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The Speed of Learning in Relation to the Amount Retained After Different Time Intervals Following Original Learning

George H. Zimny
Loyola University Chicago

THE SPEED OF LEARNING IN RELATION TO THE AMOUNT RETAINED AFTER DIFFERENT TIME INTERVALS FOLLOWING ORIGINAL LEARNING

By

George H. Zimny

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VITA

George H. Zimny was born in Chicago, Illinois, February 6, 1926.

He was graduated from Weber High School, Chicago, Illinois, February, 1944.

The Bachelor of Philosophy degree with a major in Philosophy was conferred by Loyola University, June, 1946.

From 1946 to 1948 the writer did graduate work. During the same time he was employed by Loyola University first as an Assistant in the Department of Psychology and then as a Fellow. At present, he is an Instructor in the Department of Psychology at Loyola University.

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CHAPTER I

INTRODUCTION

The problem upon which the experiment in this thesis bears is the relation between the speed of learning and the amount retained after different time intervals following original learning. It is the old question of whether the fast learner or slow learner retains more of what is learned. This question has been answered many times but the procedure employed was that of having the subjects learn and be tested for retention soon after learning. A procedure such as this did not test adequately the possibility that a fast learner might retain better for a certain interval of time following learning but after that interval might lose his retentive advantage over the slow learner. Thus the general problem of whether the fast or slow learner retains more must be made the specific problem of whether the fast or slow learner retains more at distributed time intervals following learning.

The general problem, besides being interesting psychologically, is practical from an educational point of view. In 1927 Stump said, "One need scarcely remark that it is a matter of great importance for a teacher to be able to determine whether the material which a child

learns is retained in a permanent or in a merely transitory manner."[1] Thus Stump introduces the factor of relatively long time intervals following original learning. Teachers' tests should not merely measure immediate retention but should also measure retention after longer intervals of time following learning. This is necessary from the point of view of fast and slow learners. At present the slow learner is held to be poor in long time retention because of his slowness in learning. The slow learner scores very low on a test for immediate retention and it is assumed that this poor retention continues. But such an assumption should be tested experimentally because it may be true that the slow learner retains more than the fast learner after a longer interval following learning. The later worth of both the fast and slow learner is judged on the basis of immediate retention. This judgement must be proved or disproved experimentally.

This problem bears also upon the assignment of grades for school work. Test grades, despite grave admonitions against the practice of cramming, are, practically speaking, based on immediate retention. Final averages are usually based very much on test grades. These final averages are

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[1] N. F. Stump, "A Classroom Experiment in Logical Learning," Journal of Applied Psychology, 11: 126, 1927.

looked upon as an indication of the worth of the student. In terms of this the slow learner's worth is low. However, if the slow learner retains more than the fast learner after a longer time interval following learning, is not the worth of the slow learner to be raised and that of the fast learner lowered? This important consideration is based upon determining the relation between speed of learning and amount of retention at varying time intervals following original learning.

This problem quickly became recognized as one worthy of experimental investigation and as early as 1903,[2] published reports on it appeared. Since then, experimental investigations have been made but very infrequently. Most of these investigations have used very few and very short time intervals following learning. On the whole this type of investigation finds that the fast learner is the best retainer. Thus the great majority of psychologists who have an interest in this problem hold such a position. Implicit in such a position is that this advantage of the fast learner continues not only for the interval of time used in the experimental investigations but for the entire period of retention. Some psychologists make this point explicit as in the case of McGeoch who says:

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[2] E. N. Henderson, "A Study of Memory for Connected Trains of Thought," Psychological Monographs, 5: No. 23, 1903.

> This high positive relation between individual scores in learning and retention is to be expected, of course, from the fact that learning and retention are continuous processes. Learning involves the retention of the effects of preceeding trials, and the greater the amount retained, the faster the learning. The introduction of a relatively long interval between measurements should not greatly alter this relation.[3]

Thus McGeoch assumes, and obviously with good reason, that the advantage of the fast learner continued. This assumption that the time interval does not change the relationship should, however, be verified experimentally.

That experimental verification is needed is emphatically pointed out by the results of a recent investigation of the problem. H. J. Leavitt[4] in a recent paper found, using intervals of one day, one week, four weeks and ten weeks, that as the time interval between original learning and the test for retention is increased, the correlation between speed of learning and amount of retention changes from a plus to a minus. This means that the fast learner had the advantage in retention soon after learning but as the interval increased the slow learner acquired the advantage. This is in almost direct contradiction to what McGeoch explicitly and other investigators

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[3] J. A. McGeoch, The Psychology of Human Learning (New York; Longmans, Green and Co., 1946), 388-89.

[4] H. J. Leavitt, "Relation of Speed of Learning to the Amount of Retention and Reminiscence," Journal of Experimental Psychology, 35: 134-40, 1945.

implicitly assumed about the retentive advantage of the fast and slow learner. Two facts then indicate that this assumption, or dogma as Leavitt calls it, should be subject to experimental investigation. The first fact is that the assumption was based primarily upon experiments employing a short time interval between learning and retention, and the second fact is the results obtained by Leavitt. In Leavitt's own words:

> But again it may be pointed out that the evidence for one of psychology's most widely accepted dogmas, i.e., that the faster learner is the better retainer, is neither conclusive nor supported on any satisfactory theoretical grounds. The generalization seems at the most to be only partially true. For the immediate present at least, we are satisfied to reopen a question which may have been inopportunely closed.[5]

The first purpose of this thesis is to attempt to determine experimentally whether or not the initial advantage of the fast learner over the slow learner in retention is retained when the size of the time interval between learning and retention is increased. This purpose is in direct response to Leavitt's reopening of the question of the relation between the speed of learning and the amount of retention. In order adequately to fulfill the purpose stated, this experiment will employ

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[5] Ibid., p. 139.

time intervals of the same length as did Leavitt's experiment, namely, one day, one week, four weeks and ten weeks. In this way both the initial advantage and the continuation or cessation of that advantage can be determined.

The second purpose of this thesis utilizes the same experiment as is used in the first but considered from a little different point of view. It is to determine whether or not Leavitt's results will be obtained using the same experimental situation that he did but with a variation of one factor, namely, the type of material. Leavitt employed nonsense syllables in his experiment but the experiment in this thesis will employ meaningful but logically unconnected common four letter nouns. By doing this Leavitt's work can be closely approximated since nonsense syllables and meaningful but logically unconnected material are similar materials both of which are capable of acquiring meaning and hence of being learned and retained. Still they are sufficiently different to make it a necessary experimental step to determine if this factor of prior meaningfulness influences the results obtained.

In line with this second purpose it will be possible, since Leavitt's experimental situation is being substantially repeated, to investigate several factors, such as

method of scoring, which could have influenced his results. Depending on the outcome of such an investigation Leavitt's position on the problem may be strengthened or weakened. If it can be shown, for instance, that certain important factors are relegated to a minor role or that other important factors are disregarded, then perhaps the basis on which Leavitt reopened this question will prove inadequate.

CHAPTER II

The work done on this problem has not been too extensive. Table I[1] contains the greater part of the studies that have been made in the last forty-five years. These studies have been broken down and tabled on the basis of time interval between learning and retention. As many studies contain several intervals it was necessary to separate one set of results for one interval from another set of results for another interval both of which are found in one study. In this way a study containing five different intervals will be entered in five different places on the table. To facilitate recognition of different parts of the same study, every time an entry is made the author's name and year of publication is entered. When an author is entered for the first time he is given a number to the left of his name and all necessary data recorded. If this author is again entered, as usually happens, a new number is not given. However, if the same data such as method of learning are used the reader is merely referred to the previous entry of this data. If different data are used it is entered.

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[1] Based on a similar table by A. L. Gillette, "Learning and Retention- A Comparison of Three Experimental Procedures," Archives of Psychology, 28: No. 198, 1936.

TABLE I

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

	Investigator	N	Material	Learning	Retention	Inter-val	Results and conclusions r	P.E.
1	Brown, W. 1924	264	48 words	Equal opportunity. Words read aloud; phrase using word; list read as whole.	Written recall	8 min.	.86	
	Brown, W. 1924	267	Same as 1	Same as 1	Same as 1	16 min.	.83	
2	Luh, C. W. 1922	20	12 nonsense syllables	Equal amounts. Anticipation method.	Relearning in terms of speed.	20 min.	.50	.17
	Luh, C. W. 1922	20	Same as 2	Same as 2	Same as 2	1 hr.	.21	.21
	Luh, C. W. 1922	20	Same as 2	Same as 2	Relearning in terms of saving.	1 hr.	-.42	.18
	Luh, C. W. 1922	20	Same as 2	Same as 2	Same as 2	4 hrs.	.98	.01
3	Gates, A. I. 1918	299	Nonsense syllables	Equal opportunity. Study 9 minutes by whole method.	Recall using absolute amount.	3or4 hrs.	.74	.04
		299	Bibliography				.82	.03

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

	Gates, A. I. 1918	299 299	Same as 3	Same as 3	Recall using % saved.	3or4 hrs.	.39 .41	.09 .09
	Native retentiveness and other factors being equal those who recall more immediately after study would recall more after an interval.							
4	Leavitt, H. J. 1945	12	15 nonsense syllables	Equal opportunity. Anticipation method.	Relearning in terms of % saved.	1 day	.04	.29
4 A	Leavitt, H. J. 1945	12	Same as 4	Same as 4	Anticipation on first relearning trial. Absolute amount.	1 day	.84	.05
4 B	Leavitt, H. J. 1945	12	Same as 4	Same as 4	Anticipation on first relearning trial. Relative amount.	1 day	.08	.28
	Luh, C. W. 1922	20	Same as 2	Same as 2	Same as 2	1 day	.35	.20
	Luh, C. W. 1922	20	Same as 2	Same as 2	Relearning in terms of % saved.	1 day	-.42	.18

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

5	Pyle, W. H. 1911	4	Nature study passage	Equal amount. Auditory or visual presentation of whole.	Recall	1 day	No correlations The fast learner is at no disadvantage in retention.
6	Thorndike, E. L. 1910	40	5 lists of 12 unconnected words each	Equal opportunity. List read to subject at rate of 1 word per second.	Recall for 60 words.	1 day	raw .55 .10 estimated true .80 .10 The relation between retention of the effects of an experience for one or two minutes and their retention for one or two days seems to be one of the closest yet measured in human nature.
7	Radossawljewitsch 1907	12	8 nonsense syllables	Equal amount. Read by subject.	Relearning	1 day	.46 .04
		12	12 nonsense syllables				.35 .02
		12	16 nonsense syllables				.53 .14
		11	poetry				.88 .05

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

	Radossawljewitsch 1907	12	Same as 7	Same as 7	Same as 7	2 days	.44	.04	
		12					.37	.03	
		12					.65	.11	
		11					.72	.10	
8	Henderson, E. N. 1903	120	Essay material; "King..."	Equal opportunity. Subjects read essays. Written recall of ideas.	Written recall of ideas.	2 days	.96	.00	
		74	Essay material: "Cicero"				.87	.01	
9	Gillette, A. L. 1936	147	word-word	Equal opportunity. Paired associates in lists of 20 presented 3 or 4 times.	Subject shown first word and is to recall second word. Absolute amount.	2 days	.83	.02	
		149	picture-number				.78	.02	
		146	color-letter				.81	.02	
		147	form-word				.77	.02	
		149	face-name				.82	.02	
	Luh, C. W. 1922	20	Same as 2	Same as 2	Same as 2	2 days	.78	.09	The speed of learning and the amount of retention are positively correlated.

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARN ING AND RETENTION

10 Norsworthy, N. 1912	83	German-English vocabulary	Equal opportunity. Subjects studied 20 minutes a day for 5 days. Continued for 3 weeks.	Test on 50 German to English words of 200 studied.	2 days	.41	
11 Peterson, J. 1916		2 lists of 20 words each.	Equal opportunity. Subjects copied words from black-board.	Written recall	2 days		
	12		intent to recall			.68	.10
	12		no intent to recall			.29	.18
	29		intent to recall			.66	.07
	29		no intent to recall			.23	.12
				(No conclusions on the fast-slow learner problem.)			
Brown, W. 1924	150	Same as 1	Same as 1	Same as 1	3 days	.74	

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

Radossawljewitsch	12	Same as 7	Same as 7	Same as 7	3 days	.14	.04
	12					.41	.03
	12					.52	.14
	11					.52	.15
Brown, W. 1924	100	Same as 1	Same as 1	Same as 1	4 days	.70	
Radossawljewitsch	12	Same as 7	Same as 7	Same as 7	4 days	.08	.07
	12					.34	.03
	12					-.23	.09
	11					-.69	.11
Brown, W. 1924	72	Same as 1	Same as 1	Same as 1	5 days	.63	
Radossawljewitsch	12	Same as 7 but no	Same as 7	Same as 7	5 days	.25	.07
	12	poetry.				-.70	.10
	12					-.72	.10
							(No conclusions on the fast-slow learner problem.)

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

	Gillette, A. L. 1936	54	word-word	Equal amount. Paired associates presented alternately with written recall until learned.	Same as 9	5 days	-.02	.09
		54	form-number				.08	.09
		54	color-letter				-.13	.09
	Gillette, A. L. 1936	54	Same as immediately above	Same as immediately above	Same as 9 but used re-learning method	5 days	.36	.08
		54					.15	.09
		54					.21	.09
					We conclude, therefore, that the three methods do not contradict each other and indicate clearly that the fast learner is the better retainer.			
	Brown, W. 1924	143	Same as 1	Same as 1	Same as 1	6 days	.68	
12	Peterson, H. A. 1925	56	250 word geographical selections	Equal opportunity. Studied for 2.5 minutes.	Recall, absolute amount.	1 wk.	.87	.02
	Peterson, H. A. 1925	56	900 word selection on theory of labor unionism	Subject answered questions after determining his own learning time.	Absolute amount. Questions answered.	1 wk.	.94	.01
					... there is a decided tendency for fast and slow learners to retain about the same proportion of what they have learned.			

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

Brown, W. 1924	66	Same as 1	Same as 1	Same as 1	1 wk.	.65	The evidence here indicates, however, that a positive relation is normal.... The relation between amount learned and amount retained gradually falls off with increase in the length of interval.... Although this decrease is not very large it is regular.
Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4	1 wk.	-.10	.27
Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4A	1 wk.	.67	.10
Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4B	1 wk.	.24	.23
13 Winch, W. H. 1924		367 word poem	Equal opportunity, Poem read to subjects and then subjects read it for 10 minutes.	Written recall.	3 wks.		
	26		whole method			.829	
	26		part method			.936	(No conclusions on the fast-slow learner problem.)

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

14	Gordan, K. 1925	40	Athenian Oath	Equal opportunity. Read by experimenter. read 3 times in 1 day	Recall	3 wks.	.52	
		82		read 3 times with one week interval			.71	
	Norsworthy, N. 1912	83	Same as 10	Same as 10	Same as 10 but different words.	4 wks.	.50	The rapid learners retain more than the slow learners.
	Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4	4 wks.	-.84	.05
	Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4A	4 wks.	-.26	.23
	Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4B	4 wks.	-.45	.17
	Henderson, E. N. 1903	120	Same as 8	Same as 8	Same as 8	4 wks.	.88	.01
		74					.75	.02

The positive values of r indicate a constant tendency for those who learn more quickly to retain a greater percentage of what they gave gained.

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

	Gordan, K. 1925		Same as 14	Equal opportunity. Read by experimenter.	Same as 14	4 wks.		
		101		read 6 times in succession in 1 day			.42	
		74		read 3 times; 3 day interval; read 3 times			.70	(No conclusions on the fast-slow learner problem.)
15	Pyle, W. H. 1913	300	"Marble Statue" a prose passage.	Read aloud once by experimenter. Equal opportunity.	Recall	5 wks.	.76	.02
		300					.70	.03 (No conclusions on the fast-slow learner problem)
16	Thorndike, E. L. 1908	22	German-English paired associates with 10 pairs in a list.	Equal opportunity. Each list studied 5 times at the rate of 10 lists per hour within 6 days.	Tested on words at different intervals.	5 wks.	.40	But it is the quick learners who are the good retainers.
	Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4	10 wks.	-.87	.04
	Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4A	10 wks.	-.17	.25

TABLE I (continued)

STUDIES ON SPEED OF LEARNING AS RELATED TO AMOUNT OF RETENTION ARRANGED ACCORDING TO TIME INTERVAL BETWEEN LEARNING AND RETENTION

Leavitt, H. J. 1945	12	Same as 4	Same as 4	Same as 4B	10 wks.	-.40	.25	The rank order correlations between amount learned and amount retained change from positive to negative for both materials as the retention interval increases.

When the last entry of an author is made his conclusions, if any, are quoted.

A general survey of the related literature shows that the great majority of workers interested in this problem hold that the fast learner is the best retainer. Of the sixteen studies listed in Table I, pages 9-19, there are thirteen that, on the basis of correlations or statements, would hold this position. Most investigators state this explicitly. A. I. Gates,[2] finding correlations of .74±.04, .82±.03, .39±.09 and .41±.09 for intervals of three or four hours concludes that, "Native retentiveness and other factors being equal those who recall more immediately after study would recall more after an interval."[3] Using intervals of two days and four weeks E. N. Henderson[4] found correlations of .96±.00, .87±.01, .88±.01 and .75±.02. From these he concludes that, "The positive values of r indicate a constant tendency for those who learn more quickly to retain a greater percentage of what they have gained."[5] A Correlation of .40 for a five week interval

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[2] A. I. Gates, "Correlations of Immediate and Delayed Recall," Journal of Educational Psychology, 9: 489-96, 1918.

[3] Ibid., p. 492.

[4] E. N. Henderson, "A Study of Memory for Connected Trains of Thought," Psychological Monographs, 5: No. 23, 1903.

[5] Ibid., p. 44.

lead E. L. Thorndike[6] to conclude, "But it is the quick learners who are the good retainers."[7]

There are a few workers, however, who hold a different position. As was seen previously Leavitt[8] contends that the fast learner may entirely lose his advantage in retention after a sufficiently long time interval following learning. The work of W. Brown[9] leads him to hold somewhat the same position but in a more modified manner. Using intervals of eight minutes, sixteen minutes, three, four, five, six and seven days Brown found correlations ranging from .86 to .63. These correlations decreased in size as the time interval between learning and retention increased. On the basis of this Brown states that:

> The evidence here indicates, however, that a positive relation is normal....
> The relation between amount learned and amount retained gradually falls off with increase in the length of interval.... Although this decrease is not very large it is regular.[10]

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[6] E. L. Thorndike, "Memory for Paired Associates," Psychological Review, 15: 122-38, 1908.

[7] Ibid., p. 134.

[8] H. J. Leavitt, "Relation of Speed of Learning to the Amount of Retention and Reminiscence," Journal of Experimental Psychology, 35: 134-40, 1945.

[9] W. Brown, "Effects of Interval on Recall," Journal of Experimental Psychology, 7: 469-74, 1924.

[10] Ibid., p. 472.

Thus both Brown and Leavitt agree that the fast learner has the definite advantage in retention soon after learning and that the fast learner loses this definite advantage as time intervals are increased. However, they seem to differ as to the extent of this loss. Leavitt, of course, holds to a complete loss but Brown appears to hold only a partial loss. It must be pointed out that Brown's intervals extend to only one week whereas Leavitt's extend to ten weeks. It may be possible that had Brown extended his intervals his results would have coincided with Leavitt's since Brown does say that the correlation decreases with increase of interval. Radossawljewitsch,[11] using intervals of one, two, three, four and five days, reported negative correlations as high as -.72 for the five day interval. Correlations such as these tend to substantiate the position taken by Leavitt.

As can be seen in Table I, pages 9-19, there are many different sized correlations obtained for the same time interval. For instance, with the one day interval the correlations range from .04 to .88. The explanation for this wide range is found in the fact that size of time interval between learning and retention is but one of a multitude of variables that enter into such learning-retention experiments. The remainder of this chapter

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[11] Cited by M. J. Drake, "The Correlation Between Learning and Retention Capacity." (unpublished Master's thesis, Columbia University, 1926.)

shall be devoted to pointing out and exemplifying the more important variables. It is not within the scope of this thesis to pass final judgement upon the relative merits or shortcomings of the methodological variables, but since they often play such an important part in determining the correlations that are actually obtained their presence should be indicated.

One of the important variables is the method of learning employed in the experiment. The two general methods of learning that can be used are the method of equal opportunity to learn and the method of equal amount learned. In the first the subjects are given, for instance, the same amount of time or number of trials to learn. In the second, all the subjects learn the total amount of material regardless of the amount of time or number of trials that it takes. Gillette[12] holds that the method of equal opportunity favors the fast learner especially if absolute amounts are used in scoring retention. Since the fast learner will learn more in a given time he will retain more. This difficulty can be eliminated to a great extent by scoring retention in terms of percentage of amount learned. The method of equal amount learned favors the slow learner since he will spend more time learning

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[12] A. L. Gillette, op. cit., p. 12.

the material and may learn it better. This appears to be a valid objection to the method. Other disadvantages inherent in this method are pointed out by Norsworthy.[13] Gillette, however, in his experiment using these two methods plus a third states, "We conclude, therefore, that the three methods do not contradict each other...."[14]

Any factor that influences learning in general can have an influence on the correlations obtained between speed of learning and amount of retention. There are a multitude of factors influencing learning and consequently a wide variation in correlations can be expected on the basis of learning alone. Two examples of the influence of learning conditions on correlations can be profitably noted here with the understanding that these are only two of many conditions. Winch[15] had two equated groups learn a poem. One group learned by the whole method and the other group by the part method. He found correlations of .829 and .936 between speed of learning and amount of retention. This is a difference of .107 between the two correlations. Winch ascribes the difference in correlations to the method

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[13] N. Norsworthy, "Acquisition as Related to Retention," Journal of Educational Psychology, 3: 218, 1912.

[14] A. L. Gillette, op. cit., p. 54.

[15] W. H. Winch, "Should Poems be Learnt by School Children as Wholes or in Parts," British Journal of Psychology, 15: 64-79, 1924.

of learning employed. In another experiment Gordan[16] had four groups learn the Athenian Oath. One pair of groups learned by a spaced method and the other learned by the unspaced method. The mean correlation for the first pair was .47 and for the second pair was .705. This is a difference of .235 in the correlations between speed of learning and amount of retention. Gordan explains the difference as being due to the method of learning when he says that "When learning had taken place by the spaced method there was a closer correlation between immediate and delayed recall than in the case of unspaced learning."[17]

Another condition influencing both learning and the correlations between speed of learning and amount of retention is the type of material employed in learning. Almost every experiment reported employs different materials. The same general results are obtained using the different materials as is pointed out by Lyon when he says that, "....with all materials, excepting digits, those who learn the quickest forget the least."[18] However, in the effort

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16 K. Gordan, "Class Results with Spaced and Unspaced Memorizing," Journal of Experimental Psychology, 8: 337-43, 1925.

17 Ibid., p. 343.

18 D. O. Lyon, "The Relation of Quickness of Learning to Retentiveness," Archives of Psychology, 5: No. 34, P 45, 1916.

to point out causes of differences in correlations it must be noted that even though the same general results are obtained the different kinds of material do produce a variation in correlations. Lyon emphasizes this by saying that, "With the same subjects and the same method of experimentation, different materials give different results."[19]

A second general condition affecting correlations is retention. There are a multitude of factors influencing retention and consequently correlations. One of the first of these conditions that should be mentioned is the subjects attitude toward retention. In some experiments the subjects are told that they will be tested again and in other experiments they are not told. Thus some groups of subjects acquire a set to learn to retain. Other subjects do not. This difference in set produces difference in correlations. Even within the same experiment some subjects may intend to remember and others may not. Also, some subjects may rehearse the material and others may not.

The method used to determine retention has a great effect on the correlations obtained. This fact is borne out by Lyon who states that, "The relation of quickness of learning to retentiveness depends upon the method used of

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[19] Ibid., p. 56.

ascertaining this 'retentiveness'."[20] Some of the methods that can be used are anticipation, relearning, reproduction, reconstruction and recognition. The chief difficulty appears to be with the relearning method. It is often used but some authors object to its validity for studying the relationship between speed of learning and amount of retention. Gates states that:

> For this particular purpose, delayed recall should not be measured by relearning since the quicker learners, other things being equal, would excel, on that account, in the relearning test as well as in the original test.[21]

Luh holds that "This analysis confirms our previous contention that the relearning method constitutes a poor measure of retention."[22] Lyon also gives several disadvantages found in the relearning method.[23] That these objections to the relearning method are not to be too seriously considered can be seen by other statements these authors made. "The different methods," states Lyon, "give opposite results, and yet, in one sense of the word, one method is as 'correct' as another."[24] Luh says that, "all the curves

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[20] Loc. cit.

[21] A. I. Gates, op. cit., p. 490.

[22] C. W. Luh, "The Conditions of Retention," Psychological Monographs, 31: No. 142, pp. 80-81, 1922.

[23] D. O. Lyon, op. cit., p. 21.

[24] Ibid., p. 56.

for different methods are relatively uniform and can be described by mathematical formulae."[25] Thus it would appear that although different methods do produce some variation in correlations, the use of any one method is permissible.

A last condition concerning retention is the method of scoring retention. There are two main methods. The first is to use the absolute amount retained and the second is to use the percentage of material retained. The use of one or the other method produces differences in correlation between speed of learning and amount retained. Most probably this is due to the fact that the method employing absolute amounts favors the fast learner.[26]

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[25] C. W. Luh, op. cit., p. 21.

[26] A. L. Gillette, op. cit. p. 12.

CHAPTER III

The experimental phase of this thesis was carried out in the laboratory booths at Loyola University. The booths are not completely soundproof but attempts were made to overcome the difficulty of distraction and it is believed that these attempts were, on the whole, successful.

There was a total of seventy-eight male subjects used in the experiment. However, in equating the groups only a total of fifty-six were used. Correlations were obtained for both the equated and unequated groups. The subjects were college students attending Loyola University. They were all taken from various elementary psychology classes. Those subjects that were actually used in the experiment were chosen on the basis of availability for experimentation. The age range was 17-28 years with a mean of approximately 20.5 years.

The material employed was a list of fifteen common logically unconnected four letter nouns. They were typed on plain white paper in capitals. The words in order of presentation were seat, barn, fish, sign, fork, bond, moss, star, wire, blue, pole, cell, fern, snow, hand and gold. Since the words are meaningful some association value will be present for different subjects, but a serious attempt was made during the construction of the fifteen word list of nouns

to avoid this by careful and repeated analysis of the words. The success of this attempt was shown to some extent by several subjects who spontaneously remarked that it was hard to learn the list because of the difficulty in connecting the words. A dotting test was given to the subjects during each thirty second rest period on the memory drum. This was considered necessary in order to avoid any possibility of rehearsal of the words during the rest period.

Data sheets having the words and spaces for checking answers were used in order to facilitate the recording and analysing of data. A sample of the data sheet used can be found in the Appendix I.

The words were presented on a memory drum at the rate of one word every two seconds. Three memory drums were used.

In order to effectively handle a large number of subjects in one day it was necessary to have three experimenters. Each experimenter was situated in a separate booth and used one memory drum. Each experimenter was provided with a detailed list of instructions. This list can be found in the Appendix II. The instructions were studied and the procedure practiced before the experimenter began to work. Subjects were assigned to an experimenter arbitrarily. The task of retesting the subjects was assigned to the same experimenter in the same booth with the same

memory drum as in learning. There were only eight or nine exceptions to this rule. In these exceptions it was generally the experimenter that was varied.

The procedure consists actually of two parts although the second part is similar in many respects to the first. The first is the learning phase of the experiment and the second is the retention phase.

In the learning phase the subjects were told to report to a classroom at an appointed time. At this time a subject was taken to a booth and seated. The experimenter wrote the subject's name on his data sheet. The experimenter then read the following instructions:

> This is an experiment in learning a list of words. Shortly after this apparatus starts you will see a four letter noun in the window. You are to pronounce this noun and those that follow it as you see them. After you have seen the list once you are to try to anticipate each noun, except the first one which is merely a cue noun; in other words, as you see one noun you are to pronounce the noun that will follow it before this noun appears. If you anticipate a noun incorrectly, correct yourself as soon as the noun itself appears. Speak the nouns as distinctly as possible. A short rest will be given between lists. During this rest you are to encircle every other dot on this page. (Show them how to do it.) When I say to "stop circling" turn the paper over and look at the window. Start pronouncing and anticipating the nouns as soon as they appear in the window. Any questions?

The dotting test was demonstrated and the subject laid it aside after writing his name on it. A ready signal was given and the memory drum started. The experimenter

recorded the correct and incorrect responses of the subject by means of plus and minus signs in the proper space opposite the words on the data sheet. As the last word disappeared on the memory drum it was stopped. The subject was told his score on that trial. Then followed a thirty second rest period. This rest period was timed with a stop-watch. During this thirty second rest period the subject worked on the dotting test. About five seconds before the end of the rest period the subject was told to put the dotting test aside and to direct his attention to the window of the memory drum. The ready signal was given and the above procedure followed. This was done for ten trials. After the tenth trial the subject was told that that was all and the following instructions were read to him:

> You will probably be needed again. Your teacher will notify you as before. If you are notified please respond promptly at the time appointed.

In the interim between the test for learning and the test for retention the learning data was scored, and on a new data sheet the highest score obtained by each subject was noted in the upper right hand corner along with his name, time of testing, experimenter and booth.

In the retention phase of the experiment essentially the same procedure was followed as in the learning. The same subjects were used as previously but the time interval

between learning and test for retention varied with each group. The group having a one day interval between learning and retention contained twenty-three subjects. The group having a one week interval contained nineteen subjects. The groups having a four week and a ten week interval had fourteen and twenty-two subjects respectively. The size of groups stated above refers to the number of subjects that actually returned for retesting. The original learning groups were somewhat larger in all four cases but some of the subjects in each group did not return for retesting for various reasons such as forgetting or being absent from school that day. The subjects received notice of the time they were to appear again, and at the appearance of a subject he was put in the same experimental situation as before except in the case of the eight or nine subjects previously noted. An attempt was made to have the subjects reappear at approximately the same time of day at which they were tested for learning. In general this condition prevailed but there were variations of two to six hours in many cases. All the subjects reappeared on the correct day. When the subject was in the proper booth the following instructions were read to him:

> You will follow the same procedure as you did last time. This is the same list of words. Remember you are to try to anticipate each noun before it appears. It is not necessary to anticipate the first noun. Speak the nouns out

> loud as previously and correct yourself if you make a mistake. Begin anticipation the first time the list is presented. During the rest periods you are again to circle every other dot on this paper. Remember, begin anticipation the first time the list is presented. Any questions?

A dotting test was provided him. Then followed exactly the same procedure as was used in learning. However, instead of being given ten trials the subject was given two trials beyond the trial in which he relearned to his previous score noted on his data sheet. The chief concern in the retention phase was the actual point at which the subject relearned to his previous score, but it was deemed advisable to add two more trials in case they might be needed later. As it turned out they were not needed. After the subject had completed the proper number of trials he was read the following instructions and then dismissed:

> That completes your part in the experiment. In order to keep the conditions of the experiment the same would you please avoid telling the others who have not yet been retested what happens when they are called back? This is necessary if the experiment is to be carried out successfully. If someone finds out you were recalled and asks what you did, it will be sufficient to tell them that you did some more work on the memory drum. Remember, though, to avoid telling them what kind of work you did.

In order to get a complete picture of the data obtained several different scoring procedures were used for both learning and retention. The necessity of this was

clearly shown when the actual correlations were worked out. Using the same data different methods of scoring produced different sets of correlations. Thus an incorrect view of the data might be obtained if only one scoring combination is used. In this experiment six different scoring combinations are used as will be pointed out in Chapter IV.

Learning was scored in two ways. The first was to consider the number of words correctly anticipated on the tenth trial as the score for learning. This is designated as "score on 10." However, this method, the only one used by Leavitt[1] to score learning, seemed inadequate because it often happened that the subject got his highest score not on the tenth trial but on a previous trial. Thus it would be incorrect to represent a subject's speed of learning by his score on the tenth trial if he had obtained a higher score on a previous trial. To avoid this difficulty a second scoring category was used, namely, the highest score regardless of the trial on which it was obtained. However, the subject was still considered as having had ten learning trials which he actually did. This is designated as "highest score." A third possible method of scoring

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[1] Leavitt, H. J. and Schlosberg, H., "The Retention of Verbal and Motor Skills," Journal of Experimental Psychology, 34: p. 406.

learning would be to average the scores on the last two or three trials.[2] In this thesis the first two scoring methods described are employed.

Retention was scored by three methods. The first of these was the percentage of trials saved to relearn to the score obtained during the learning period. Thus if a subject took three trials to relearn to his previous score then he saved 70 per cent since in the learning period it took him ten trials to gain that score. This is designated as "% of 10." There are two such relearning scores since there are two learning scores, namely, "highest score" and "score on 10." The second method of scoring was to consider the absolute score on the first relearning trial as the score for amount of retention. This was expressed as the actual number of words correctly anticipated. It is designated as "score on 1." This absolute score is considered in relation to the two learning scores. The third method of scoring retention is in terms of the relative score on the first relearning trial. This score is considered in relation to the score for learning and is expressed as a percentage. Thus if the score for learning is eight and the score on the first relearning trial is two then the score for retention is 25 per cent. This is

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[2] Based on personal correspondence with H. J. Leavitt; letter dated Sept. 13, 1948.

designated as "% on 1." There are two such retention scores since there are two learning scores.

CHAPTER IV

ANALYSIS OF RESULTS

In order to compare the correlations obtained for the four different groups used in the experiment it was necessary to equate the groups on the basis of learning scores. There was a different number of subjects in each of the four groups. The one day group had twenty-three subjects, the one week group nineteen. In the four week group there were fourteen subjects and in the ten week group twenty-two subjects. Thus it was necessary to limit the number of each equated group to fourteen since this was the size of the smallest group. This four week group was used as a basis for determining the members of the other three groups. The other three groups were matched with the four week group as closely as possible. At times ties occurred. For example, in the four week group there were only two subjects having a learning score of five words. In the one day group there were four subjects having a score of five words. Only two of these four subjects could be used. A chance method of selection was used. The four names were written on four separate sheets of paper and these were placed in a bowl and shaken. Then two of the four names were picked out. This same procedure was followed in all cases of ties.

In equating the groups a definite effort was made to

avoid the use of low learning scores, especially scores of one and two. This was unavoidable in only two of the 112 scores used. The reason for avoiding the low learning scores is that when the relearning method is used the retention score is most probably due more to chance than to retentive ability. Thus if a subject gets a learning score of one he can usually quickly acquire one word when he is retested. This will result in a saving of possibly 80 per cent or 90 per cent. Such a subject will be low in learning and high in retention, thus promoting lower or negative correlations. That this actually occurs is shown in the case of the rank difference correlation obtained for the ten week unequated group using the scoring combination score on 10, % of 10. The sum of the deviations squared was 3,044. N equaled twenty-two. Of these twenty-two scores 4 were scores of one. These four scores accounted for 1,135 in the sum of the deviations squared. This means that 18 per cent of the total N accounted for 37 per cent of the sum of the deviations squared. Since these low scores are poor measure of learning-retention capacity their use was excluded except in two cases.

As was seen above, low learning scores tend to lower correlations. Also, these low learning scores are unreliable when the relearning method is used to determine retention. These two facts may be a partial explanation of the low and

negative correlations obtained by Leavitt.[1] He states that his range of learning scores is one to twelve. Since he uses low learning scores low or negative correlations can be expected. His correlations for the four week and ten week intervals using the relearning method are the lowest of all his correlations. This is in accordance with what was stated previously, namely, that low learning scores especially when combined with the relearning method produce low or negative correlations. It appears logical to state that Leavitt's low and negative correlations obtained using the relearning method are at least partially a function of the low learning scores.

In each section of four equated groups N=14. From Table II it can be seen that the groups are adequately equated. In the "score on 10" section the M's differ by no more than .20 words and the S.D.'s differ by no more than .23. The "highest score" section has differences of only .30 words in the M's and .28 in the S.D.'s. The ranges of the groups are adequate especially in the "highest score" section.

In determining the relation between speed of learning and amount of retention rank order correlations were used.

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[1] H. J. Leavitt, "Relation of Speed of Learning to the Amount of Retention and Reminiscence," Journal of Experimental Psychology, 35: 134-40, 1945.

The reliability of the correlations was determined by using the T scale because of the small N,[2] and a comparison of correlations significant at .05 and .01 levels of confidence was made.

Since there are two ways of scoring learning and three ways of scoring retention it was possible to obtain six different scoring combinations and consequently six different sets of correlations. As has been previously noted,[3] this was deemed necessary in order to answer the question of the relation between speed of learning and amount of retention from as many points of view as possible. The more ways that are used to check the data the more adequate will be the answer given. The six scoring combinations used are: 1) Score on 10, % of 10; 2) Highest score, % of 10; 3) Score on 10, Score on 1; 4) Highest score, Score on 1; 5) Score on 10, % on 1; 6) Highest score, % on 1. The correlations obtained from these six combinations are shown in Table III along with the .05 and .01 levels of confidence.

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[2] H. E. Garrett, Statistics in Psychology and Education, (New York: Longmans, Green and Co., 1947), 297-302.

[3] p. 29.

TABLE II

MEANS, STANDARD DEVIATIONS AND RANGES OF TWO SETS OF FOUR EQUATED GROUPS OF LEARNING SCORES WITH NUMBER OF FOURTEEN

	Score on 10				Highest Score			
	One day	One week	Four weeks	Ten weeks	One day	One week	Four weeks	Ten weeks
M	6.00	6.07	6.20	6.00	6.93	6.70	6.70	7.00
S.D.	2.23	2.34	2.28	2.10	2.05	2.24	2.28	2.00
Range	2-11	2-10	4-13	3-11	4-11	4-11	4-13	4-11

TABLE III

SIX SETS OF CORRELATIONS BETWEEN SPEED OF LEARNING AND AMOUNT OF RETENTION FOR EQUATED GROUPS HAVING NUMBER OF FOURTEEN AT THE .05 AND .01 LEVELS OF CONFIDENCE

	One day			One week			Four weeks			Ten weeks		
	r	.05	.01	r	.05	.01	r	.05	.01	r	.05	.01
Score on 10 % on10	.049	.532	.661	-.161	.532	.661	-.349	.532	.661	-.460	.532	.661
Highest score % of 10	.403	.532	.661	-.285	.532	.661	-.018	.532	.661	-.303	.532	.661
Score on 10 Score on 1	.736	.532	.661	.480	.532	.661	.670	.532	.661	*		
Hightest score Score on 1	.647	.532	.661	.339	.532	.661	.704	.532	.661	*		
Score on 10 % on 1	.382	.532	.661	.213	.532	.661	.524	.532	.661	*		
Highest score % on 1	.391	.532	.661	-.029	.532	.661	.561	.532	.661	*		

*Using the rank difference method no correlations were obtainable because there were too many retention scores of zero.

In the first combination, "Score on 10, % of 10," the score on the last learning trial was correlated with the per cent of trials saved to relearn to the learning score. The correlations obtained were .049 for the one day group, -.161 for the one week group, -.349 for the four weeks group and -.460 for the ten weeks group. The correlations should be .532 to be significant at the .05 level and .661 to be significant at the .01 level. Thus none of the correlations are significant at the .05 level. However, a very definite trend in the correlations can be noted. The longer the time interval between learning and retention the more negative the correlations become. This means, then, that there is a tendency for the slow learner to retain more than the fast learner as the intervals are increased. This is in agreement with Leavitt's results and contrary to the opinion of the majority of psychologists. The absence, however, of a positive correlation for the smaller intervals is unusual in terms of what Leavitt and the great majority of workers found. There are, however, positive correlations when the second scoring combination is used.

In the second combination, "Highest score, % of 10," the highest score obtained on any one learning trial was correlated with the per cent of trials saved to relearn to the learning score. The correlations obtained were .403 for

the one day group, -.285 for the one week group, -.018 for the four weeks group and -.303 for the ten weeks group. None of these correlations are significant at the .05 level. Nevertheless, the presence of negative correlations for the longer time intervals bears out the correlations obtained by the previous scoring combination. This may be expected, though, since there were many scores used in the second combination that were also used in the first combination. However, a definite change is noted in the one day group. A rather high positive correlation is obtained. Thus this method of scoring indicates that the fast learner has the advantage in retention for short intervals following learning but the slow learner has the advantage as the time intervals are lengthened.

In general, the results obtained from the two methods of scoring used above agree with Leavitt's results, that is, a change from positive to negative correlation with increase of the time interval between learning and retention. It should be borne in mind, however, that the basic method used to obtain the above two sets of results was the relearning method. This is one of the methods employed by Leavitt. Other investigators condemn the use of this relearning method for studies of this type.[4] Hence, it may be that the

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[4] p. 23 and 24.

particular results obtained are a function of the relearning method and are not due to an actual change in retentive advantage from the fast to the slow learner. This can be easily decided by turning to the results obtained by the use of other methods of testing retention. If these methods produce essentially the same results then it can be concluded that the particular results obtained are not solely a function of the relearning method.

In the third combination, "Score on 10, Score on 1," the score on the last learning trial was correlated with the score on the first relearning trial. The correlations obtained were .736 for the one day group, .480 for the one week group and .670 for the four weeks group. It was impossible to obtain a correlation for the ten weeks group because there were so many subjects who got a score of zero. Except for the .48, which is very close, the correlations are significant at the .05 and the .01 level. They are all high positive correlations. This indicates that at least for this four week period, and probably longer, the fast learner keeps a definite advantage in retention. These results contradict the results obtained by the relearning method. The advantage appears to be in favor of this present method since its results are statistically reliable whereas this is not true of any of the results obtained by the

relearning method. This advantage is borne out by the fourth scoring combination.

In the fourth combination, "Highest score, Score on 1," the highest score obtained on any one learning trial was correlated with the score on the first relearning trial. The correlations obtained were .647 for the one day group, .339 for the one week group and .704 for the four weeks group. These results substantiate those obtained above. They provide a further basis for doubting the adequacy of the relearning method. Further basis for doubting can be had from the correlations obtained by the last two scoring combinations.

In the fifth combination, "Score on 10, % of 1," the score on the last learning trial was correlated with the ratio, expressed as a per cent, between the score on the first relearning trial and the score on the last learning trial. The correlations obtained were .382 for the one day group, .213 for the one week group and .524 for the four weeks group. Only the four weeks group has a correlation significant at the .05 level although not at the .01 level. However, all correlations are positive. Again this contradicts the results obtained by the relearning method. It is interesting to note that the statistically significant correlation is found in the four weeks group. This emphatically indicates that the fast learner does not lose

his retentive advantage merely because the time interval between learning and retention is increased.

In the sixth scoring combination, "Highest score, % of 1," the highest score obtained on any one learning trial was correlated with the ratio, expressed as a per cent, between the score on the first relearning trial and the highest score obtained on any one learning trial. The correlations obtained were .391 for the one day group, -.029 for the one week group and .561 for the four weeks group. These results, on the whole, are contrary to those obtained by the relearning method. Again, the correlation significant at the .05 level is for the four weeks group. This bears out the results of the previous three scoring combinations.

From the above six scoring combinations we have contradictory results. Using the relearning method it is indicated that the fast learner loses his advantage in retention as the time interval between learning and retention is increased. Using the score on the first relearning trial it is indicated that the fast learner does not so lose his advantage. Leavitt's results using the relearning method agree with the results of the relearning method obtained here. His results using the second method disagree with those found here. What, then, is the answer to the problem

of the relation between the speed of learning and the amount of retention?

The answer to this question depends primarily upon a more critical evaluation of the statistical data obtained. The question is answered by most investigators on the basis of correlations. If the answer is to be reliable, then the correlations upon which the answer is based must be reliable. Taking the .05 level of confidence as an adequate indication of the significance or reliability of correlations, only those correlations which satisfy this criterion should be used in answering the question. In Leavitt's paper only two of the seven negative correlations satisfy the criterion. However, these two negative correlations were obtained using the relearning method. As was noted earlier, Leavitt used scores with a range of one to twelve. Scores of one and two are very unsatisfactory when the relearning method is employed since the subject can easily relearn to these scores without any retention being present. This tends, as was shown, to promote low or negative correlations. Leavitt used such scores. Hence they probably decrease the reliability of his correlations. On the basis of the two above points Leavitt's answer to the question of the relation between speed of learning and amount of retention might be seriously questioned.

In this paper none of the negative correlations obtained satisfy the criterion. Hence, to state that the fast learner loses his retentive advantage would be incorrect. However, six of the positive correlations satisfy the criterion. Of the six, two are found for the one day group and four for the four weeks group. Thus on the basis of the criterion set, it may be concluded that at least for a four weeks period, using meaningful but logically unconnected material, the fast learner retains his retentive advantage over the slow learner. However, it must also be stated that with the relearning method there is a decided tendency for the fast learner to lose his retentive advantage as the interval between learning and retention is increased.

CHAPTER V

SUMMARY AND CONCLUSIONS

The general opinion of psychologists was that the fast learner retained his retentive advantage over the slow learner regardless of the time interval between test for learning and test for retention. Leavitt in 1945 challenged this opinion and stated that the fast learner lost his retentive advantage as the time interval between test for learning and test for retention was increased.

The purpose of this paper was to discover the relation between the speed of learning and the amount of retention with different time intervals between learning and retention. Its second purpose was to discover if the correlational basis upon which Leavitt based his statement was completely valid.

The experimental phase of this paper closely approximated that used by Leavitt.[1] The only change was the substitution of meaningful but logically unconnected material for the nonsense syllables used by Leavitt. On the basis of the experimental evidence obtained three main conclusions were reached.

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[1] H. J. Leavitt and H. Schlosberg, "The Retention of Verbal and Motor Skills," Journal of Experimental Psychology, 34: p. 406, 1944.

1. There is a positive relation between the speed of learning and the amount of retention. This positive relation lasts for at least four weeks but probably longer. The learning and retention deals with meaningful but logically unconnected material. Thus the fast learner retains his retentive advantage over the slow learner at least for a four weeks period.

2. Using the relearning method to test retention, there is a strong indication that the fast learner loses his retentive advantage over the slow learner as the time interval between learning and retention is increased. This change of the correlation between speed of learning and amount of retention from positive to negative appears to be only a function of the relearning method.

3. The basis upon which Leavitt claims that the fast learner loses his retentive advantage may be questioned. A statistical analysis of his correlations indicates that only two of his negative correlations are reliable at the .05 level of confidence. An analysis of his method of obtaining these two correlations indicates that even their reliability may be questioned. Since the basis upon which Leavitt made his claim may be questioned so may his claim be questioned.

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APPENDIX

APPENDIX I

SAMPLE OF DATA SHEET USED IN RECORDING LEARNING AND RELEARNING DATA

SUBJECT _____

DATE _____

SCORE _____

NO. OF WORD	WORD IN ORDER OF PRESEN-TATION	TRIAL NUMBER									
		1	2	3	4	5	6	7	8	9	10
CUE	SEAT										
1	BARN										
2	FISH										
3	SIGN										
4	FORK										
5	BOND										
6	MOSS										
7	STAR										
8	WIRE										
9	BLUE										
10	POLE										
11	CELL										
12	FERN										
13	SNOW										
14	HAND										
15	GOLD										

APPENDIX II

INSTRUCTIONS FOR EXPERIMENTERS

1) Have stopwatch going and convenient.
2) Put your name, booth, date and hour on the data sheet.
3) Record the S' name on the data sheet.
4) Read the instructions to the S. Try to make him understand but do not spend too much time on this as he will understand after two or three trials.
5) Lay the instructions aside face down.
6) Demonstrate the circling of dots - do five or six.
7) Have the S write his name on the circling test.
8) Put the circling test face down on the table to the right of the S.
9) Be sure a pencil is provided for S to use.
10) Tell S "Ready" and make sure he is looking at the window.
11) Start the memory drum.
12) Go thru the list noting the plus's and minus's.
13) Stop the drum just as "Gold" starts to disappear.
14) Start the stopwatch.
15) Tell the S his score (number correctly anticipated) for the trial just completed.
16) Tell S to turn over circling test and to begin circling every other dot.
17) After twenty-five seconds stop the stopwatch and click it back to starting point.

18) Tell S to stop circling, turn paper over and look at the window.

19) Tell S "Ready" and start the memory drum.

20) Complete the ten trials (S doesn't do circling after trial ten).

21) Tell S he is done and read "After" instructions to him.

APPROVAL SHEET

The thesis submitted by George H. Zimny has been read and approved by three members of the Department of Psychology.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Arts.

Jan. 25, 1949
Date

Vincent V. Herr S.J.
Signature of Adviser