought that interference plays a far greater role in forgetting.

The interference theory suggests that failure to recall occurs because the memory can no longer be distinguished from all the other memory traces. The trace itself does not necessarily fade, but as more and more memories are accumulated, it becomes harder to recall, especially those with associations, inferring that memories interfere with each other. Resulting not so much from repression, decay or overcrowding of the memory as from a lack of suitable retrieval cues to distinguish one memory from another.

The search theory which is related to interference shows that retrieval of a memory is more of a problem-solving operation. P. H. Lindsay and D. A. Norman, 1977 show that if you were to ask a person what he was doing on the Monday afternoon in the third week

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of September two years ago, his response might be as follows:

Come on. How should I know?

O.K. Let's see: two years ago....

I'd be in high school in Pittsburgh....

That would be my senior year.

The third week in September—that's just after summer—that would be the fall term...

Let me see. I think I had chemistry lab on Mondays....

I don't know. I was probably in the chemistry lab....

Wait a minute—that would be the second week of school. I remember he started off with the atomic table—a big fancy chart.

I thought he was crazy, to make us memorize that thing. You know, I think I can remember...[1]

As the retrieval process continues and more and more clues are put together, it becomes easier to remember, even though at first one may have been totally at a loss. So as with the interference theory, failure to recall occurs as more and more memories are accumulated without sufficient cues to differentiate between them. Thus, it becomes more and more difficult to recall any one particular memory.

Hermann Ebbinghaus, (1913) realized that memory is strongly affected by meaning and association, and in order to control for these factors, decided to use words that had no meaning or association.

His method was to take a list of nonsense syllables (e.g. PFJ, JZK, CBT, XAB) and set about trying to remember the list by what he called the anticipation method.

In a typical experiment he would learn eight lists and after a given lapse of time relearn one of the lists again. By comparing the relearning time with the original learning time, he was able to estimate how much of the original had been retained. By relearning different lists after differing intervals of time, he was able to trace how retention decayed. He repeated this procedure 163 times over a six-year period in order to analyze the results statistically.

Fig. 1 shows a summary of Ebbinghaus's results. From this we can see a rapid initial decrease in retention followed by a gradual trailing off over time. The greatest loss of retention occurs immediately after learning. One hour after learning more than 50% of the original had been forgotten. Nine hours later about 60%, and one month later 80% had been lost.[2]

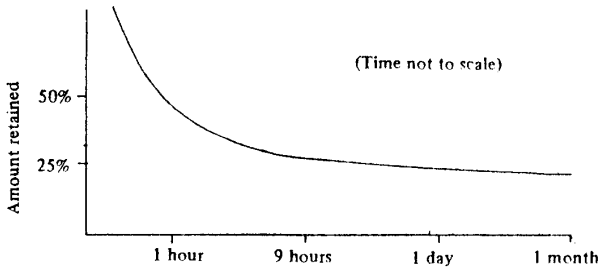

Fig. 1 Ebbinghaus. Curve of forgetting.

In using nonsense syllables Ebbinghaus had attempted to eliminate the effect of meaning and association, which are difficult factors to evaluate. As we will see later by stripping away meaning and association Ebbinghaus had effectively stripped away all that was most valuable to memory.

Reminiscence

If children are given a song or poem to learn but are not allowed to learn it by heart, it is often found that they could remember it better the next day than they did initially, often recalling lines that they had failed to recall initially. Thus, for a short period after the initial learning the memory may slightly improve. This effect is known as the reminiscence effect.[3]

Various psychologists in a number of various situations have looked at the reminiscence effect and even though it occurs frequently, it is not found in all learning situations. The material being learned, the method of testing, and the activities a subject is engaged in between initial learning and retesting are all determiners. Lloyd R. Peterson, (1966) found in a paired associate test, in which subjects are presented with a list of paired words and asked to recall the second word after been given the first showed that recall was at its peak after about 30 seconds.[4] L. B. Ward, found reminiscence to be at its highest one minute after learning lists of nonsense syllables,[5] B. Milner, found that one and a half minutes after the initial viewing, memory for photographs of faces was found to be at its peak,[6] and G. A. Kimble and B. R. Horenstein found that in mechanical tasks, reminiscence occurred around ten minutes after initial learning.[7]

Notice the more tangible the material and the more interest the subject shows for the material to be learnt, the stronger the effect.[8]

Numerous theories have been put forward over the last fifty years but the exact reasons for the reminiscence effect are still not clear, and none have satisfactorily explained all aspects of the phenomenon. Inhibition theories suggest that during the initial learning recall performance is impeded by the task of learning, but that this effect dissipates afterwards. According to this hypothesis it is not improvement in recall. However, the consolidation theory suggests that during the rest period the memory trace itself is being strengthened. The memory is being integrated and reinforced with other memories, and the permanence of the record is strengthened by this unconscious process.[9]

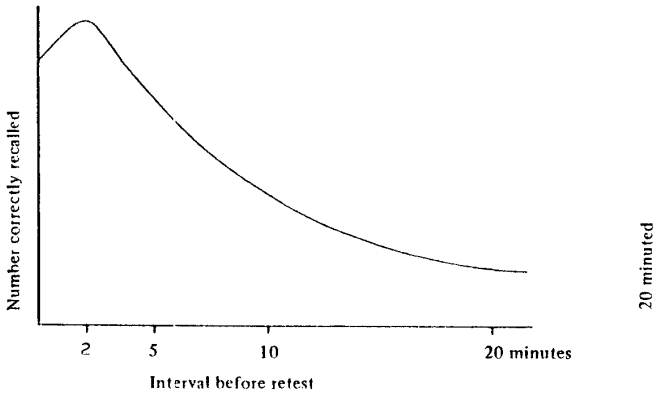

Fig. 2 Forgetting curve for nonsense syllables showing reminiscence after 2 minutes. The improvement in recall is usually between 5 and 10 percent.

McGeoch and Irion (1952), reveal that on the whole there is a positive correlation between meaningfulness and ease of learning and retention.

In attempting to account for the relationship between meaningfulness and ease of learning, some psychologists have invoked the concept of positive transfer. Positive transfer, refers to those situations where the learning of A facilitates the learning of B. Thus, learning to play the piano ensures that with little additional training the subject can play the harpsichord. The transfer is both positive and almost complete.

McGeoch and Irion assume that the same process accounts for the relative ease of learning meaningful as opposed to meaningless material. To encounter a word such as love or a nonsense syllable such as LUV (which a typical subject will remember as love) is to recognize something already learned and is therefore a case of positive transfer of identical elements. The subject's only task is to remember the serial order of the list under study. However, to encounter such syllables as HPT, XZA, SPM (or lists of unrelated digits) is to begin learning practically from scratch.[10]

In accounting for the greater ease of learning meaningful material in paired-associate

learning. Underwood and Schultz (1960) have suggested that verbal learning involves two stages: a response-integration stage and an association stage. In the response-integration stage the subject learns to identify the responses that he or she is called upon to make. If there are meaningless combinations such as BPC, the task is made more difficult, since the subject must learn the letter sequences. If meaningful words are employed, the more familiar they are the less difficult and protracted the response-integration stage is likely to be, since more familiar words have a higher response availability to the subject.[11]

An alternative theoretical explanation for the advantage of meaningful material in serial learning has been offered by the Gestalt-oriented psychologists in the form of the principle of differentiation. Differentiation refers to the fact that familiar terms have been discriminated from other terms in past experience, whereas meaningless terms, because they have not been discriminated in past experience, do not stand out from other such terms until considerable practice has made them familiar. Evidence for this hypothesis comes from studies of serial learning in which the middle portion of the series proves the most difficult to master whether the material be nonsense syllables, lists of common words, or a maze. Fig. 3 shows this effect as it is revealed in verbal rote learning. (Hovland, 1938)[12]

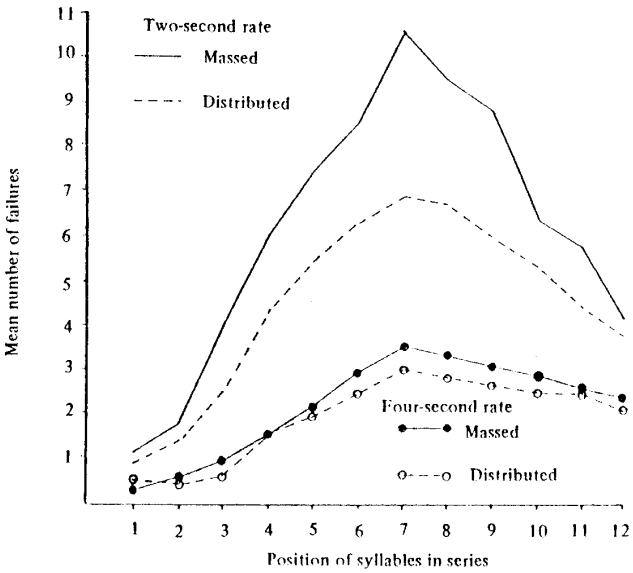

Fig. 3 A family of curves showing the effect of massed and distributed practice on the serial order position of nonsense syllables under two different presentation rates. Note the significantly increased difficulty of learning with massed practice under a high rate of presentation, especially for syllables in the middle of the list. (Hovland 1938).

Primary and Recency

Let's look at an example of how memory works. The results will illustrate several important factors in memory. Read through the following list of words once only. Now find a pencil and write down as many words as you can remember, without referring back to the list.

Car, brother, paper table, tree, book, ball, month, mouse, pencil, stone, hill, horse, skirt, floor, xy'lophone, speaker, boat, square, wind, door, field, man, tape, road, shape, flower, bucket, wife.

It is doubtful that you have recalled the whole list. However, among the words that you have written down you will probably find that you have recalled more words from the beginning and the end of the list. The increased probability of recalling the first two or three items is called the primacy effect, and that of recalling the last few items is called the recency effect. Fig. 4 shows the two effects in what is called a serial position curve.

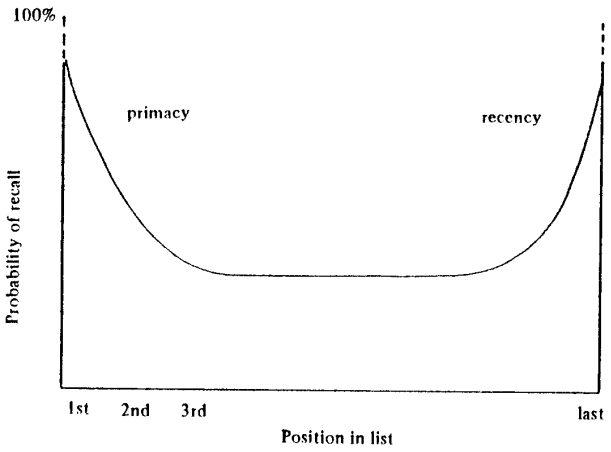

Fig. 4 Serial position curve showing primacy and recency effects.

A number of variables determine the exact shape of the curve, i. e. the length of the list, the nature of the list－whether it be words, prose, pictures, or the learning of skills,－and how much the subject organizes the material to be learned and thereby improves memory throughout. Whatever, the general finding that the beginning and end of a learning session are remembered better reoccurs time and again in many different learning situations.[13]

During lectures the curve has been found to be like that of Fig. 5. At the beginning of the lecture memory of the lecture is good, at its peak a few minutes after the start, and gradually falling off during the lecture, to improve markedly again at the end.[14]

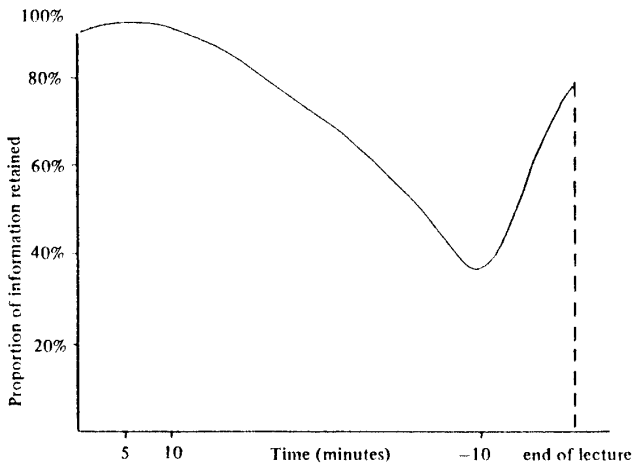

Fig. 5 Recall during lecture. Memory for the beginning and end of lecture is almost perfect, but it tails off increasingly rapidly in the middle.

Distribution of Learning & Von Restorff Effect

When short rest intervals were introduced between successive periods of practice, Ebbinghaus found that his learning efficiency improved. It was expected at first that the rest periods would lead to forgetting and hence to reduced learning. However, it was later realized, that the reason for the increase lay partly in the reminiscence effect.

Immediately after learning, the memory was actually improving, so that when he returned to the task, more rather than less of the material was available as a basis for further learning. Supporting evidence for this is revealed in (Hovland, 1933) where it was found that the greater the reminiscence effect, the greater the value of taking short breaks.

Two other factors that enhance the value of taking breaks are the primacy and recency effects. One learning period benefits from primacy and recency only at the start and finish. Therefore if the session is broken into a number of smaller blocks, with short breaks in between, there are more times at which primacy and recency effects can occur.[15]

In the memory example earlier most people will have recalled xy'lophone. This tendency to remember outstanding or unusual elements in a list is called the Von Restorff effect.

H. Von Restorff, (1933) showed that a two-digit number was more readily learned if placed in a list of nonsense syllables than if mixed with other digits. Similarly, if a nonsense syllable in the middle of a list is printed in red, it will be easier to learn than if printed in ordinary black.

The effect has since been found to be true in any situation in which items stand out in some way from those around them, or are in any way surprising. Thus a brightly coloured picture is better remembered than the black

and white surrounding it, and the flamboyant person will be remembered better than many other people.

It is quite possible that the words floor and speaker—words positioned on either side of xy'lophone were also recalled. The higher arousal created by the outstanding word also effects the retention of those words close to it in the learning sequence. Thus the serial position curve Fig. 4 can be modified to include high retention for outstanding items and their neighbours:[16]

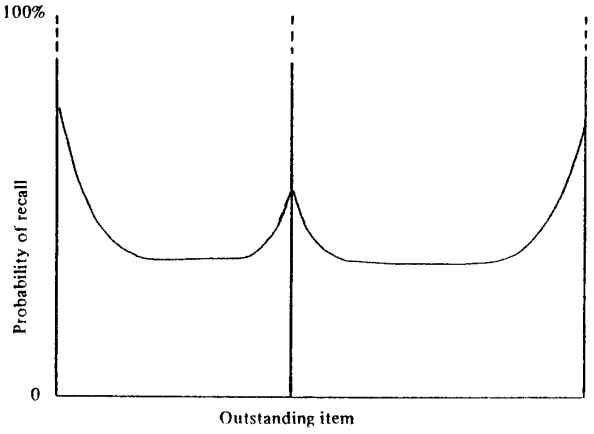

Fig. 6 The Von Restorff Effect. High recall of outstanding items, and increased recall of their neighbours.

The Gestalt psychologists attribute these findings to isolation, or perceptual differentiation, a special case of the figure-ground effect.

An alternation hypothesis to account for the serial order phenomenon has been offered by learning theorists who favour interference effects as the cause of forgetting. They argue that the serial order effect is the result of inhibitory effects that build up as the subject progresses further and further into the list. Presumably, the more meaningless the material, the greater the interference effects. The Von Restorff effect is accounted for simply on the basis that printing the middle syllable in a distinctive colour is the equivalent of breaking the list into two parts and thereby reducing intralist interference.

Applications

Any period of study or learning is best broken down into smaller blocks, with short breaks between each session. The actual size of each block will depend upon the type of material being studied. In practice, it is found that somewhere between fifteen and forty-five minutes is the best. If the block is too small, there is not sufficient meaning and internal coherence to gain a proper understanding of the material, and if it is too large, the full benefit of taking breaks is lost.

As to the questions of how long the break should be, it has been found that learning improves when the time between blocks is increased from thirty seconds to ten minutes, but no further improvement is gained by increasing the break period further.[17]

This finding can be understood in terms of the reminiscence effect. After a few minutes break, recall of the material actually will have risen. Thus when planning a lesson it is important to decide how often you are going to break and when. And having done so, keep approximately to the schedule. When regular short breaks are taken, the retention curve of Fig. 5 changes to look like that of Fig. 7.

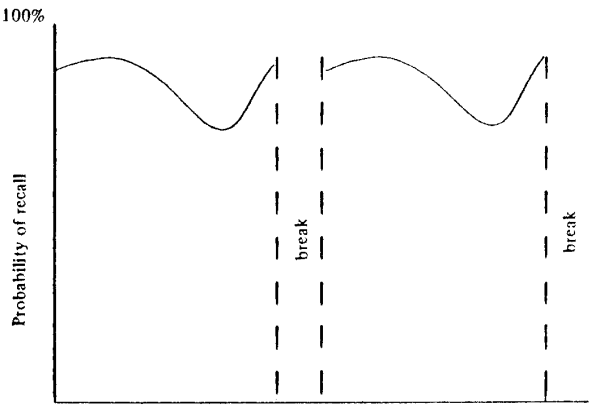

Fig. 7 Retention curve when regular short breaks are taken.

At certain times when you should be taking a break the class may be going excellently and it might seem tempting to continue on. In fact it is still better to take a break. It has been found that interrupting a task in which a person has become involved can lead to higher recall of the material—an effect known as the Zeigarnik effect.[18]

Also, despite the fact that the understanding may be very good, the later recall of the material will be worse if the students' minds are not given a short break.

During the break you should not merely switch to something similar, not only are the students' minds not given a real break, but numerous interfering associations will be made that will later impede recall.

In a lecturing situation, including regular breaks is going to make the subject more enjoyable as well as better remembered.

Since people tend to recall the beginnings and ends of the lecture, it is advantageous to arrange the material so that the most important points come when the memory is particularly high. The high recall at the end can be used to both summarize the main points and to preview some of the important points to come after the break or in the next lecture.

Particularly during the second half of the lecture when memory is at its lowest, the Von Restorff effect can be used to give greater emphasis to important points. Deliberately make the point unique.

In writing on the board, use outlining, colour, bold print, caricatures, the more grotesque the better. The more bizarre an idea is, the more it will stand out in the memory. I remember my high school chemistry teacher introducing us to the concept of molecular weight. He stood at the front of the class, and from his pocket pulled a small black stuffed mole and as he did so, dryly said, "And now we come to the mole."

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