Motivation and long-term memory¹

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This experiment investigated the effects of motivation on long-term memory. It was hypothesized that when Ss are highly motivated to recall a nonsense syllable list they learned one week earlier, they recall the list better than Ss who are not motivated before recalling the same list. Motivation was found to have an effect only when introduced during the actual learning of the list, one week before recall. It had no effect on trace utilization when introduced just prior to recall one week after learning.

The process of memory consists of three stages: trace formation, trace storage, and trace utilization (Weiner, 1966). The initial stage, trace formation or learning, involves sensory or ideational registration and the subsequent fixation of the memory trace of an event. The second stage consists of the interval during which the trace is latent, yet potentially available for evocation. The final stage consists of the recall or evocation of the trace.

The majority of studies investigating the effects of motivation on memory were designed so that motivational variables were introduced during the trace formation stage. Heyer & O'Kelly (1949) found that a group of Ss highly motivated to learn a list of nonsense syllables showed significantly greater retention of this list one week later than a similar group of Ss who were not motivated to learn the list. There were no significant differences between the two groups in the amount of original learning. Weiner & Walker (1966) demonstrated that in short-term retention, the greater the incentive value of a given stimulus during learning, the better this stimulus is recalled 15 sec later. Finally, several studies (e.g., Kleinsmith & Kaplan, 1963) have shown that high arousal during learning leads to greater retention one week later than low arousal.

All that the above experiments show is that motivation affects learning; they say nothing about its effects on memory—assuming that there is a difference between motivational factors acting on learning and consequently on retention, and that of motivational factors acting directly on trace storage and consequently on trace utilization. It is conceivable that events learned under low motivation are in trace storage along with events learned under high motivation. However, these events learned under low motivation might have a higher threshold for recall and if motivation was again introduced prior to recall, their threshold might be lowered, making these events more available for recall.

Several studies have investigated the effects of motivational variables on short-term memory when these variables are introduced prior to recall instead of during the trace formation stage. Bourne (1955) demonstrated that 4 min after learning, recall of paired associates under tension (i.e., while Ss squeezed a hand dynamometer) was better than recall under no tension, when tension under the learning phase was controlled. Thus he concluded that induced tension affects trace utilization. However, Weiner (1966) found that when motivational factors were presented immediately prior to recall rather than during the learning phase, they had no significant effect on recall 15 sec after learning.

The following experiment investigated the effects of motivation on long-term memory when motivation is introduced just prior to recall. The experimental design was similar to that of Heyer & O'Kelly (1949). The hypothesis was that high motivation both during learning and just before recall, one week later, would result in better retention than low motivation.

Subjects

The Ss were 64 students enrolled in undergraduate classes in psychology at the University of Washington.

Materials

A list of 20 three-letter consonant-vowel-consonant (CVC) nonsense syllables, taken from Trapp & Kausler (1959), was used as learning material. Each syllable was printed in black letters on an 11 x 7 in. white card. The associative strength of these syllables varied from 7% to 25%.

Procedure

The Ss were divided into four subgroups of 16 Ss each. The nonsense syllable list was presented to each group of Ss five times, always in the same order. Each syllable was presented for 10 sec, 2 sec intervening between presentation of one syllable and another syllable, and 30 sec intervening between each presentation of the list. The Ss were then given 10 min to write down, in the order presented, as many syllables as they could remember. At the end of the 10 min, the Ss were reminded that they had volunteered to come back at the same time the following week for a different experiment. They were given no indication that they were going to be retested on this list a week later in order to minimize the effects of rehearsal. All Ss did, in fact, participate in another experiment, but were given a recall test just prior to their participation in it. When retested, the Ss were allowed 8 min to recall as many syllables as they could. They were also asked if they had practiced the list at all during the week. Fifteen of the 64 Ss state they had practiced the list from one to three times, usually right after the immediate recall test. The remaining 49 Ss reported that they did not practice the list at all.

Two motivating conditions were used during the learning phase. The low motivation condition consisted of asking the Ss to learn the nonsense syllable list under the pretense that the E wanted to know if some of the syllables in the list were easier to learn than others. The high motivation condition consisted of telling the Ss that the E wanted to know if some of the syllables in the list were easier to learn than others, and in order to get them to do their best, cash prizes (one-\$10.00; two-\$5.00; five-\$2.00) would be given to those who recalled the greatest number of syllables. During recall one week later, two motivating conditions were used also, the low motivation condition simply consisting of asking the Ss to recall the list while the high motivation condition consisting of offering the same cash prizes used during the learning phase.

The control Group L-L received low motivation both during learning and just before recall one week later. The remaining three groups of Ss served as experimental groups. Group L-H received low motivation during learning and high motivation prior to recall one week later; Group H-L received high motivation during learning and low motivation prior to recall one week later; Group H-H received high motivation both during learning and prior to recall one week later.

The data from the lists were scored three different ways. First, the number of correct syllables recalled, irrespective of order, were

Fig. 1. Mean number of nonsense syllables correctly recalled (irrespective of order) as a function of time.

Table 1
Mean Recall Scores for Combined Initial Low Motivation and High Motivation Groups

Initial Condition	Mean Score							
	CS			CS+O			TS	
n=32 per group	Immed. Recall	1 Week Recall	Diff. Score	Immed. Recall	1 Week Recall	Diff. Score	Immed. Recall	1 Week Recall
High (H-L,H-H)	16.3	11.5	4.8	47.6	34.2	13.4	18.1	14.3
Low (L-L,L-H)	14.7	7.8	6.9	41.3	22.1	19.2	16.6	12.3
t	1.36	2.74	2.23	1.70	3.10	2.28	1.38	1.49
p*	N.S.	<.01	<.05	<.10	<.01	<.05	N.S.	N.S.

* two-tailed test

counted. This was called the CS score. Next the lists were rescored, two points being given for each syllable correctly recalled or one point being given if two out of the three letters of a syllable were correctly recalled, and one point being given if the syllable was recalled in its correct order. The maximum number of points obtainable for this score, known as the CS + 0, was 60. Third, the total number of three-letter CVC nonsense syllables written, regardless of whether they were correct or not, were counted. This score is known as the TS score.

Results

The hypothesis was not supported by the results of this experiment. No significant differences were found between any of the scores for the L-L and L-H groups or between any of the scores for the H-L and H-H groups. As a result, these groups were combined into two groups according to the type of motivation received during the original learning of the list. The mean scores of these two combined groups are given in Table 1.

A t-test analysis of the CS scores showed no significant differences in original learning between the two groups. However, there was a significant difference ($p < .01$) in recall scores one week later, the high motivation group showing better retention. The relationship between motivation and retention for all four groups is illustrated in Fig. 1. There was also a significant difference ($p < .05$) between the difference scores (i.e., number of syllables originally learned minus number of syllables recalled correctly one week later); the high motivation group remembered a greater number of the syllables they learned. Analysis of the CS + 0 scores essentially recapitulate the results using the CS scores. There were no significant differences between the TS scores of the two groups.

Discussion

The hypothesis that motivation would affect retention when introduced after learning, just prior to recall, was not supported in this experiment. The fact that there were no significant differences between the L-L and L-H groups nor between the H-L and H-H groups indicates that when motivation is introduced just prior to recall rather than during the learning phase, it has no effect on memory. Therefore if motivation is to somehow affect the memory of a learned event, it will have to be presented while that event is being learned. The results of this experiment are in agreement with those of Weiner (1966) but are contrary to the findings of Bourne (1955). However, the differences in type of motivation, learning task, etc., between Bourne's experiment and this one make comparisons rather difficult.

The finding that Ss who originally learn a nonsense syllable list under high motivation conditions show significantly better retention of this list one week later than Ss who originally learn the list under low motivation conditions essentially confirms the results found earlier by Heyer & O'Kelly (1949). It is interesting to note that there are no significant differences between any of the groups with respect to the TS scores. One might expect Ss who were

highly motivated to guess and write down more syllables since they had nothing to lose and at the same time could increase their chances of obtaining more points. The fact that they didn't shows that the higher one week recall scores of the highly motivated Ss are not simply due to the fact that they guessed correctly more often than the low motivated Ss.

Kleinsmith & Kaplan (1963) have put forth a simplified physiological explanation of what happens during learning under high arousal. For example, when a person perceives an event, a closed reverberating neural circuit is set up in his brain corresponding to this event. The more nonspecific neural activity or arousal present, the greater the number of times which the trace is likely to reverberate. And the greater this perseverative consolidation of the neural trace, the stronger the permanent memory. However, it should be pointed out that an increase in nonspecific neural activity due to motivational factors may also result in an increase in the number of neurons involved in reverberation or an increase in the rate of circulation of reverberatory activity (John, 1967). These two mechanisms might also lead to stronger permanent memory.

The results of this experiment imply that motivation does not affect trace storage or trace utilization, only trace formation. It is very likely that once a memory trace is consolidated and placed in storage, it is no longer affected by motivation. As a result, it would be more reasonable to talk about motivation affecting learning and, consequently, memory rather than saying motivation acts directly on memory (i.e., trace storage or utilization). In other words, motivational factors determine what the *strength* of a trace will be in storage.

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NOTES

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