STUDIES IN THE RETENTION OF INTERRUPTED LEARNING ACTIVITIES[1]

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INTRODUCTION

Zeigarnik (7) found that when such simple tasks as modeling an animal out of clay, printing a name and address, stringing beads, multiplying, solving riddles, etc. were interrupted while being performed among other tasks, the subject would recall them better as tasks having been performed than he would those tasks which he had been allowed to complete. In one experiment the names of the interrupted tasks were recalled 90 per cent better than the finished problems. Numerous other experiments show similar results. This difference existed in spite of the fact that the completed tasks consumed more time and were favored by the factor of greater use. The difference was not as great when the recall of the task was given the following day rather than on the day of performance.

The possibility that greater stress, due to the interruption was the cause of increased recall of incompleted tasks was shown to be slight by a control in which both tasks were interrupted, one group being completed immediately following a short pause. The uncompleted tasks were recalled in greater number, showing the interruption, *per se*, was not the cause of greater retention. Likewise, a thought on the part of the subject that he would complete the task later, which might lead to preparation and anticipation, was shown not to be the cause of greater retention by conducting a control experiment in which some subjects were told that they were to complete the tasks later and others were not so instructed. Those subjects believing that they had to

[1] Parts of this manuscript were presented in a paper at the 1933 meeting of the Midwestern Psychological Association. See Psychol. Bull., 1933, xxx, 573.

recall the tasks later showed no better recall of interrupted tasks than those not having this belief. The author concludes that a *Quasibedürfnis* probably translated best as an arbitrary requirement or goal for which there is a desire on the part of the subject to meet, was probably responsible for the differences between the groups.

For this point of view he finds experimental evidence in that problems outwardly finished and inwardly unfinished, as those with solutions not satisfying to the subject or beyond the ability of the subject, produced greater recall. Conversely, outwardly unfinished problems and inwardly finished problems, as for example those which the subjects "give up," and incomplete problems, generally regarded as complete, do not produce higher recall scores. This hypothesis is further supported by data showing that finished continuous problems, that is, problems without a goal, show a greater recall than those with a goal, but when these problems are interrupted, those with a goal show a greater retention. The further fact might be added that the nearer to the goal the interruption occurs the greater the retention of that problem as one having been performed. Thus, the existence of a definite requirement which is not met seems to be related to the recall of the name of an act as having been one of a series of acts.

Schlote (6) has repeated Zeigarnik's work and has found corresponding results on the whole. He has the belief that the decisive factor was the subject's interest in the task. Because he objected to the inequality of tasks Zeigarnik used, he employed nonsense syllables and required the subject to substitute a letter in them. He found greater persistence in memory of attitudes involving incompleted acts.

Rosenzweig (5) has shown experimentally the results of interruption are largely conditioned by the attitude or interest of the subject. In using jig-saw puzzles as material he found that when he gave the subject the impression that the puzzle was a test of his ability the finished puzzles were recalled more often, but when the subject believed he was carrying on the experiment to help the experimenter classify the puzzles, the unfinished puzzles were recalled more often.

The greater retention of the names of interrupted tasks seems established. Zeigarnik has pointed out and Freeman (2) has shown experimentally the interruption of these tasks before completion causes a tension and possibly some other conditions which become associated with the task and cause greater retention of that task.[2] The interruption seems to have a motivating effect upon the subject. The question arises as to how extensive is such an effect and how general is its influence upon retention. Dose the interruption affect the reproduction of the task itself as well as the memory of the task, or does the condition which the interruption causes influence only the retention of some specific part of the task? It is the answering of these questions that this experiment has as its purpose.

Before discussing the purpose of this experiment it might be well to point out some of the differences between Zeigarnik's experiment and the traditional memory experiments. First, in Zeigarnik's experiment the individual did not usually *learn* a new task. He merely carried out an act which was partially habitual. The tasks were not performed under the standard learning conditions; there were no standards of performance or criteria of mastery in the strict sense. Further, the amount of time spent on each problem was not carefully controlled nor was the degree of stability of the habit tested or known. There are no quantitative data concerning the effect of interruption on a task when all other factors, as time spent with problem, method of solving and other variables are held constant. Second, the retention test did not consist of reënacting the task. All the subject was asked to recall, when retention was measured, was the *name* of the act. Third, Zeigarnik's tasks were quite different from the usual material experimented upon in the laboratory such as maze-learning, card-sorting, nonsense syllable-memorizing, ball-tossing, etc. They were usually simpler tasks, more meaningful in a sense, and also more life-like in nature.

In view of these considerations all that can be said regarding the retention of interrupted material at present is that the name

[2] Zeigarnik however, speaks in terms of psychic tensions and also avoids the use of the concept association.

of a task so affected is retained longer than one not so affected. Nothing can be said however, regarding the retention of the act as a whole or the retention of any part of the act, except this particular symbol (name) associated with the activity. Nor can we say anything about acts interrupted during the process of learning. These problems are still open for investigation, and it is to these that attention will be turned.

STUDY I. THE RETENTION OF INTERRUPTED MAZE PERFORMANCE AFTER VARIOUS DEGREES OF COMPLETION OF THE ACT

It is the specific *purpose* of the first 3 experiments to ascertain whether the interruption of a standard laboratory task such as maze learning, will affect the retention of the task itself. It is possible in using the maze to control the degree of learning, as well as it can be controlled, and have as the only variable the completed or uncompleted task. This was accomplished by varying merely the instructions given to the two groups. One group was told to learn to three perfect repetitions and the other to one perfect repetition. Both groups were stopped after they had made one perfect traversal. To the one which had been told that the maze must be traversed three times for mastery the task was incomplete, to the other group the task was a complete one.

Experiments I and II

Method. Two mazes were used in this study, an easy one and a more difficult one. The former had seven short culs-de-sac and all except one contained but one section. The latter had ten culs-de-sac, six with only one section, two with two sections and two with three sections.[3] The usual records of trials, time and errors were taken. Entrance into any cul-de-sac section and retracing of any section or part thereof, of the true path, was counted as an error.[4] The number of trials taken for mastery

[3] Diagrams of the mazes may be found in the article by J. A. McGeoch and A. W. Melton (3). The easier maze is shown in figure 1 and the harder one in figure 2.

[4] As will be made clear later, one experimenter recorded the entrance into an alley regardless of the number of sections traversed as only 1 error.

did not include the last perfect run. An opaque black cloth maze-screen was used. The subject extended his hand under the cloth and manipulated the stylus. The subject sat on one side of the table and the experimenter on the other. The mazes were learned on one day and recalled at the same hour a week later. If the subject failed to return at the exact hour the next week his record was discarded. The criterion to which all subjects *performed* was one perfect trial in the learning series and three perfect in the recall series. One minute rest was allowed between trials. Forty-nine college students acted as subjects for the easy maze, 25 performing under the control condition and 24 under the experimental condition. Fifty-one subjects learned the harder maze, 25 working under the control condition and 26 under the experimental. None of the subjects had any previous experience in learning mazes.

An advanced student in experimental psychology ran some of the subjects under some of the conditions and another experimenter[5] well trained, experienced and supervised, ran the others. Care was taken to make both situations comparable and the results from the two experimenters were similar. However, one experimenter recorded each section of the cul-de-sac as an error and the other recorded the whole cul-de-sac as only one error. The group of subjects in which each section of a cul-de-sac was regarded as an error will be spoken of as experiment II and consists of 40 cases distributed as shown in table 2 under experimental and control conditions for hard and easy mazes. The other group in which the whole cul-de-sac was regarded as a single error will be spoken of as experiment I. This group has 60 subjects distributed as shown in the table under experimental and control conditions for each maze.

As mentioned above the experimental and control conditions differed only in the instructions given the subjects. In the experimental condition, the subjects were given the following instructions:

> The maze is a series of grooves, some of them blind alleys and others leading to the goal or end of the maze. You will trace a path through

[5] Mr. Harold Diehl and Mr. Harold S. Fischer.

the maze from start to finish with the aid of a stylus. The stylus is a penciled piece of wood. It is held firmly in the hand and moved through the channels of the maze. You are to learn to avoid the blind alleys and check any retracing, that is, going backwards. Always attempt to go forward and in time your progress will be unhampered. As soon as you have learned to go from the starting point or beginning to the finishing point or goal without error, that is, without entering a blind alley or retracing, *three consecutive times*, the task will be completed. Remember the task is ended when you have traversed the maze *three consecutive times* perfectly.

These instructions were typed and handed to the subject. This was done in order to depersonalize the experiment as much as possible and thereby to avoid any cues that might have been given by the voice. The subject was quizzed orally however, to ascertain if he had comprehended the instructions before starting the experiment. The instructions for the control group were exactly the same except for the words "three consecutive times" the words "one time" were substituted. The phrase "one time" was underlined, making the instructions comparable to those for the experimental group.

In both groups after the subject had learned the maze to one perfect trial the experimenter said, "Now I want you to cancel all the fives on this number sheet." The number sheet was a number cancellation sheet containing the digits five, six, seven, eight, and nine in random order. In experiment I, the subject cancelled the whole sheet, which consisted of 60 rows of 43 numbers. In experiments II and III, this procedure was altered because of the laboriousness and uselessness of such an extended task. In the latter cases, the subject merely counted the number of fives in each line and recorded the number for each line on a separate piece of paper.

If a subject in the experimental group showed any surprise at the interruption he was told to proceed with the experiment, that time demanded the interruption in order to go on with the cancellation sheet. In most cases this explanation sufficed. In a few cases in which it did not and the subject seemed disturbed an attempt was made to make the cancellation sheet seem the most

important part of the experiment. An attempt was made to keep the factor of "blame" out of the experimental situation, but yet not to minimize any effect which the interruption might exert.

The relearning was identical in both groups. Three perfect repetitions was the criterion. The subjects were told not to

TABLE 1

Learning and retention means for hard and easy mazes—Experiment I

Hard maze

Experimental, N = 15

	LEARNING MEANS	RELEARNING MEANS	SAVING
Trials	17.60 ± 3.31	7.40 ± 1.75	57.20
Time	738.00 ±300.70	284.00 ± 94.21	57.10
Errors	52.70 ± 11.30	22.00 ± 6.10	61.50

Control, N = 15

Trials	19.70 ± 8.36	10.40 ± 3.73	47.50
Time	802.00 ±230.20	352.00 ±115.03	56.00
Errors	69.50 ± 20.20	31.90 ± 11.20	54.20

Easy maze

Experimental, N = 15

	LEARNING MEANS	RELEARNING MEANS	SAVING	RECALL
Trials	16.40 ± 4.83	4.60 ± 2.59	71.95	
Time	702.00 ±350.00	168.00 ± 78.40	91.30	32.13
Errors	90.40 ± 78.40	7.93 ± 5.45	91.22	2.77

Control, N = 15

Trials	19.73 ± 9.70	5.90 ± 4.24	70.09	
Time	700.00 ±376.30	224.00 ±102.50	68.00	38.87
Errors	93.46 ± 78.49	11.60 ± 10.13	86.52	3.80

attempt to rehearse and in some cases in which they were available, they were not told of the retention test until the time of relearning. An equal number were treated in this fashion in both control and experimental groups. The recall date was exactly one week to the hour after relearning.

Results. The results from the 2 experiments are shown in

tables 1 and 2.[6] In table 1 are given the data for experiment I: the means and sigmas of the distribution for learning and relearning in terms of the three measures used for both conditions, the saving scores[7] in terms of the three measures for both conditions, and the recall scores in terms of time and errors for the two conditions.[8] In table 2 are given the data for experiment II: the means for learning and relearning in terms of the three measures

TABLE 2

Learning and retention means for hard and easy mazes—Experiment II

	LEARNING MEANS		RELEARNING MEANS		SAVING		RECALL	
	Experimental	Control	Experimental	Control	Experimental	Control	Experimental	Control
Hard maze								
Trials	17.72	21.20	12.35	12.70	30.87	40.08		
Time	731.00	899.10	285.90	237.20	60.88	73.61	48.90	32.10
Errors	236.81	213.90	65.36	25.50	72.31	88.07	17.63	4.10
N	11	10						
Easy maze								
Trials	17.77	14.70	15.11	15.40	14.96	−4.76		
Time	485.66	492.20	277.88	337.90	42.79	53.96	20.00	23.90
Errors	108.88	76.70	37.00	35.30	67.03	31.34	2.22	3.20
N	9	10						

used for both conditions and the recall scores for time and errors for the two conditions.

The saving scores calculated from the averages seemed to be

[6] It will be noted that the means of the various measures used here differ from those published in the study of McGeoch and Melton (3). This difference can probably be explained in terms of uncontrollable variables which exist in different laboratories as differences in experimental rooms, experimenters, subjects, instructions, inclusion or exclusion of criteria in calculating means, and the relationship between some of these variables.

[7] Saving scores were calculated in terms of the following formula:

$$100 \times \frac{\text{(trials to learn not including criterion)} - \text{(relearning trials not including criterion)}}{\text{(trials to learn not including criterion)}}$$

[8] Recall scores consist of total time and errors on first relearning trial.

more consistent and did not show the unstable character exhibited by individual saving scores. In the case of individual saving scores it happens that several individuals have freak learning or relearning records which effect unduly the computation of the total saving score. Therefore the tables contain the saving scores computed from the averages. These are given for all measures. The reliability of the differences between the conditions is determined in terms of the relearning averages and sigmas instead of in terms of the saving scores.

Examination of table 1 shows superior learning on the part of the group which was instructed to learn to three perfect trials. There is one exception, the case of the data for time on the easy maze, where the averages are about the same. This superior learning may be the result of the attitude of the subject in response to the criterion of learning set for him, the more difficult problem eliciting a more vigorous attack. These differences here are slight however, and not statistically significant and therefore, for the purposes of this experiment the differences in learning ability under the two situations may be ignored.

Relearning scores are lower under the experimental or interrupted condition for time, trials and errors of both hard and easy mazes. The difference between the two conditions divided by the sigma of the difference for relearning scores are for trials, time, and errors in the case of the hard maze 2.83, 1.78, and 3.03 respectively, and in the case of the easy maze 1.02, 1.69, and 1.24 respectively. These show in the case of the trial and errors for the hard maze a reliable difference with some of the other differences tending toward reliability. All saving scores favor the experimental or interrupted condition. Although the differences are small, the consistency is again conspicuous. Recall scores[9] show slight superiority for the experimental condition and thus corroborate the other data.

[9] In connection with the relearning scores of the hard maze, the experimenter used a stop clock and found the cumulative time of relearning by stopping the clock at the end of one trial and starting it again at the beginning of the next trial. Recall scores obviously cannot be calculated for this part of the experiment.

Table 2 with a smaller number of cases shows slightly superior learning scores for experimental conditions in three of the six instances. The phenomenon shown, namely that of the greater requirement producing better learning, is not shown as clearly in these data.

Superior relearning scores for the experimental conditions are shown in only 3 of the 6 cases, 2 of these being in connection with the easy maze. The saving scores show greater retention in the control condition in the case of the hard maze. The differences between the two groups in terms of percentages are: 9.21 per cent in the case of trials, 12.73 per cent in the case of time, and 15.76 per cent in the case of errors. For the easy maze the following differences are found: 19.72 per cent in the case of trials, and 35.69 per cent in the case of errors favoring the experimental condition, and 11.17 per cent favoring the control condition in the case of time.

The recall scores favor the experimental group only in the case of the easy maze. Although the data presented in table 1 gave greater evidence of a more consistent nature that an interrupted condition was superior in affecting retention than an uninterrupted condition, the data of table 2 do not show clearly the superiority of the experimental condition. Therefore the conclusions which follow from these two studies are to the effect that interrupted learning tends to be superior to uninterrupted learning in affecting the retention of a learning process when retention is measured after the lapse of one week.

Experiment III

The lack of absolute unequivocal evidence in experiments I and II favoring interrupted learning can possibly be explained in several ways. One of the most obvious probabilities is that although the interruption may have had an effect this effect had not shown itself reliably after the period of a week. In order to test this the following experiment was devised.

Method. The experimental set-up was identical with the above with the following exceptions. Retention was tested on the following day after the lapse of twenty-four hours rather than

after a week, and the instructions were read aloud distinctly and deliberately. The latter was done to make sure that the subjects would be impressed by them. The easy maze was used here. Twenty-three of the same type of subjects traversed the maze under the interrupted condition and 21 under the uninterrupted condition. For procedure, criteria of learning and relearning and the instructions given to the subjects in experiments I and II should be consulted.

TABLE 3
Learning and retention means—Experiment III

	LEARNING MEANS	RELEARNING MEANS	SAVING
Experimental, N = 23			
Trials	14.43 ± 6.78	9.87 ± 7.58	31.67
Time	644.43 ±352.65	299.67 ±198.85	53.50
Errors	137.00 ± 85.52	27.82 ± 21.27	87.72
Control, N = 21			
Trials	15.85 ± 9.22	10.80 ± 9.30	31.92
Time	643.14 ±336.78	323.42 ±374.69	49.71
Errors	144.00 ± 71.74	30.52 ± 44.67	78.74

Recall

	EXPERIMENTAL	CONTROL
Time	29.21 ±17.19	74.70 ±109.10
Errors	4.00 ± 4.32	9.52 ± 15.31

Results. The means of trials, errors, and time, and the sigmas of the distributions for the learning and relearning under the experimental and control conditions are presented in table 3 in a form similar to that found in table 1. In addition to these data recall scores were calculated in terms of the time and the number of errors on the first relearning trial. These are presented in the lower part of table 3 and act to corroborate the other data.

The learning of the maze in this case under experimental conditions is superior in two measures to that of the control condition, a similar occurrence to that found in experiments I and II and explained there in terms of motivation. As in the above case

this difference although reasonably consistent is not statistically significant and for our purposes may be ignored in comparing recall and relearning scores.

In terms of the retention scores it is evident that the experimental condition or the condition in which the task was interrupted is consistently superior to the control condition. The difference between these conditions divided by the sigma difference are 1.98 and 1.67, for recall time and errors, and .37, .26 and .26 for trials, time and errors respectively. Although the recall scores are the only ones which show a tendency toward the superiority of interrupted learning, the consistency of the superiority of the interrupted condition is worth noting. The superiority of the recall scores over the relearning scores is not surprising in the light of Zeigarnik's results. It will be remembered that Zeigarnik had his subject recall the name of the tasks and not relearn them, and his results showed high retention values.

The saving scores also show a slight superiority for the experimental or interrupted condition but the superiority does not show itself as greatly in these scores as in the recall.

Examination of the sigma of the retention scores in tables 1 and 3 show them to be all without a single exception, greater under the control condition. There is also a tendency for them to be greater in the case of learning, under the control condition, as in 6 of these 9 cases they are greater. This can probably be explained in terms of the fact that those working under the experimental conditions all had a harder task facing them and therefore had a more definite set. This caused them to get right down to work to meet this rather difficult goal. Since this stronger directing influence was not present in the control condition the result was that the learning attempts were more variable.

In order to ascertain in some sort of objective manner whether the interruption did influence the subjects, records were kept under the conditions of experiments II and III of the number of errors and the amount of time taken in cancelling numbers in the number sheet. These data are listed in table 4. Reference to

table 4 will show little difference in the cancellation time under the two conditions either in experiment II or III. However in both cases the experimental conditions have a greater time score and in both cases there are differences in errors there being a tendency for errors to increase in the experimental condition. This shows that there probably is not only a conscious factor which the subjects later reported to exist, but one of such strength as to influence subsequent behavior to a measurable degree.

These data warrant the conclusion that the interruption of a novel motor learning task tends to affect to a slight degree the retention of that task after a day's interval and to a lesser degree the retention of that task after a week's interval.

TABLE 4

Average cancellation time and errors

	EXPERIMENTAL	CONTROL
Experiment II		
Time	292.26	291.86
Errors	1.34 ±1.35	.72 ±1.18
Experiment III		
Time	234.68	232.11
Errors	2.70 ±2.98	1.70 ±1.72

Discussion of experiments I, II and III

The results show a tendency for the interruption of a complex task to affect the retention of that task over a period of twenty-four hours. This tendency seems to exist to some extent after a week. It remains for these results to be interpreted.

The difference between these findings and those of Zeigarnik may be explained in terms of several factors. First, they may be the result of the *subject's attitude.* It is possible that not all of the subjects took the interruptions seriously, and this might have reduced the magnitude of the averages. There is some evidence from post-experimental discussions with the subjects that such was the case in some instances. Some subjects thought

that they had misunderstood the instructions when they were interrupted after one perfect trial instead of three; others had not paid much attention to the instructions in spite of the fact that they had been emphasized. Still others knew that "there was something wrong somewhere" but dismissed the matter from their minds. Finally, there were those who knew that they had gone through the problem once correctly and this meant to them that they could solve the maze. The other two perfect traversals were more or less superfluous. In one sense these tasks were not incomplete tasks at all in that the subject did learn the maze to the point where he could traverse it without a single error; they were merely tasks interrupted after a degree of completion as the title of this paper suggests. It is possible that even in these cases in which the subjects failed to view this as an incomplete task, the interruption had some immediate effect. This effect may have been minimized by rationalizations and may have become weak after one day or a week, but the effect was there, however small. It is difficult to believe that this factor is the most important in explaining the above mentioned difference in results because of the subjects' reactions to the experimental conditions. Further, a careful and emphatic reading of the instructions on the part of the experimenter in experiment III eliminated the misunderstanding of instructions.

A second possibility in the explanation of these results is the *interval between retention and recall.* The smallest interval used in this experiment was twenty-four hours. Zeigarnik found in his experiment that after twenty-four hours, in the case of a somewhat simple task, the effect of the interruption was largely lost. Most of the retention studies on mazes however, have been concerned with the twenty-four-hour and the one-week interval. This experiment was aimed at testing the effect of interruption of the tasks usually used in the laboratory. What is more, there is relatively little loss of retention after a few hours in the case of the maze, which suggests that results would not be very valuable for this interval. Nevertheless, it might be well to test later the retention of interrupted maze performance after several shorter intervals to ascertain whether the interruption shows itself to any great extent only then.

A third reason somewhat related to the first might be due to the *nature of the maze problem*, namely that there is less meaning or wholeness in the case of the maze than there is in the case of simpler every day tasks. A criterion of learning set in connection with a maze is much less definite and much less meaningful to the average subject than the completion of an everyday task. To use an example, the completion of a maze is not "as necessary" or as meaningful as the completion of a multiplication problem. This possibility has little validity as some of Zeigarnik's tasks were not entirely novel or any more meaningful than the maze.

Last, probably the most important reason for the results is that suggested in the beginning of the paper namely, the *inherent difference between experimental set-ups* in this experiment and Zeigarnik's experiment. This experiment aimed to test the effect of the interruption on the retention of a newly learned task and not the retention of the *name* of an *habitual* task. We should not expect the acquisition and organization of a number of behaviorial elements to be affected as much by any factor as only one element —the name of the task. Interruption would be a *very* potent influence if it were able to affect advantageously all the associations made in learning to traverse one of these mazes perfectly. That would mean that this factor would have to influence in some manner all the numerous correct and incorrect associations made in learning the maze.

Theoretically, a phenomenon of this kind is related to a number of other investigated processes, viz.: reminiscence, the beneficial effect of distributed practice, perseveration, motivation. The existence of such a phenomenon would be welcomed and it would find a place in the structure of the psychology of learning. Although it may seem that the above paragraph suggests its improbability, there are many related phenomena as those mentioned here which strongly support its possibility.

It is entirely within reason that there is some sort of disrupting in cases where we find reminiscence. The subject may be prevented for example, from completing the act he is engaged in as learning, reciting, or reviewing. Such a form of interruption

then could exert an affect upon the recall, either causing a conscious perseveration or some sort of central or peripheral perseveration. This could be especially true in cases where we find considerable reminiscence, as for example, poetry which is a unit to the subject, not to be broken, a unit which usually arouses in him the tendency to react to it as a unit, to complete it.

Likewise, this phenomenon could conceivably be effective in distributed practice.[10] Some sort of interruption due to the rigidity of laboratory conditions may cause parts of the group of material to perseverate. To be specific, in mass practice the subject finishes the material at hand, in distributed practice he only goes through several repetitions and then he is interrupted and might rest or go on with some other activity. This is particularly the case when the subject is not informed during these distributed practice experiments of the number of trials he has to complete at that experimental period. This is an incomplete task for in many cases the subject knows that he must come back to it, or he may have a desire to have another glance at the material, to have another trial in which he might do better, etc. Such tension might cause perseveration, a phenomenon which is actually found under these and similar conditions.

STUDY II. THE RETENTION OF INTERRUPTED VERBAL LEARNING AFTER VARIOUS DEGREES OF COMPLETION OF THE ACT

It is the purpose of these 3 experiments to test further the hypothesis that a task interrupted in acquisition is retained longer than one which is not interrupted. In this case however, a verbal learning task rather than a motor task was used and the retention was tested after one day only, in view of the poor results obtained with the maze on the week retention interval. Although little effect of the interruption was shown in the motor task, it might be that verbal material, being a symbolic material, is effected to a greater extent by interruption. It will be remembered that it was the retention of the name of the task that Zeigarnik found was influenced by interruption.

[10] As suggested by Dr. John A. McGeoch in conversation.

Experiment IV

Method. Twenty-five subjects learned each of two lists of 11 two-syllable nouns. They were exposed by a Guhin Card Changer.[11] The syllables were exposed at the constant rate of two and one-half seconds each. A word was neatly typed on every other card so that there was a two and one-half second period following the exposure of a word, during which the subject merely looked at a blank card. These blank cards were distributed among the word cards because of the nature of the machine, it being arranged to expose cards for only certain definite periods. An interval of fifteen seconds followed each trial. This period was necessary for reloading the machine. The subject was instructed against rehearsal during these intervals. The list was preceded by an initial card with three x's on it. This card was a stimulus for the subject to respond with the first word. One list was given to the subject under the experimental condition and the other list under the control condition. The lists were arranged in counterbalanced practice order, one subject taking the experimental condition first and the control second, another vice versa. The criterion of learning was one perfect trial. As in the maze experiments reported above, subjects in one group were instructed that mastery of the task consisted of three consecutive perfect repetitions[12] but they were interrupted at the end of one perfect trial. The other group, the

[11] This apparatus is shown in C. H. Stoelting Company's catalog (1930 edition) on page 91 as No. 21113.

[12] The instructions for the experimental group were as follows: Here is a list of words that are not necessarily associated. You are to learn this list in the order in which the words appear and in such a manner that one word will mean the next one to you. For example, if the first word is "cat," the second "dog" and the third "cow," when you see "cat" you are to say "dog," and when you see "dog" you are to say "cow." When you see the initial card, you are to say the first word. The words in this list will not be related as the example used here. The list will be shown to you once, after which you will be expected to start reciting the list to the best of your ability. After you have recited the syllables three consecutive times perfectly, you will have mastered the list. While the experiment is in progress, no questions will be answered. Now, do you understand that you are to learn to three perfect trials? Do you understand the instructions and know just what to do? Are there any questions before starting?

control, was told that the task would be mastered when the words were recited one time perfectly. Thus, for one group the task was a completed one; for the other it was interrupted, but both groups learned to the same degree of perfection. The list was relearned after twenty-four hours to the criterion of three perfect consecutive trials. The instructions for the control group were the same except the phrase "one perfect trial" was substituted for "three perfect consecutive trials."

In both experimental and control groups, when the subject had finished one perfect trial, he was given a cancellation sheet, consisting of the numbers five, six, seven, and eight in a scrambled order, and was told to cancel all the five's in it. His time was

TABLE 5

Means and sigmas of learning and relearning trials, recalls 1 and 2, and individual and group saving scores for interrupted and uninterrupted verbal learning in experiment IV

LEARNING TRIALS	RELEARNING TRIALS	RECALL 1	RECALL 2	SAVING	
				Individual	Group
N = 25 Experimental condition (interrupted)					
10.28 ±4.90	2.76 ±2.40	6.56 ±3.11	9.56 ±2.41	59.18 ±38.93	73.14
N = 25 Control condition (uninterrupted)					
11.28 ±6.41	3.32 ±2.82	7.00 ±3.34	9.40 ±2.10	68.78 ±29.67	70.56

taken, then he was dismissed for the day and returned the next day to recall.

Subjects were students taking General Psychology who had volunteered to take part in the experiment. They were naïve in respect to psychological experimentation and to this problem in particular.

Results. Table 5 contains the means and sigmas of the distributions for the trials to learn, the trials to relearn and recall 1 and 2 and saving scores (group and individual) for the interrupted and uninterrupted groups. The individual saving scores were calculated by finding the percentage of trials saved by each individual in relearning, and taking an average of these. The

group saving scores were calculated by finding the percentage savings in terms of group averages. Recall 1 refers to the average number of words recalled by the subject on the first relearning trial. Recall 2 refers to the average number of words recalled on the second relearning trial. As in the maze experiment the higher criterion or the greater task (the instructions to learn to three perfect repetitions instead of one) apparently causes the subject to put forth greater energy, as it takes him less time to learn. The differences between the learning and relearning however, are small and unreliable statistically, and for our purposes can be ignored.

The measures of retention show the following: A smaller number of trials for relearning under the experimental condition, greater recall 1 scores for the control, greater recall 2 scores for the experimental, greater individual saving scores for the control, and greater group saving scores for the experimental. All of the differences are small and unreliable, three favoring the experimental condition and three the control. The only conclusion that such data warrant is that there is no significant difference between the interrupted and uninterrupted groups in learning verbal material. Although some of the differences tend to approach statistical significance[13] the lack of uniformity of the measures in direction makes consideration of them pointless.

Experiment V

Method. It was thought that the results of the preceding experiment might be due to the fact that each subject was given both conditions, so this control was used as a check and also as a means of accumulating further data. Ten nonsense syllables paired with ten words were given to two groups of 15 subjects each. These were learned by the method of paired comparison. The syllables were neatly typed on cards and presented manually at the rate of one every three seconds. The experimenter had practiced beforehand so as to be very accurate in giving the presentation at the proper intervals. After each presentation, a test was taken, the subject being shown the first of each pair (the

[13] The mean differences divided by the sigma differences are all fractions.

nonsense syllable) and asked to recall the second (the word). Five seconds were allowed for each syllable before passing on to the next. Practically the same instructions were given as in the above reported experiment. The subjects relearned after twenty-four hours and to the criterion of three perfect consecutive trials.

Results. Table 6 is similar to table 5, having the averages of the trials to learn (not including tests), trials to relearn, number of items recalled on the first relearning trial, and the group and individual saving scores. The sigmas of all distributions except the group saving scores accompany them.

TABLE 6

Means and sigmas of learning and relearning trials, recall 1, and individual and group saving scores for interrupted and uninterrupted verbal learning in experiment V

LEARNING TRIALS	RELEARNING TRIALS	RECALL 1	SAVINGS	
			Individual	Group
N = 15 Experimental condition (interrupted)				
5.80 ±1.98	1.40 ± .90	7.73 ±1.57	77.90 ±12.56	70.58
N = 15 Control condition (uninterrupted)				
7.73 ±1.30	1.20 ±1.39	8.13 ±1.50	82.45 ±11.18	84.47

In so far as learning is concerned these data show the same sort of results shown above and in the previous maze study, namely, a smaller average under the condition requiring greater learning,—the experimental condition. However, as above, the difference between these means is not reliable. In retention there are very slight and statistically unreliable differences[14] which favor the control condition in trials to relearn, and in all other measures. These differences are small and unreliable and are even more conclusive than those of experiment IV in their negative implications.

[14] The mean differences divided by the sigma of the differences are all fractions as in experiment IV with the exception of that for the saving score which is 1.35.

Experiment VI

Method. To eliminate the factor of rehearsal during the learning and recall sessions which, if present might conceivably have made the groups in experiment V more identical than they would actually be, and to collect more data on this problem under a different method, this experimental set-up was arranged. The subjects were given the same words used in experiment V without the nonsense syllable key word, that is, they learned by the serial method instead of the paired comparison method. In this experiment the ten words were presented on an electric memory drum with a two-second exposure, and were learned by the anticipatory method. Twenty-six subjects learned under each condition. An attempt was made to control rehearsal by instructing the subjects to return the next day, telling them they would have a new list. After the experiment was over they were instructed not to mention the experiment to other students. This method with its careful control of presentation should eliminate any error which might have crept into the other two experiments.

TABLE 7

Means and sigmas of learning and relearning trials, recall 1, and individual and group saving scores for interrupted and uninterrupted verbal learning in experiment VI

LEARNING TRIALS	RELEARNING TRIALS	RECALL 1	SAVINGS	
			Individual	Group
N = 26 Experimental condition (interrupted)				
6.92 ±3.41	.96 ±1.34	9.15 ±1.23	86.90 ±15.40	86.12
N = 26 Control condition (uninterrupted)				
6.34 ±2.68	1.15 ±1.00	8.50 ±1.42	81.15 ±13.51	82.01

Results. Table 7 is very similar to tables 5 and 6, showing practically the same measures of learning and relearning. Very slight and unreliable differences exist between the learning scores under the two conditions.

Measures of retention all show a small superiority for the ex-

perimental or interrupted condition. These differences between the two conditions are small[15] but are consistently in favor of the experimental or interrupted conditions and in this way they differ from the data of experiments IV and V.

Table 8 contains some data calculated from the cancellation sheets, the product of the subjects' performance just after learning and in some cases,—the experimental condition,—just after being interrupted.

It is of interest to see if the interruption of the learning task affects the subsequent activity of the subject. If it does, it might show evidence of the potency of the interruption. The data shown here are very similar to the data found on the subsequent cancellation tests in connection with the maze. The data

TABLE 8

Time and errors in cancellation of numbers following learning in experiment IV and errors in experiment VI

CONDITIONS	EXPERIMENT IV, N = 50		EXPERIMENT VI, N = 52
	Time	Errors	Errors
Experimental	466.08	10.52	1.61
Control	450.64	9.68	1.30

were calculated from experiments IV and VI, careful records being kept under these conditions. The errors in experiment I are slightly greater for the experimental group. This difference is much smaller than the difference in connection with the maze experiment. The errors in connection with the cancellation following the learning in experiment VI are also larger under the experimental conditions. As in the maze experiment the time differences are small. Time differences were only recorded accurately in experiment IV and those are presented.[16] Although

[15] The mean differences divided by the sigma differences are fractions as in the other two experiments with the exception of that of the saving score which is 1.91.

[16] It was intended to collect these data in the other two experiments but in a large number of cases the subject consumed more time in learning than had been allotted to him in the daily schedule, and the experimenter had to leave him in

these differences are small and unreliable they corroborate the results in the interrupted maze experiment and tend to show the interruption affects the individual insofar as it affects his subsequent activity.

Discussion of experiments IV, V and VI

What do these data show? First, they corroborate to some extent the result of the study on the retention of interrupted maze performance and much of the discussion given in that connection holds here also. The results reported here in terms of verbal material however, are even less conclusive in their implication of greater retention due to interruption than those in connection with the maze. These data also show that the difference between the effect of the interruption of a verbal learning task and a motor learning task is practically nil, supporting some recent work (1), (3), (4), which has demonstrated the similarity of the retention of verbal and motor learning.

It seems rather well established in the light of these two experiments, that the retention of a fairly complex verbal or motor task itself tends to be only slightly increased by interruption as measured by this specific experimental set-up. Zeigarnik's findings of a *marked* increase in retention of the names of interrupted tasks do not hold for the retention of the task itself.

STUDY III. THE RETENTION OF INTERRUPTED MAZE AND VERBAL MATERIAL PRIOR TO THE COMPLETION OF THE ACT

It is the purpose of the final 3 experiments to attack the same problems with the same types of material but interrupting the tasks before any degree of completion has been reached. There is one difficulty involved which is the reason why this procedure was not used in the experiments preceding these and that is the difficulty of maintaining a constant degree of learning under the two conditions. By the very nature of the interrupted condition

an experimental room while he cancelled the sheet, and proceed with another subject in another room. An equal number of subjects were left alone in the experimental room after the experiment and while cancelling numbers on a sheet, so the conditions were comparable in all cases.

the subject will not spend as much time nor do as much repeating in the learning period. The unequal degree of learning makes comparison of the two conditions at recall difficult, but this difficulty has been overcome in this study by combining learning and relearning scores and comparing them as a unit.

Experiments VII and VIII

Method. These 2 experiments involve the maze as learning material. The same maze which was used in experiment III was used in this condition. The experimental conditions except for the time of interruption were precisely the same in every detail. The experiment began immediately at the termination of the previous maze study. Experiments VII and VIII differ from each other only in terms of the point of interruption. In experiment VII the subject was interrupted at the end of that trial at which the subject had reached the point of perfection, involving four or less errors. This point was chosen arbitrarily after examining the results of Zeigarnik's experiment and the records of the previous experiments with the maze. It was chosen because it was near the point of completion of the problem and interruption would probably be as effective there as at any point. Further, there are some subjects who although making four errors on one trial make no errors on the next. If a point nearer the completion of the problem and involving fewer errors on the trial before interruption were selected some of these subjects probably would have completed the problem before they could have been interrupted and thus their records would have been of little value as far as this experiment is concerned.

The choice of this point for interruption proved later to be unwise in so far as effectiveness of the interruption is concerned as the results will show. The four-error point in the course of the mastery of the maze was probably not near enough to the end of the problem to allow the factors concomitant with interruption to be very effective. The data derived from an interruption at this point, in spite of their negative character, nevertheless have value in throwing light on the general phenomenon of interruption.

Experiment VIII was started after experiment VII had been completed and the data had been compiled. The point of interruption, namely at one error, was selected after the records of experiment VII were examined. Some subjects completed the task before interruption was possible. They were treated the same as the subjects in the interrupted group in that they returned the next day for recall. Their records were not, however, considered among those averaged in table 9. Twenty subjects were employed in each group under the experimental or interrupted conditions.

No control condition was devised for this experiment since the control condition in experiment III in the previous study could very well be used. It will be recalled that there were no differences in the procedure of the two experiments, except those involving the variable under investigation. In the previous study the subjects in the control condition were told that they must traverse the maze until they could go through it in one trial without making an error. It differed then from the two experimental conditions here only in that the subjects in the latter cases were interrupted before they reached this criterion of one perfect trial. Twenty-one subjects had been used in this control condition.

Results. Table 9 shows the learning and retention scores in terms of time, trials and errors for the control condition and the two experimental conditions investigated in this study, namely interruption at a point at which the subject's performance involved four or less errors and when his performance involved one error. In addition to these data there will be found in the table the scores reported previously of the subjects interrupted at the end of one trial after having been told that three trials was the criterion of mastery.[17] These were included because their presence allowed a comparison of a task interrupted at a point well before completion and yet near the end of the task with one interrupted almost at completion, with one interrupted at com-

[17] These scores and their sigmas are taken directly from the other article in which the sigmas of the distribution rather than the sigmas of the means are given. All the other scores in table 9 are accompanied by sigmas of the mean.

TABLE 9

Average learning and retention scores of maze performance interrupted at various points

INTERRUPTION AT	LEARNING		
	Trials	Errors	Time
None	15.85 ± 9.22	144.00 ±71.74	643.14 ±336.78
Completion	14.43 ± 6.78	137.00 ±85.52	644.43 ±352.65
1 error	9.05 ± 1.20	83.75 ±12.07	414.65 ± 45.87
4 errors	4.55 ± .74	73.80 ±12.39	341.75 ± 39.83

	RELEARNING			RECALL	
	Trials	Errors	Time	Errors	Time
None	10.80 ±9.30	30.52 ±44.67	323.42 ±374.69	9.52 ±15.31	74.70 ±109.10
Completion	9.87 ±7.58	27.82 ±21.27	299.65 ±198.85	4.00 ± 4.32	29.21 ± 17.19
1 error	10.05 ±1.61	18.05 ± 3.58	331.70 ± 40.12	2.70 ± .51	35.10 ± 3.11
4 errors	18.65 ±2.56	79.55 ±14.34	695.90 ±106.53	12.70 ± 4.19	71.85 ± 13.48

	COMBINED LEARNING AND RELEARNING		
	Trials	Errors	Time
None	26.65 ±3.18	174.52 ±15.34	966.56 ±105.54
Completion	24.30 ±2.62	164.82 ±20.77	944.08 ± 94.52
1 error	19.10 ±2.37	101.80 ±14.37	746.35 ± 73.11
4 errors	23.20 ±2.88	153.35 ±19.06	1037.65 ±131.33

pletion, and with a task uninterrupted. Finally there is included in the table combined learning and relearning scores.

All learning scores for the interrupted conditions with one exception, that of time, under the task interrupted after one perfect traversal, were superior to those of the uninterrupted condition. The scores with the same one exception become progressively lower as interruption is moved toward the beginning of the task. The differences between the condition requiring completion to a criterion of one perfect trial and the two interruptions in learning prior to completion are large. Since the scores of learning and relearning are combined in another part of the table and the final comparison is to be made on the basis of this combined score, no consideration of the difference in these scores is necessary. The relearning and recall scores show a superiority for the interrupted conditions both where the degree of learning is apparently the same and also with one exception, in the conditions in which interruption takes place before complete learning namely, at a point in performance where one error exists. The relearning and recall scores under the condition in which the performance was interrupted at the point where the subject's learning involved four errors were higher than all the other conditions with one exception. This might be expected in that the subject was interrupted before the task was well learned.

It is interesting to observe that in spite of the difference in degree of learning between the non-interrupted condition and the two more effective interrupted conditions there is an apparent superiority in all but one of the ten retention measures of the interrupted conditions. Because of this difference in degree of learning the reliability of the data for the various conditions is not calculated in terms of the relearning and recall scores but will be discussed later in terms of the combined learning and relearning scores.

Before discussing the combined learning and relearning scores it should be pointed out that these scores are combined on the logical basis that the same criterion is met in both conditions at recall and the difference between the measures under the various

conditions is due to the extent of interruption during the learning process.[18]

The conditions in which the interruptions occur after one perfect trial and in which the interruption occurs after all but one error has been eliminated show combined learning and relearning scores superior to the uninterrupted condition, the latter condition showing the greater superiority. The differences between the one-error interruption condition and the control condition divided by the sigma of the difference are 2.31, 2.67 and 3.19 for trials, errors and time respectively. The sigma of the difference for time is statistically reliable and the others deviate from the conventional point of statistical reliability by small amounts. Similar scores for the other conditions are 1.21, .19 and .70 for trials, errors and time in the case in which the interruption is at the four-error point and .99, .27 and 1.50 for trials, errors and time respectively in the case in which the interruption is after an errorless trial. These data show the superiority of the interruption immediately prior to completion of the task. The condition in which the interruption occurs after all but four errors have been eliminated shows superior combined scores in terms of trial and errors.

Experiment IX

Method. Ten nonsense syllables were used as material in this experiment. They were the nonsense syllables used in experiment V, one of the previous experiments on verbal material. They were presented by a McGeoch electric memory drum at the rate of two and one-half seconds each. They were learned by the anticipation method. The list was preceded by three x's. This was the stimulus for the first word. A constant six-second in-

[18] There is one factor which possibly may be influential in determining the results, particularly the results of the four-error interruption condition namely, the uneven distribution of practice. By interrupting the maze performance before completion and by forcing the individual to complete the task later the practice in the experimental condition is distributed differently than that in the control conditions. It may be that placing the twenty-four-hour interval earlier in the learning period aids learning. This factor, however is intrinsic to the problem itself.

terval separated each trial. There were two groups of 20 subjects each. The subjects were of the same type of student used previously. In one group the subjects were allowed to learn the syllables to the given criterion of one perfect repetition and those of the other group were interrupted when they had learned all but one syllable. The interruption was planned at this point in view of the results of experiments VII and VIII on the maze. This is practically at the end of the task when motivation is high and when the interruption will be a real one as far as the subject is concerned. Some subjects completed the task before they could be interrupted because of the fact that a trial containing

TABLE 10

Average learning and retention scores of nonsense syllable learning interrupted at various points

CONDITION	LEARNING		RELEARNING	
	Trials	Errors	Trials	Errors
Interrupted	13.25 ±1.92	67.75 ±11.45	3.90 ±.57	6.85 ±1.53
Uninterrupted	20.50 ±3.28	96.60 ±15.57	4.20 ±.82	7.60 ±2.08

	RECALL	COMBINED LEARNING AND RELEARNING	
	Errors	Trials	Errors
Interrupted	2.80 ±.36	17.15 ±1.79	74.60 ±12.11
Uninterrupted	2.75 ±.41	24.70 ±3.95	104.20 ±17.25

several errors would be followed with one containing no errors. These subjects were then transferred to the control group. The two groups were given the same instructions and they were the same instructions used in the previous experiment on verbal material. The subjects returned after twenty-four hours and recalled the material. They were instructed against rehearsal. This is difficult to control in any type of verbal material but the subjects showed a coöperative spirit. Subjects from both groups reported that they kept the syllables from perseverating only with effort. The recall criterion was three perfect consecutive trials. As in previous experiments, when the subject was either interrupted or had finished the learning he was given a number

counting task to prevent in the case of the experimental condition the interruption from seeming too abrupt.

Results. Table 10 shows the learning and relearning, recall, and combined learning and relearning scores for both interrupted and uninterrupted conditions. The learning was superior as might be expected, under the control or uninterrupted condition. The relearning and recall scores although not significantly different, show slight superiority for the interrupted group. The combined scores show differences which are of considerable magnitude[19] similar to those found in experiment VIII of this paper.

Discussion of experiments VII, VIII and IX

These last three experiments substantiate in general the findings in the two previous studies but are much more positive in implication. They show that an interruption in learning before the completion of the task is effective in producing greater recall of that learning task itself. The nearer this interruption is to the termination of the task the greater its effectiveness. An interruption prior to the completion of a task is more effective than an interruption after a certain degree of completion.

These experiments show that whereas interruption increases retention of the task itself this increase is not as great as the increase in the retention of the names or parts of the interrupted tasks.

The results of these three experiments show that one reason for the great difference between the findings of the previous investigations above and those of Zeigarnik and Schlote is due to the fact that the interruptions in the former investigations were not real interruptions, as brought out in the beginning of this study. This experimental set-up definitely links the problem of interrupted learning and that of distributed practice.

[19] The differences between the experimental and control condition divided by the sigma of the differences are not quite as high as in experiment VIII; they are 1.75 for trials and 1.38 for errors.

SUMMARY

Three studies each consisting of 3 experiments, concerned with the interruption of (*a*) maze performance and (*b*) verbal learning after various degrees of completion of the act, and also the interruption of (*c*) the same materials prior to their complete mastery.

The first study employed 100 subjects and a hard and an easy maze learned under an interrupted and an uninterrupted condition. The former condition consisted of stopping the subject after the first perfect traversal although he had been instructed to run the maze to a criterion of three perfect trials. In the uninterrupted condition the subject also performed to one perfect traversal but this was a completed task because he had been instructed that one perfect traversal was mastery. The two conditions differed only in that to one group the act was a completed one and to the other the act was an uncompleted one. Retention was tested after a week. In another similar experiment employing 44 subjects, retention was tested after twenty-four hours. There were slight inconsistent tendencies in these experiments for the interrupted tasks to show greater retention. These results differ from Zeigarnik's who tested the retention of the *name* of a simpler and more habitual task. The difference can probably be explained in terms of material, objects of experiments and methods used.

In the second study 107 subjects, three different methods of learning, and words and nonsense syllables as materials were used. Retention was tested after twenty-four hours. The same type of interruption set-up as described above was employed. The results showed even slighter tendencies for the interrupted material to show greater retention. There is evidence from both studies showing that the interruption affected subsequent mental activity.

In the third study using the maze, the interruption occurred both immediately prior to completion of the task when the subject had reduced the number of errors to one, and further towards the beginning of the task when the subject's performance involved four errors. In the case of the nonsense syllables the in-

terruption came at the one-error performance level. Eighty subjects were employed. Interruption immediately prior to completion caused greater retention of the task than in the uninterrupted condition both with the maze and with the nonsense syllables. As in previous studies the retention of the maze tends to be increased more by interruption than the retention of verbal material. Results of the interruption at the four-error level are more comparable to the results of the interruption after a degree of completion.

The relationship of this phenomenon to the problems of distributed practice, reminiscence, perseveration, and motivation is discussed.

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