



A STUDY IN THE RECALL OF PERCEIVED RELATIONS

by

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I. Introduction

The problem and method of this investigation were suggested by a monograph entitled Recall as a Function of Perceived Relations by Cora B. Key*. In this monograph Dr. Key reports a quantitative study of the learning and retention of material, principally, of the type of the paired-word associate. Assuming that recall is a function of perceived relations, she selected and presented the material in such a way as to secure statistical measures of the extent to which it operates in such antitheses as: (1) the commonplace versus the unique relation, (2) the relation subjectively estimated as "close" or "loose", and (3) the relation perceived under free and under controlled conditions. The results indicate that learning and retention are greater for that material which has commonplace, close, and freely selected relations. Dr. Key concludes that her assumption is justified as being a necessary if not a sufficient factor in the interpretation of the results, and that that relation is most easily learned and recalled which is most easily perceived.

*Key, Cora B., Recall as a Function of Perceived Relations, Archives of Psychology, No. 83, May, 1926.

As a part of her investigation Dr. Key considered the possibility of constructing a graded series of paired-word associates. Inspection of these pairs which were more easily learned and recalled during the course of experimentation indicated the presence of four factors: (1) clarity of relationship, (2) identity of the meaning of the terms, (3) interdependence of the meaning of the terms, and (4) lack of interfering terms. In order to secure word-pairs which would exhibit these factors in graded amount the following scheme was adopted: (1) Part of the material was taken from the dictionary. The basis of selection was the fact that, in a large dictionary, the essential meaning of a word is given best in the first definition and less well in succeeding definitions. Accordingly, (a) ten pairs were selected in which the definition of each of the two words appeared in the first definition of the other, e. g., nostril--nose; (b) five pairs in which one of the two words appeared in the first definition of the other but not vice versa, e. g., skate--iceot; (c) five pairs in which the second of the two words appeared in the second or a later definition of the first, e. g., face--watch. (2) The remainder of the material was selected on the subjective judgment of what is

well and poorly constructed. (d) The experimenter selected five pairs that seemed to be well constructed. (e) Five other pairs were judged to be poorly constructed by a number of persons.

This list of thirty paired-word associates were presented to two groups totaling 112 subjects. The procedure adopted was used, in the main, throughout the investigation. Each pair in the list was exposed separately on a card for five seconds. After the list had been presented once in this manner, the subjects were shown the first word in each pair and asked to write the second. A delayed recall was taken unexpectedly one week later.

The results show that the graded list worked fairly well. The relative amounts of the different grades learned and retained are in about the same order as that anticipated in the preparation of the list. The superiority of the better pairs is slight but constant. However, it was observed that the subjective judgment of the experimenter was not as sure a basis for selection of well constructed pairs as the more objective factors used with the dictionary.

With this background we may raise the question which the present study was designed to answer. On the assumption that recall is a function of the perceived or apprehended relation, is it possible to submit the dependence of recall

upon the nature of this relation to further experimental analysis? More particularly, if the clarity of the relationship is controlled as far as possible, what is the effect on learning and retention of systematically varying the nature of the interdependence of the meaning of the terms?

It was felt that the nature of the relationship could be more readily controlled if it were possible to give it a logical as well as a psychological interpretation. Accordingly, five categories were selected which, by inspection and preliminary experimentation, gave fairly unambiguous relations. They have been designated as follows:

- I. Synonyms (Syn.).
- II. Antonyms (Ant.).
- III. Object--Attribute (O.-A.).
- IV. Whole--Part (W.-P.).
- V. Cause--Effect (C.-E.).

So far as the writer can determine, no one has attacked such a problem in a similar manner. However, it is possible to glean some relevant experimental data concerning these categories from the literature, especially, of the free and controlled association experiments.

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Woodrow and Lowell* secured the responses of 1000 school children to the same stimulus words used by Kent and Rosanoff with adults. The free associations obtained in both studies were classified into various categories. It was then possible to compare children with adults with respect to association types. The data for the five categories in which we are interested is presented in Table 1 (p. 7). It can be seen that adults respond more frequently with antonyms and the cause--effect relation than children. Children, on the other hand, respond more frequently than adults with the object--attribute and whole--part association. The response to synonyms is about the same for both children and adults. Any attempt to compare the various categories for either children or adults separately must proceed with more caution. In extreme cases, however, the differences are probably significant. Thus, children respond with over 4 times as many synonyms as antonyms. The authors offer no explanation of their findings.

Wreschner# measured the reaction time of adults to various categories in controlled association. Some of the data is reproduced in Table 2 (p. 7). It can be

*Woodrow, H. and Lowell, F. Children's association frequency tables. Psychol. Rev., Monograph Suppl., 22, 1916, No. 5.

#Wreschner, Arthur. Die Reproduktion und Assoziation von Vorstellungen. Zsch. f. Psychol., 3, 1909, 495-512.

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seen that an antonym is produced more quickly, on the average, than an "effect". Wreschner points out that a word has only one or a few antonyms while a "cause" may have many possible "effects". He supposes that the reaction time is shorter where the possibilities of selection are fewest.

Table 1

Comparison of Children and Adults in the Percentage of
Free Associative Responses of the Type Indicated
(Woodrow and Lowell)

Category	Children	Adults
Similarity (Syn.)	8.6	8.9
Contrast (Ant.)	1.3	10.6
Noun--Adjective (O.-A.)	7.8	4.3
Whole--Part	3.6	2.1
Cause--Effect	1.9	2.5

Table 2

Reaction Time to Various Categories in
Controlled Association
(Wreschner)

Category	Reaction Time (Visual stimulus)
Similarity (Syn.)	1.804 sec.
Opposites (Ant.)	1.716 "
Subject--Adjective (O.-A.)	1.940 "
Whole--Part	1.953 "
Cause--Effect	2.359 "

II. Major Experiment.

Problem

As pointed out in the introduction, there is some experimental evidence for the contention that when paired-word associates are graded into what might be called a quantitative series within a single category--the degree of identity in the meaning of the terms--the averages are fairly constant and correlated with the position of the different grades in the series. This suggests the possibility of securing fairly uniform sets of word-pairs which differed mainly in the logical character of the relationship involved. If, under constant conditions, these sets varied uniformly in the ease with which they could be learned or recalled, some evidence might be secured, not only for the existence of a relational factor, but also, for the manner in which it operates.

Hence, the first problem requiring solution was the standardization of a set of associates for each category mentioned in the introduction. With this problem solved, at least tentatively, it was possible to secure some measures of central tendency.

Material

The standardization of meaningful words is a difficult process. It is not only difficult to control the words in any recognized aspect but there is also the probability that some effective factors may be overlooked entirely. Furthermore, when the attempt is made to control a set of associates in all aspects except the one which is to be systematically varied, the difficulties increase enormously. Those who believe that the work with nonsense syllables adequately expresses the nature of all learning question the possibility of using meaningful material scientifically*. But to one who does not share this belief the attempt seems worth the effort.

In constructing sets of word-pairs to express opposition or causality one of the most obvious differences is in the familiarity of the terms used. The antonyms tend to be very common while the expression of "cause--effect" requires less familiar words. In order to balance this tendency we wished to control the "familiarity value" of the words used in constructing the associates for each type of relation.

The best means available for this purpose seemed to be Thorndike's Word Book†. This book contains a reading

*Carr, H. A., The laws of association, Psychol. Rev., Vol. 38, No. 3, May, 1931, 212-228.

†Thorndike, E. L., The Teacher's Word Book, 1921.

vocabulary of 10,000 words. Following each word is a credit-number which measures its "range" and "frequency". Range answers the question, "How widely is the word used?" Frequency answers the question, "How often is the word used?" The larger the credit-number the higher the word stands with respect to these two values. Table 3 (p. /4) gives a summary of the scheme used. An account of the reliability of the credits will be found in an article entitled Word Knowledge in the Elementary School, by E. L. Thorndike, published in the Teachers College Record for September, 1921.

Besides controlling the commonness of the words we wished to avoid mere clang associations and those secondary cues which were independent of the meaning of the words. We hoped, also, to eliminate emotional factors as far as possible. Accordingly, the following rules were adopted.

Rules for Constructing Pairs

1. All words must occur in Thorndike's list of 10,000 common words or be derived from the words in this list according to Thorndike's rules.
2. No word shall be used which occurs in Thorndike's list of the 500 most common words.
3. The two words of each pair must:

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- (a) begin with different letters,
 - (b) have different derivations,
 - (c) have dissimilar formation,
 - (d) avoid the possibility of easy phrase
compounding.

4. No word shall be used which is likely to produce an emotional inhibition in recall.

The twenty pairs actually chosen for each category are listed in Table 4 (p. 15). The number before each word is the credit-number from Thorndike's Word Book. The figures in the first column on the right (Fam. Value) are the arithmetic means of the credit-numbers attached to the words of each pair. It should be noted that this "familiarity value" does not express the frequency with which the two words of a pair appear together, but is simply a convenient single measure of the commonness of the paired words. It is undoubtedly more representative for those pairs in which the credit-numbers are nearly equal and decreases in representativeness as the difference between these numbers increases.

Each word-pair which appears in Table 4 was subjected to a further standardizing process with respect to what may be called its "classification value". Each pair was presented to a number of subjects who were asked to write

a sentence expressing the meaningful connection between the two words. This seemed to be the best method available for determining at once the clarity of the relationship and the extent to which each pair gave the relation intended.

These classification values are recorded in the last column on the right of Table 4 (Class. Value). They express, in the form of a per cent, the ratio of favorable responses to the total number of responses. An average of about 54 responses were secured for each pair; the number ranging from 44 to 62. In scoring the data no response was considered favorable unless a judgment of reasonable certainty was possible concerning the nature of the relation perceived by the subject. All scoring was done by the experimenter.

The subjects used in classifying the material were members either of the lecture or laboratory sections of the beginning course in psychology. The pairs were always presented in lists similar to those of Table 7 (p.27). Unfortunately, the procedure used had to be somewhat irregular. This irregularity is not so much between the different pairs as between the cases compiled for each pair. Approximately three-fifths of the subjects worked during the class period and had about one minute for noting the relation between the two words

of a pair. The remainder of the subjects worked outside of the class period and spent an undetermined amount of time on each pair. The results obtained under the two conditions are so similar, however, that the discrepancy in method is probably not serious. Although not as reliable as could be desired, the measures are presented as the best obtainable under the circumstances.

As previously stated, the results of the several standardizing processes are recorded in Table 4. In Table 5 (p.20) the word-pairs are arranged in order of merit with respect to both their familiarity and classification values. Since an even number of pairs was selected for each category the median pair can be determined only arbitrarily. The blue lines divide the range into equal percentiles. The red lines mark the limits of the range common to each category in one particular value. By noting the number of pairs above, within, and below the common range, the relative variability and distribution of the measures can be estimated. Table 6 (p.25) summarizes the averages of the two values for each category.

Table 3
Key to Familiarity Values*

Credit Number	Position of Word
49 or over	1 to 1000
29 to 48	1001 to 2000
19 to 28	2001 to 3000
14 to 18	3001 to 4000
10 to 13	4001 to 5144
9	5145 to 5544
8	5545 to 6047
7	6048 to 6618
6	6619 to 7262
5	7263 to 8145
4	8146 to 9190
3	9191 to 10000

*From The Teacher's Word Book, by E.L. Thorndike, p. vi.

Table 4

Familiarity and Classification Values

I. Synonyms

No.	First Member Credit No.	Second Member Credit No.	Famil. Value	Class. Value
1	3. accurate	48. exact	25.5	94.7
2	31. avoid	19. shun	25.0	91.4
3	11. bashful	14. shy	12.5	88.5
4	55. brave	11. fearless	33.0	95.8
5	35. calm	62. quiet	48.5	90.3
6	47. climb	24. ascend	35.5	90.7
7	29. cure	25. heal	27.0	89.2
8	34. dangerous	16.* risky	25.0*	93.8
9	36. distant	14. remote	25.0	93.8
10	50. famous	20.* renowned	35.0*	97.9
11	43. furnish	47. provide	45.0	92.9
12	67. gather	31. collect	49.0	90.0
13	5. jeer	11. scoff	8.0	95.5
14	29. lazy	3. indolent	15.5	93.8
15	16. moist	20. damp	18.0	87.7
16	57. necessary	11. essential	34.0	89.1
17	27. ordinary	62. common	44.5	94.1
18	64. pleasant	21. agreeable	42.5	92.7
19	53. rapid	45. swift	49.0	92.6
20	61. sad	6. dejected	33.5	95.5
Av.	37.7	25.5	31.6	66.9

*Uncertain

Table 4 (cont.)

II: Antonyms

No.	First Member Credit No.	Second Member Credit No.	Famll: Value	Class: Value
1	75. beautiful	29. ugly	52.0	84.5
2	67. clean	21. dirty	44.0	98.2
3	28. create	50. destroy	39.0	89.1
4	60. doubt	56. trust	58.0	96.2
5	69. dry	42. wet	56.0	88.3
6	68. easy	37. difficult	52.5	91.7
7	13. failure	39. success	26.0	91.2
8	38. giant	14. dwarf	26.0	86.7
9	23. guilty	26. innocent	24.5	90.4
10	48. honest	7. deceitful	27.5	94.6
11	35. idle	57. busy	46.0	86.7
12	9. indulge	6. abstain	7.5	94.2
13	11. intelligent	14. stupid	12.5	95.2
14	65. joy	42. sorrow	53.5	79.3
15	31. kindness	15. cruelty	23.0	86.4
16	48. scarce	21. abundant	34.5	74.1
17	49. sharp	25. dull	37.0	96.3
18	70. slow	53. rapid	61.5	98.3
19	48. smooth	48. rough	48.0	98.1
20	54. strength	26. weakness	40.0	83.3
Av.	45.5	31.5	38.5	90.0

Table 4 (cont.)

III. Object--Attribute

No.	First Member Credit No.	Second Member Credit No.	Famil. Value	Class. Value
1	30. beach	21. sandy	25.5	95.8
2	58. bee	17. industrious	27.5	94.1
3	55. butter	11.* greasy	25.0*	98.1
4	33. deck	44. flat	28.5	93.1
5	41. desert	19. barren	20.0	94.2
6	37. diamond	24. sparkling	20.5	96.5
7	39. fox	17. sly	26.0	98.0
8	70. glass	6. brittle	28.0	100.0
9	10. glue	68.* sticky	29.0*	96.5
10	10. hermit	18. solitary	14.0	87.0
11	61. ice	16. slippery	28.5	94.8
12	25. kitten	5. playful	15.0	100.0
13	51. oak	10. sturdy	20.5	92.0
14	44. orange	6. juicy	25.0	98.2
15	46. plate	18. circular	22.0	96.4
16	6. quinine	36. bitter	21.0	98.3
17	31. rabbit	16. timid	23.5	100.0
18	9. razor	49. sharp	29.0	95.5
19	16. tiger	4. ferocious	10.0	96.2
20	13. vinegar	15. sour	14.0	94.6
Av.	34.3	21.0	27.6	96.0

*Uncertain

Table 4 (cont.)

IV. Whole--Part

No.	First Member Credit No.	Second Member Credit No.	Famil. Value	Class. Value
1	33. automobile	5. fender	19.0	95.8
2	57. band	33.* drummer	45.0*	98.1
3	4. banjo	35. string	14.5	92.0
4	25. barrel	11. hoop	18.0	90.4
5	54. basket	45. handle	48.5	87.5
6	16. bicycle	71. seat	45.5	92.7
7	75. box	19. lid	47.0	93.0
8	17. comb	29. tooth	25.0	92.3
9	54. cow	46. horn	50.0	83.3
10	13. cupboard	15. shelf	14.0	88.3
11	70. dinner	25. soup	47.5	79.6
12	19. elephant	42. trunk	30.5	89.7
13	43. hen	45. feather	44.0	92.7
14	23. ladder	9. rung	16.0	89.7
15	52. lion	12. mane	52.0	98.1
16	27. poem	3. stanza	15.0	94.1
17	32. rat	54. tail	43.0	95.8
18	17. stool	65. leg	41.0	94.1
19	28. volume	18. chapter	23.0	93.1
20	53. wheel	52. spoke	52.5	95.2
Av.	35.6	31.6	53.5	91.8

*Uncertain

Table 4 (cont.)

V. Cause--Effect

No.	First Member Credit No.	Second Member Credit No.	Famil. Value	Class. Value
1	7. alcohol	5.* intoxication	6.0*	91.1
2	4. bomb	23. destruction	13.6	72.7
3	67. cloud	47. shadow	57.0	83.6
4	3. dynamite	5. explosion	4.0	79.0
5	5. electricity	33. shock	19.0	82.0
6	51. exercise	4. perspiration	27.5	79.3
7	30. freeze	40. burst	35.0	80.4
8	9. germ	5. epidemic	7.0	92.7
9	17. insult	36. anger	26.5	82.1
10	41. match	36. flame	38.5	75.0
11	40. mistake	26. wreck	33.0	86.5
12	5. mosquito	33. fever	19.0	86.5
13	16. pepper	7. sneeze	11.5	86.3
14	25. poison	16. agony	20.5	88.3
15	13. spank	6. bawl	9.5	66.0
16	34. sunshine	13. tan	23.5	79.2
17	28. thorn	25. scratch	26.5	70.2
18	34. thunder	14. startle	24.0	84.5
19	4. torpedo	7. shipwreck	5.5	88.9
20	22. whirl	9. dizzy	15.5	75.0
Av.	22.8	19.5	21.1	81.5

*Uncertain

Table 5

Order of Merit in Familiarity and Classification Values

I. Synonyms

No.	Familiarity Value		Classification Value
1	gather--collect	49.0	famous--renowned 97.9
2	rapid--swift	49.0	brave--fearless 95.8
3	calm--quiet	48.5	jeer--scoff 95.5
4	furnish--provide	45.0	sad--dejected 95.5
5	ordinary--common	44.5	accurate--exact 94.7
6	<u>pleasant--agreeable</u>	<u>42.5</u>	ordinary--common 94.1
7	climb--ascend	35.5	dangerous--risky 93.8
8	famous--renowned	35.0	distant--remote 93.8
9	necessary--essential	34.0	lazy--indolent 93.8
10	<u>sad--dejected</u>	<u>33.5</u>	<u>furnish--provide</u> 92.9
11	brave--fearless	33.0	pleasant--agreeable 92.7
12	cure--heal	27.0	rapid--swift 92.6
13	accurate--exact	25.5	avoid--shun 91.4
14	avoid--shun	25.0	climb--ascend 90.7
15	dangerous--risky	25.0	calm--quiet 90.3
16	distant--remote	25.0	gather--collect 90.0
17	moist--damp	18.0	cure--heal 89.3
18	<u>lazy--indolent</u>	<u>15.5</u>	necessary--essential 89.1
19	bashful--shy	12.5	Bashful--shy 88.5
20	jeer--scoff	8.0	<u>moist--damp</u> 87.7
Med.		33.3	92.8

Table 5 (cont.)

II. Antonyms

No.	Familiarity Value		Classification Value
1	slow--rapid	61.5	slow--rapid 98.3
2	doubt--trust	58.0	clean--dirty 98.2
3	dry--wet	56.0	smooth--rough 98.1
4	joy--sorrow	53.5	sharp--dull 96.3
5	easy--difficult	52.5	doubt--trust 96.2
6	beautiful--ugly	52.0	honest--deceitful 94.6
7	smooth--rough	48.0	indulge--abstain 94.2
8	idle--busy	46.0	<u>intelligent--stupid</u> 93.2
9	clean--dirty	44.0	easy--difficult 91.7
10	<u>strength--weakness</u>	40.0	<u>failure--success</u> 91.2
11	create--destroy	39.0	guilty--innocent 90.4
12	sharp--dull	37.0	create--destroy 89.1
13	scarce--abundant	34.5	<u>dry--wet</u> 88.3
14	honest--deceitful	27.5	giant--dwarf 86.7
15	failure--success	26.0	idle--busy 86.7
16	giant--dwarf	26.0	kindness--cruelty 85.4
17	guilty--innocent	24.5	beautiful--ugly 84.5
18	<u>kindness--cruelty</u>	23.0	strength--weakness 83.3
19	intelligent--stupid	12.5	joy--sorrow 79.3
20	indulge--abstain	7.5	scarce--abundant 74.1
Med.		39.5	90.8

Table 5 (cont.)

III. Object--Attribute

No.	<u>Familiarity Value</u>		Classification Value	
1	glue--sticky	59.0	glass--brittle	100.0
2	deck--flat	38.5	kitten--playful	100.0
3	ice--slippery	38.5	rabbit--timid	100.0
4	glass--brittle	38.0	quinine--bitter	98.3
5	bee--industrious	37.5	orange--juicy	98.2
6	butter--greasy	33.0	butter--greasy	98.1
7	plate--circular	32.0	fox--sly	98.0
8	diamond--sparkling	30.5	diamond--sparkling	96.5
9	oak--sturdy	30.5	plate--circular	96.4
10	<u>desert--barren</u>	<u>30.0</u>	<u>glue--sticky</u>	<u>96.3</u>
11	razor--sharp	29.0	tiger--ferocious	96.2
12	fox--sly	28.0	beach--sandy	95.8
13	beach--sandy	25.5	razor--sharp	95.5
14	orange--juicy	25.0	ice--slippery	94.8
15	rabbit--timid	23.5	vinegar--sour	94.6
16	quinine--bitter	21.0	desert--barren	94.2
17	kitten--playful	15.0	bee--industrious	94.1
18	hermit--solitary	14.0	<u>deck--flat</u>	<u>93.1</u>
19	<u>vinegar--sour</u>	<u>14.0</u>	<u>oak--sturdy</u>	<u>92.0</u>
20	tiger--ferocious	10.0	hermit--solitary	87.0
Med.		29.5		96.2

Table 5 (cont.)

IV. Whole--Part

No.	Familiarity Value		Classification Value
1	wheel--spoke	52.5	band--drummer 98.1
2	cow-horn	50.0	lion--mane 98.1
3	basket--handle	48.5	automobile--fender 95.8
4	dinner-soup	47.5	rat--tail 95.8
5	box--lid	47.0	wheel--spoke 95.2
6	band--drummer	45.0	stool--leg 94.6
7	hen-feather	44.0	poem--stanza 94.1
8	bicycle--seat	43.5	volume--chapter 93.1
9	rat-tail	43.0	<u>box--lid 93.0</u>
10	<u>stool--leg 41.0</u>		<u>bicycle--seat 92.7</u>
11	lion--mane	32.0	hen--feather 92.7
12	elephant--trunk	30.5	comb-tooth 92.3
13	comb--tooth	23.0	banjo--string 92.0
14	volume--chapter	23.0	barrel--hoop 90.4
15	automobile--fender	19.0	elephant--trunk 89.7
16	barrel--hoop	18.0	ladder--rung 89.7
17	ladder--rung	16.0	<u>cupboard--shelf 88.3</u>
18	poem--stanza	15.0	basket--handle 87.5
19	banjo--string	14.5	cow--horn 83.3
20	<u>cupboard--shelf 14.0</u>		dinner--soup 79.6
Med.		36.5	92.7

Table 5 (cont.)

V. Cause--Effect

No.	Familiarity Value	Classification Value
1	<u>cloud--shadow</u> 57.0	germ--epidemic 92.7
2	match--flame 38.5	alcohol--intoxication 91.1
3	freeze--burst 35.0	torpedo--shipwreck 88.9
4	mistake--wreck 33.0	mistake--wreck. 88.5
5	exercise--perspiration 27.5	<u>poison--agony</u> 88.3
6	insult--anger 26.5	mosquito--fever 86.5
7	thorn--scratch 26.5	pepper--sneeze 86.3
8	thunder--startle 24.0	thunder--startle 84.5
9	sunshine--tan 23.5	cloud--shadow 83.6
10	<u>poison--agony</u> 20.5	<u>insult--anger</u> 82.1
11	electricity--shock 19.0	electricity--shock 82.0
12	mosquito--fever 19.0	freeze--burst 80.4
13	<u>whirl--dizzy</u> 15.5	exercise--perspiration 79.3
14	bomb--destruction 13.5	sunshine--tan 79.2
15	pepper--sneeze 11.5	dynamite--explosion 79.0
16	spank--bawl 9.5	match--flame 75.0
17	germ--epidemic 7.0	whirl--dizzy 75.0
18	alcohol--intoxication 6.0	bomb--destruction 72.7
19	torpedo--shipwreck 5.5	thorn--scratch 70.2
20	dynamite--explosion 4.0	spank--bawl 66.0
Med.	19.3	82.1

Table 6

Summary of Averages for
Familiarity and Classification Values

Category	Familiarity			Classi- fication
	1st M.	2nd M.	Pair	
Synonyms	37.7	25.5	31.6	92.5
Antonyms	45.5	31.5	38.5	90.0
Object--Attribute	34.3	21.0	27.6	96.0
Whole--Part	35.6	31.6	33.5	91.8
Cause--Effect	22.8	19.5	21.1	81.5

The word-pairs were prepared for presentation by pasting black letters $\frac{3}{4}$ inches high on white cardboard 7 by 11 inches. The words were centered on the card with the second member of each pair below the first. For recall, The letters forming the first member of each pair were pasted on the opposite side of the card.

Four experimental lists were prepared by selecting five pairs at random from each category, making a total of 25 pairs for each list. No word was allowed to occur more than once in the same list. (The only pairs requiring this attention are rapid--swift, slow--rapid; sharp--dull, and razor--sharp.) As far as could be determined by inspection no pairs were included in the same list which might lead to a confusion of terms. Three orders were prepared for each list for use in presentation, immediate, and delayed recall. The lists with their three orders are recorded in Table 7 (p.27). The numbers following pair designates its category and position as listed in Table 4.

Table 7

Presentation, Immediate Recall
and Delayed Recall Orders for Material Used
in the Major Experiment.

List A

Presentation Order	Immed. Rec. Or.	Delayed Rec. Or.
1 ladder--rung (IV,14)	19	20
2 torpedo--shipwreck (V,19)	23	21
3 rabbit--timid (III,17)	12	6
4 dry--wet (II,5)	8	4
5 calm--quiet (I,5)	3	24
6 elephant--trunk (IV,12)	13	7
7 joy--sorrow (II,14)	17	9
8 ice--slippery (III,11)	6	15
9 wheel--spoke (IV,20)	9	25
10 climb--ascend (I,6)	18	5
11 match--flame (V,10)	4	10
12 giant--dwarf (II,8)	21	14
13 rapid--swift (I,19)	7	16
14 quinine--bitter (III,16)	1	3
15 thunder--startle (V,18)	20	1
16 gather--collect (I,12)	24	8
17 beautiful--ugly (II,1)	5	17
18 volume--chapter (IV,19)	11	12
19 idle--busy (II,11)	10	23
20 exercise--perspiration (V,6)	14	13
21 avoid--shun (I,2)	15	11
22 glue--sticky (III,9)	16	19
23 poison--agony (V,14)	2	18
24 deck--flat (III,4)	22	22
25 cupboard--shelf (IV,10)	25	2

Table 7 (cont.)

List B

Presentation Order		Immed. Rec. Or.	Delayed Rec. Or.
1	pepper--sneeze (V,13)	18	5
2	intelligent--stupid (II,13)	12	18
3	dynamite--explosion (V,4)	8	10
4	fox--sly (III,7)	17	16
5	create--destroy (II,3)	16	7
6	bicycle--seat (IV,6)	24	12
7	necessary--essential (I,16)	23	17
8	vinegar--sour (III,20)	2	9
9	moist--damp (I,15)	19	25
10	diamond--sparkling (III,6)	13	13
11	cloud--shadow (V,3)	25	20
12	box--lid (IV,7)	20	19
13	slow--rapid (II,18)	3	3
14	plate--circular (III,15)	21	24
15	germ--epidemic (V,8)	14	14
16	pleasant--agreeable (I,18)	9	8
17	honest--deceitful (II,10)	10	15
18	poem--stanza (IV,16)	6	21
19	failure--success (II,7)	22	22
20	bee--industrious (III,2)	7	4
21	hen--feather (IV,13)	11	16
22	accurate--exact (I,1)	15	11
23	thorn--scratch (V,17)	5	23
24	stool--leg (IV,18)	1	2
25	ordinary--common(I,17)	4	1

Table 7 (cont.)

List C

Presentation Order		Immed. Rec. Or.	Delayed Rec. Or.
1	doubt--trust (II,4)	11	16
2	cow--horn (IV,9)	1	11
3	bomb--destruction (V,2)	21	21
4	lazy--indolent (I,14)	19	6
5	oak--sturdy (III,13)	9	8
6	jeer--scoff (I,13)	7	1
7	band--drummer (IV,2)	16	19
8	strength--weakness (II,20)	3	2
9	razor--sharp (III,18)	20	3
10	sunshine--tan (V,16)	4	15
11	distant--remote (I,9)	23	23
12	tiger--ferocious (III,19)	5	24
13	comb--tooth (IV,8)	22	7
14	electricity--shock (V,5)	10	4
15	kindness--cruelty (II,15)	25	9
16	sad--dejected (I,20)	12	20
17	spank--lawl (V,15)	13	17
18	banjo--string (IV,3)	14	5
19	easy--difficult (II,6)	8	22
20	beach--sandy (III,1)	24	14
21	scarce--abundant (II,16)	18	12
22	whirl--dizzy (V,20)	17	10
23	dangerous--risky (I,8)	2	13
24	butter--greasy (III,3)	15	18
25	automobile--fender (IV,1)	6	25

Table 7 (cont.)

List D

Presentation Order		Immed. Rec. Cr.	Delayed Rec. Cr.
1	mosquito--fever (V,12)	17	18
2	bashful--shy (I,3)	20	12
3	basket--handle (IV,5)	23	22
4	clean--dirty (II,2)	19	11
5	glass--brittle (III,8)	9	21
6	dinner--soup (IV,11)	1	13
7	cure--heal (I,7)	3	23
8	insult--anger (V,9)	13	4
9	desert--barren (III,5)	14	7
10	guilty--innocent (II,9)	8	2
11	rat--tail (IV,17)	12	10
12	indulge--abstain (II,12)	4	20
13	freeze--burst (V,7)	7	15
14	kitten--playful (III,12)	5	1
15	famous--renowned (I,10)	10	3
16	lion--mane (IV,15)	6	16
17	mistake--wreck (V,11)	22	18
18	sharp--dull (II,17)	24	6
19	brave--fearless (I,4)	15	19
20	hermit--solitary (III,10)	21	17
21	alcohol--intoxication (V,1)	2	25
22	furnish--provide (I,11)	25	9
23	orange--juicy (III,14)	16	14
24	barrel--hoop (IV,4)	18	5
25	smooth--rough (II,19)	11	24

Apparatus and Procedure

The apparatus consisted of a black screen with an opening $5\frac{1}{2}$ by 10 inches through which the cards could be seen. Holes were punched at the top of the cards so that they could be suspended from two horizontal rods back of the screen. By the use of a stop-watch and stylus the cards could be dropped in succession after being exposed for the desired interval.

All the experimentation was done by the writer. The subjects were always assembled in regular class groups. The class instructor was generally present during the experiment.

The exact nature of the instructions can be determined from the copy on page 33. It was felt that, besides an exposition of the procedure, a rather delicate balancing of motives was necessary. We hoped to interest the subjects in the experiment from a scientific rather than a personal standpoint. The extent to which such an attitude was secured is largely a matter for conjecture, although some information can be obtained by an examination of the internal evidence of the results.

After the instructions had been read and explained further if necessary, each card was exposed successively, each exposure lasting 5 seconds. The "immediate recall"

was taken after an interval of 4 or 5 minutes. One week later records for the "delayed recall" were secured. In both recalls 10 seconds was allowed for responding to each word. The response was always to the first member of the pair; the subjects, however, were not informed of this fact.

It may be noted that the subjects were informed of a delayed recall before the presentation. This was unfortunate since it might have encouraged an attempt at further learning during the immediate recall period. This possibility of error was eliminated from the instructions for the Check Experiments (p. 68).

Instructions No. 1

Before Presentation

In this experiment you will be shown two words on a card (bird--robin). Your task is to learn these words in such a way that if one is presented alone (bird) you will be able to recall the other (robin).

In this trial you will be presented with (25) pairs of words. These pairs will follow each other at intervals of (5) seconds. Make no attempt to learn the list as such, but consider each pair of words a separate lesson and do your best to learn it. You will be asked to recall these words immediately after the list is presented and also at one or more later class periods.

The experiment, then, consists of two parts. In the first, you are simply to watch the screen and learn the pairs as they appear. In the second, one word will be presented alone and you will be asked to write the other word of the pair.

Note

This is not a test. Your work will count neither for nor against you as long as it indicates a serious effort to follow instructions. If these results are to be of scientific value it is important that you do

your best to learn each pair of words uninfluenced by any attempt to compete or cooperate with your neighbor. Do not discuss this experiment with anyone until you are told that it is completed.

Are there any questions?

The "ready" signal will be the appearance of a white card in the opening of the screen.

Before Immediate Recall

Write your initials at the top of your slip. This is necessary in order to identify each paper for comparison with others from the same person.

Write a word on your slip for each one presented on the screen. If you cannot think of the correct word guess at the one most nearly correct. Keep the words in the proper order. You will have (10) seconds in which to write each one.

Are there any questions?

Before Delayed Recall

Identify your slip in the same way that you did last week in order that the two papers may be compared.

You will be presented with one member of the same pairs of words which you learned last week. Write a word on your slip for each word which appears on the screen. If you cannot think of the correct word guess at the one

most nearly correct. Keep the words in the proper order.
You will have (10) seconds in which to write each one.

Note

You are earnestly requested to work individually.
The scientific value of the data depends largely upon
your cooperation in establishing this condition.

Are there any questions?

The "ready" signal will be the appearance of a
white card in the opening of the screen.

Subjects

Table 8 (p. 37) summarizes some data for the subjects used in this and later experiments. The numbers given are net, that is, they represent the number of subjects who were present at both experimental periods and, hence, those whose records were retained. Nine experimental groups totaling 199 subjects were secured for the major experiment. Groups I/1, I/2, and I/3, a total of 47 subjects, responded to List A. Groups II/1, II/2, and II/3, totaling 59 subjects, responded to List B. Groups III/1 and III/2, 46 subjects in all, responded to List C. Group IV, numbering 47 subjects, responded to List D. All the subjects used in this experiment were members of either the lecture or laboratory sections of the beginning course in psychology. The majority were college sophomores. The chief consideration in selecting the groups was that of equalizing the total number responding to each list. No effort was made to equate them in other respects.

Table 8

Summary of Information Concerning the Subjects Used
in the Major and Check Experiments

	Group	Class	Net No.S.	List	A.M.	P.M.
Major Exp.	I/1	Gen. Psy. Lab. Sec.	29	A	10:30	
	I/2	" " " "	11	A	10:30	
	I/3	" " " "	7	A		1:20
	I	I/1, I/2, I/3	47			
	II/1	Gen. Psy. Lab. Sec.	25	B		1:20
	II/2	" " " "	19	B	8:30	
	II/3	" " " "	15	B		3:30
	II	II/1, II/2, II/3	59			
	III/1	Gen. Psy. Lec. Sec.	35	C	11:30	
	III/2	" " Lab. Sec.	11	C	8:30	
III	III/1, III/2	46				
	IV	Gen. Psy. Lec. Sec.	47	D	8:30	
	Total		199			
Check Exp.1	V	Intro. to Edu. Meas.	23	E	9:30	
	VI	Edu. Psychology	28	F	10:30	
	Total		51			
Check Exp.2	VII	Edu. Psychology	23	G	9:30	
	VIII	Intro. to Edu. Meas.	22	G	11:30	
	Total		45			
Check Exp.3	IX	Psy. of Advertising	54	H	8:30	
Check Exp.4	X	Advanced Laboratory	10	A		2:30

Results

The protocols were scored for both accuracy and relationship. The chief exception to the former consideration was with regard to plurals. (Obvious misspellings were also exempted.) This was probably a mistake. Most of the plurals occurred in connection with the whole--part relation, and hence this category was given undue advantage. The difference between responding with a plural instead of a singular seems slight and the number occurring was not large. However, if the data were to be scored for absolute accuracy the average recall values of the whole--part category would undoubtedly be lowered. This error was eliminated from the results of Check Experiment 3. In scoring for relationship, a response was considered correct if it indicated with reasonable certainty that the subject had grasped the relation intended by the experimenter.

Tables 9 and 10 and Diagrams 1 to 5, inclusive, (pp. 41-47) summarize the results in statistical form. The measures of "immediate recall" and "delayed recall" are absolute. That is, they are the ratios of the correct responses secured immediately, or one week after the presentation, to the total number of correct responses possible for each category. The "relative recall"

is the ratio of correct delayed responses to correct immediate responses. The "rate of forgetting" is the difference between the correct immediate and delayed responses divided by the correct immediate responses. The rate of forgetting plus the relative recall include 100% of the correct immediate responses. All ratios are expressed in the form of per cents.

The data from the different groups responding to Lists A, B, and C were compiled and treated as though secured from a single large group for each list. The subjects and conditions of experimentation were so similar in each case that this procedure seemed justifiable. The final measures of central tendency for each category were secured by computing the means of the corresponding averages from the four lists.

By comparing Diagrams 1 and 2 it can be seen that, in every case, relationships are more easily learned and retained than the exact terms by which they are expressed. Although measures of reliability could not be computed, Diagram 3 shows that the differences in the extent to which the various categories are learned and retained are large enough, at least in extreme cases, to be statistically significant. The rate of forgetting "cause--effects", for example, is more than three times that of "whole--parts". A comparison of Diagram 4 with

Diagram 3 shows that when the data are scored for relationship the differences are reduced in nearly every case. The difference in the rate of forgetting antonyms and whole--parts, and of synonyms and "object--attributes" become negligible.

Diagram 5 shows the relative ranks of the various categories for each method of scoring and measure of recall in schematic form. By comparing each column with the corresponding section of Diagram 3 or 4 the statistical reliability of the rankings can be estimated. If it is assumed that the percentages for immediate recall measure the amount of material learned, it can be said that the ease of learning the categories, in descending order, is as follows: whole--part, object--attribute, cause--effect, antonyms, synonyms. The ease of retention of the categories as measured by the percentages for relative recall is more equivocal. Whole--part and antonyms stand either first or second, object--attribute and synonyms, third or fourth, and cause--effect, last.

Table 9

Summary of Results from Major Experiments---

Data Scored for Accuracy.

A. Immediate Recall

Group	List	Syn.	Ant.	O.-A.	W.-P.	C.-E.
I	A	80.9	88.1	93.6	93.6	85.5
II	B	63.7	66.1	89.2	89.8	84.4
III	C	58.7	65.6	83.5	86.5	86.1
IV	D	64.3	86.3	75.7	89.4	66.4
Average		66.9	76.5	85.5	89.8	80.6

B. Delayed Recall

Group	List	Syn.	Ant.	O.-A.	W.-P.	C.-E.
I	A	68.1	86.0	83.4	92.3	64.5
II	B	56.6	53.2	77.6	83.7	71.9
III	C	50.9	60.0	74.3	77.8	75.2
IV	D	52.8	65.5	62.9	83.8	45.9
Average		57.1	71.2	74.5	84.4	64.3

C. Relative Recall

Group	List	Syn.	Ant.	O.-A.	W.-P.	C.-E.
I	A	84.2	97.6	89.1	98.6	75.1
II	B	88.8	80.5	87.1	93.2	85.1
III	C	86.7	91.4	89.0	90.0	87.4
IV	D	82.1	99.0	83.1	93.8	69.2
Average		85.4	92.1	87.0	93.9	79.2

D. Rate of Forgetting

Group	List	Syn.	Ant.	O.-A.	W.-P.	C.-E.
I	A	15.8	2.4	10.9	1.4	24.9
II	B	11.2	19.5	12.9	6.8	14.9
III	C	13.3	8.6	11.0	10.0	12.6
IV	D	17.9	1.0	16.9	6.2	20.8
Average		14.6	7.9	13.0	6.1	20.8

Table 10

Summary of Results from Major Experiment--
Data Scored for Relationship

A. Immediate Recall

Group	List	Syn.	Ant.	O.-A.	W.-P.	C.-E.
I	A	87.2	88.5	96.2	93.6	89.4
II	B	75.9	79.3	91.5	91.2	90.2
III	C	65.7	77.0	87.0	87.8	95.2
IV	D	71.5	87.2	80.4	90.6	76.6
Average		73.1	83.0	88.8	90.8	87.8

B. Delayed Recall

Group	List	Syn.	Ant.	O.-A.	W.-P.	C.-E.
I	A	74.5	86.1	88.1	94.0	72.8
II	B	73.6	72.9	82.0	84.4	82.0
III	C	60.4	68.5	60.4	81.3	83.0
IV	D	64.7	86.4	71.5	83.8	55.7
Average		68.3	78.9	80.5	85.9	73.4

C. Relative Recall

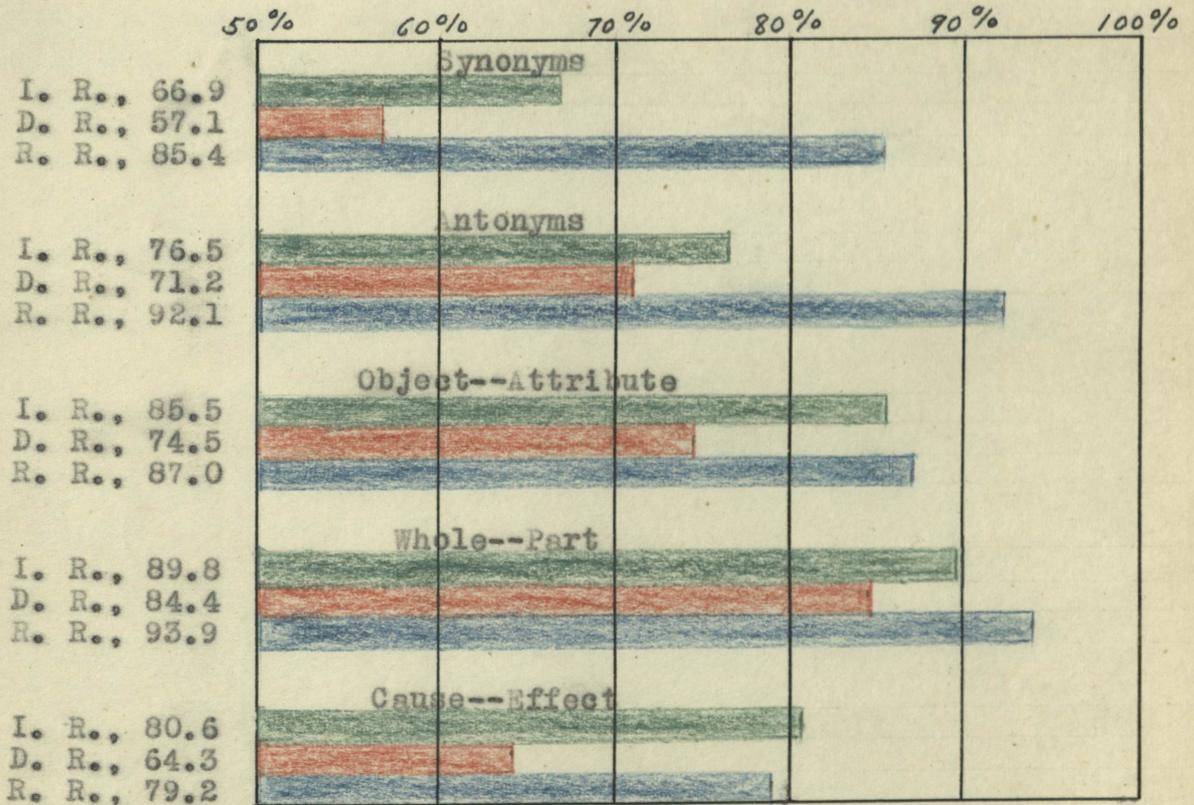
Group	List	Syn.	Ant.	O.-A.	W.-P.	C.-E.
I	A	85.4	99.5	91.6	100.5	81.4
II	B	96.9	91.9	89.6	92.6	91.0
III	C	92.1	88.7	92.5	92.6	87.2
IV	D	90.5	99.0	88.9	92.5	72.8
Average		91.2	94.8	90.7	94.5	83.1

D. Rate of Forgetting

Group	List	Syn.	Ant.	O.-A.	W.-P.	C.-E.
I	A	14.6	0.5	8.4	-0.5	18.6
II	B	3.1	8.1	10.4	7.4	9.0
III	C	7.9	11.3	7.5	7.4	12.8
IV	D	9.5	1.0	11.1	7.5	27.2
Average		8.8	5.2	9.3	5.5	16.9

Diagram 1

A. Percentages of Immediate (I. R.), Delayed (D. R.), and Relative (R. R.) Amounts Recalled For Each Category--
Data Scored for Accuracy



B. Per Cent Forgotten After One Week of Amount Originally Retained--Data Scored for Accuracy

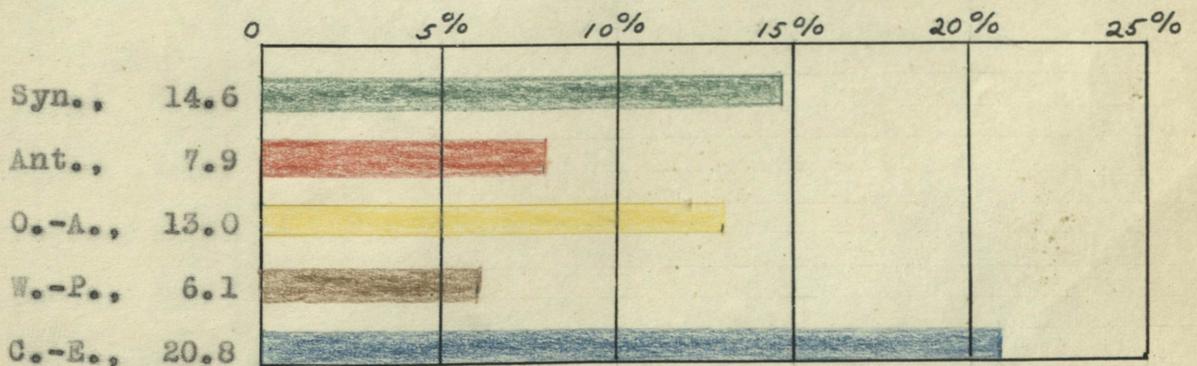
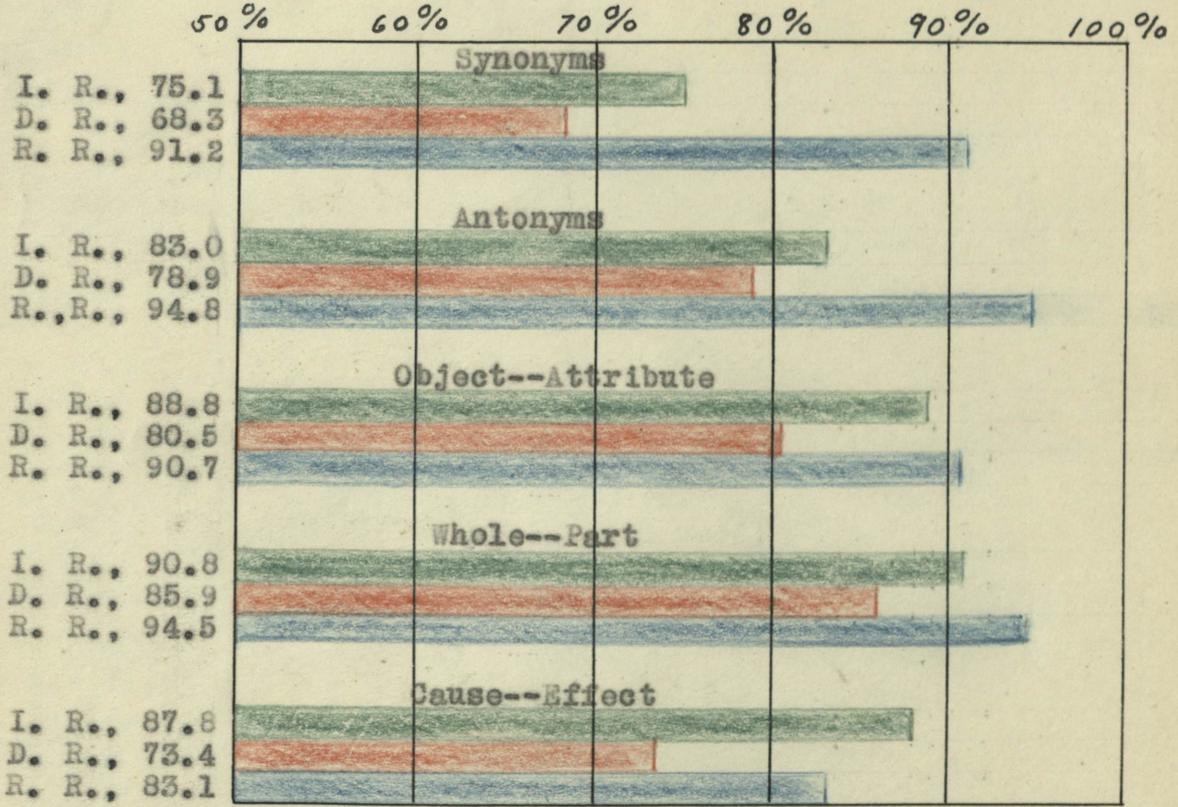


Diagram 2

A. Percentages of Immediate (I. R.), Delayed (D. R.), and Relative (R. R.) Amounts Recalled For Each Category-- Data Scored For Relationship



B. Per Cent Forgotten After One Week Of Amount Originally Retained--Data Scored For Relationship

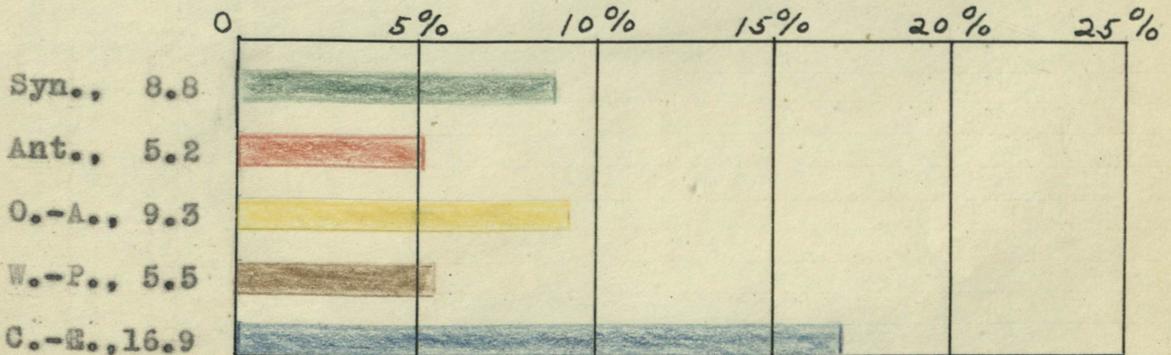


Diagram 3

Comparison Of Immediate Recall, Delayed Recall, Relative Recall, And Rate Of Forgetting For Each Category, Showing Differences--Data Scored For Accuracy

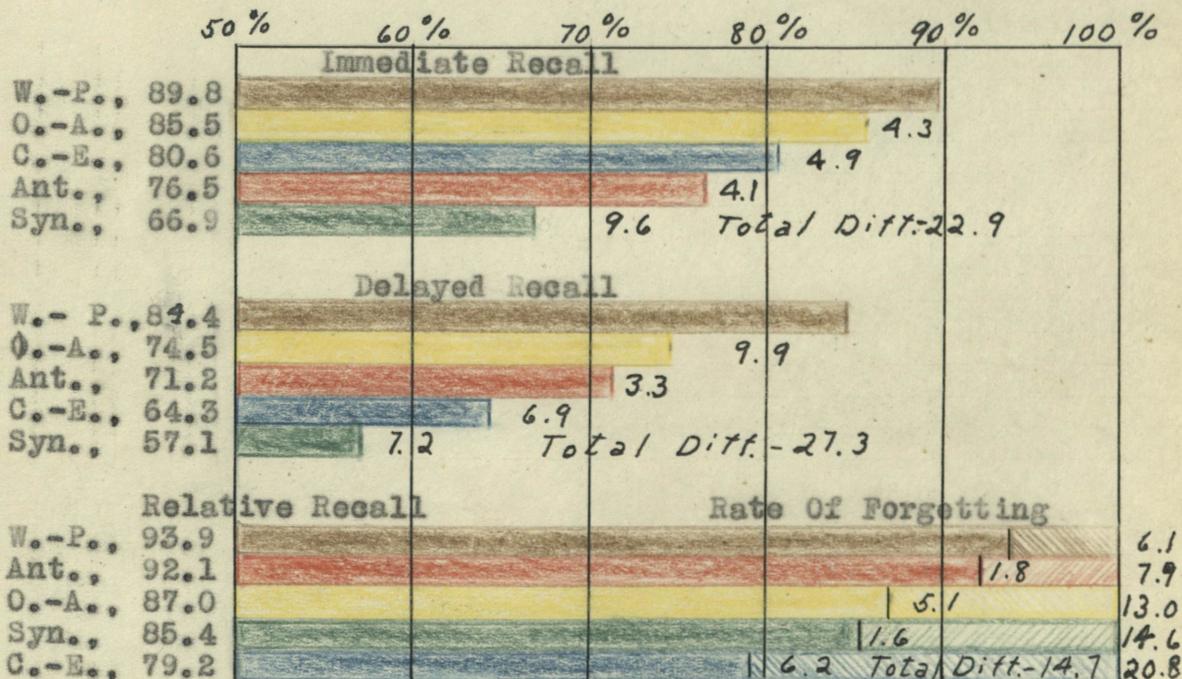


Diagram 4

Comparison Of Immediate Recall, Delayed Recall, Relative Recall, And Rate Of Forgetting For Each Category, Showing Differences--Data Scored For Relationship

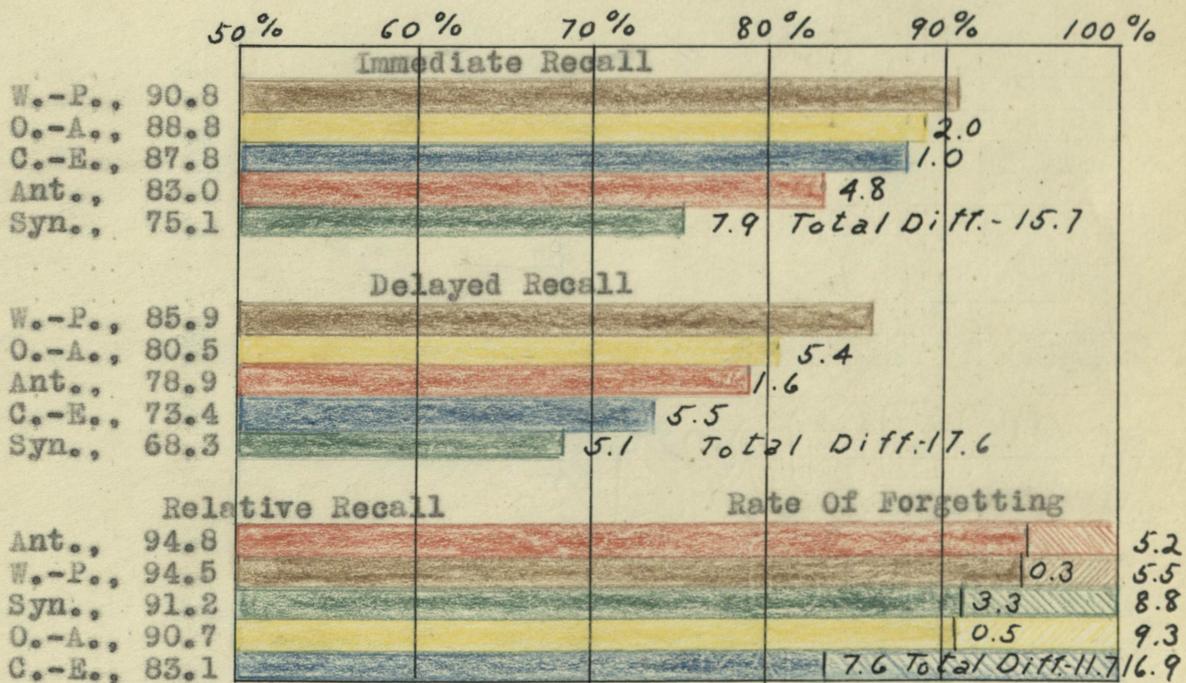
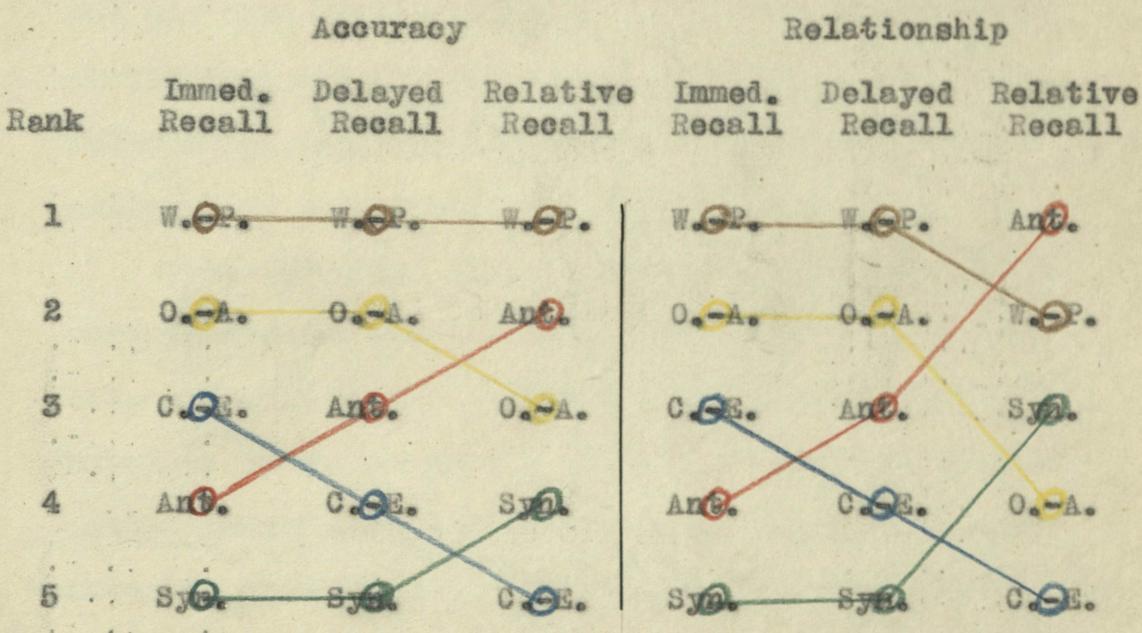


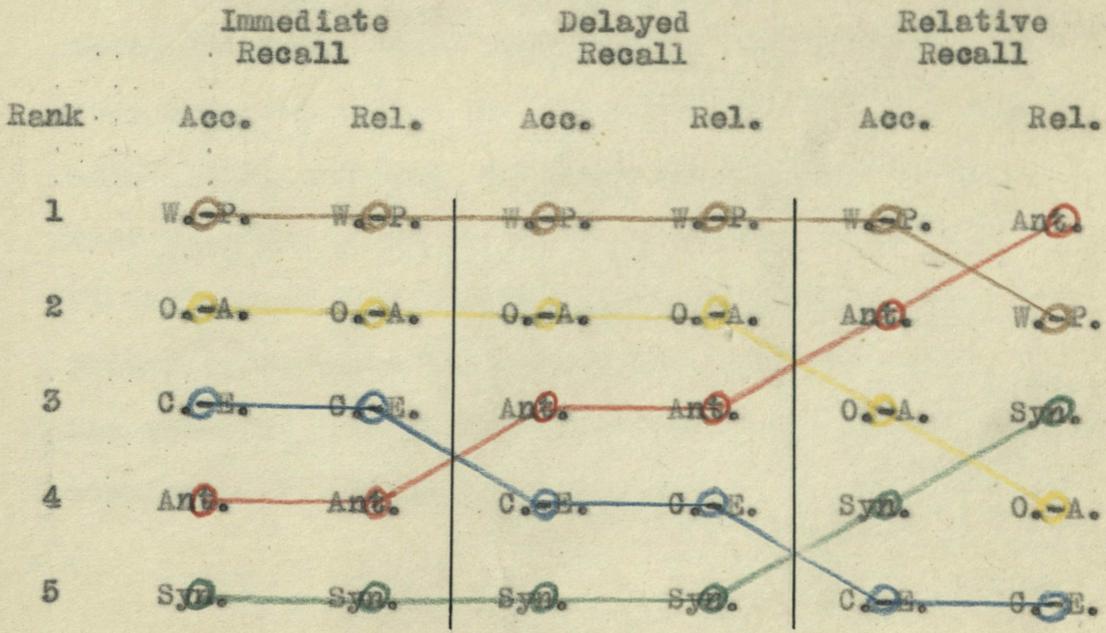
Diagram 5

Comparison Of Ranks--Major Experiment

A. By Methods Of Scoring



B. By Measures Of Recall



Tables 11 and 12 (pp. 49-63) show the recall values for each of the paired-word associates when scored for accuracy. These measures were computed in order to further standardize the material and to permit comparisons with regard to variability and distribution. The red and blue lines of Table 12 are to be interpreted in the same way as that indicated in connection with Table 5 (p. 20). The medians have to be determined arbitrarily and, hence, are not reliable.

Table 12 shows that the relative recall value of some word-pairs was more than 100%. At first thought, this seems to indicate that some of the subjects have tried to "beat the game". Presumably, if any communication occurred during the interval between the immediate and delayed call, it would be with regard to those pairs which were hard to learn. Some of the pairs in question have a low immediate recall value. Furthermore, antonyms, which were next to the hardest to learn, were apparently next to the easiest to retain. On the other hand, synonyms, although the hardest to learn, rose only one place in rank with regard to retention. It would seem that the operation of another factor is necessary in order to account for this peculiarity of the results. The probable nature of this factor will be considered in another connection.

Table 11

Recall Values---Data Scored for Accuracy

I. Synonyms

No.	Pairs	Immed. Recall Value	Delayed Recall Value	Relative Recall Value
1	accurate--exact	55.9	23.7	10.0
2	avoid--shun	74.5	61.7	82.9
3	bashful--shy	85.1	87.2	102.5
4	brave--fearless	51.1	19.2	37.5
5	calm--quiet	95.6	74.5	79.6
6	climb--ascend	95.7	89.4	93.5
7	cure--heal	85.1	61.7	72.5
8	dangerous--risky	47.8	45.5	90.9
9	distant--remote	47.8	45.7	95.5
10	famous--renowned	59.6	63.8	107.1
11	furnish--provide	40.4	31.9	79.0
12	gather--collect	82.0	68.1	82.1
13	jeer--scoff	82.6	82.6	100.0
14	lazy--indolent	60.4	56.5	70.3
15	moist--damp	88.1	78.0	88.5
16	necessary--essential	64.4	62.7	97.4
17	ordinary--common	84.8	81.4	96.0
18	pleasant--agreeable	47.5	37.3	78.6
19	rapid--swift	57.5	46.8	81.5
20	sad--dejected	34.8	26.1	75.0
Av.		66.9	57.1	84.0*

*Discrepancy with corresponding average of Table 9 (P. 4/) could not be located.

Table 11 (cont.)

Recall Values---Data Scored for Accuracy

II. Antonyms

No.	Pairs	Immed. Recall Value	Delayed Recall Value	Relative Recall Value
1	beautiful--ugly	97.9	97.9	100.0
2	clean--dirty	93.6	93.6	100.0
3	create--destroy	78.0	71.2	91.3
4	doubt--trust	41.3	45.7	110.6
5	dry--wet	95.7	95.7	100.0
6	easy--difficult	87.0	73.9	85.0
7	failure--success	88.1	88.1	100.0
8	giant--dwarf	93.6	93.6	100.0
9	guilty--innocent	95.6	89.4	95.5
10	honest--deceitful	45.8	22.0	48.2
11	idle--busy	68.1	57.5	84.4
12	indulge--abstain	78.7	63.6	81.1
13	intelligent--stupid	66.1	42.4	64.1
14	joy--sorrow	85.1	85.1	100.0
15	kindness--cruelty	71.7	60.9	84.9
16	scarce--abundant	47.8	45.7	95.5
17	sharp--dull	74.5	87.2	117.1
18	slow--rapid	52.5	42.4	80.7
19	smooth--rough	89.4	93.6	104.8
20	strength--weakness	80.4	73.9	91.9
Av.		76.5	71.2	91.8*

*Discrepant

Table 11 (cont.)

III. Object--Attribute

No.	Pairs	Immed. Recall Value	Delayed Recall Value	Relative Recall Value
1	beach--sandy	73.9	58.7	79.4
2	bee--industrious	93.2	62.7	67.3
3	butter--greasy	73.9	78.3	105.9
4	deck--flat	97.9	82.0	84.8
5	desert--barren	82.0	66.0	79.5
6	diamond--sparkling	83.1	62.7	75.5
7	fox--sly	98.3	94.9	96.6
8	glass--brittle	87.2	72.3	82.9
9	glue--sticky	95.7	91.5	95.6
10	hermit--solitary	56.2	29.8	82.4
11	ice--slippery	87.2	66.0	75.6
12	kitten--playful	89.4	87.2	97.6
13	oak--sturdy	82.6	71.7	86.8
14	orange--juicy	83.0	59.6	71.8
15	plate--circular	71.2	71.2	100.0
16	quinine--bitter	100.0	93.6	93.6
17	rabbit--timid	87.2	63.0	95.1
18	razor--sharp	100.0	80.4	80.4
19	tiger--ferocious	87.0	80.4	92.5
20	vinegar--sour	100.0	96.6	96.6
Av.		85.5	74.5	87.0

Table 11 (cont.)

IV. Whole--Part

No.	Part	Immed. Recall Value	Delayed Recall Value	Relative Recall Value
1	automobile--fender	84.8	75.9	87.2
2	band--drummer	69.6	58.7	84.4
3	banjo--string	95.7	89.1	93.2
4	barrel--hoop	87.2	87.2	100.0
5	basket--handle	83.0	78.7	94.9
6	bicycle--seat	88.1	74.6	84.6
7	box--lid	89.8	85.4	96.2
8	comb--tooth	93.5	87.0	93.0
9	cow--horn	89.1	80.4	90.2
10	cupboard--shelf	87.2	97.9	112.2
11	dinner--soup	89.4	76.6	85.7
12	elephant--trunk	97.9	95.7	97.8
13	hen--feather	86.4	79.7	92.2
14	ladder--rung	91.5	89.4	97.6
15	lion--mane	95.7	89.4	93.3
16	poem--stanza	91.5	84.8	92.6
17	rat--tail	91.5	87.2	95.4
18	stool--leg	93.2	93.2	100.0
19	volume--chapter	91.5	85.1	93.0
20	wheel--spoke	100.0	93.6	93.6
Av.		89.8	84.4	93.9

Table 11 (cont.)

V. Cause--Effect

No.	Pair	Immed. Recall Value	Delayed Recall Value	Relative Recall Value
1	alcohol--intoxication	83.0	55.3	66.7
2	bomb--destruction	71.7	56.5	78.8
3	cloud--shadow	79.7	67.8	85.1
4	dynamite--explosion	94.9	86.4	91.1
5	electricity--shock	91.3	95.7	104.8
6	exercise--perspiration	83.0	80.9	97.4
7	freeze--burst	63.8	34.0	53.3
8	germ--epidemic	79.7	83.0	66.1
9	insult--anger	55.3	29.8	53.9
10	match--flame	93.6	80.9	86.4
11	mistake--wreck	38.3	27.7	72.2
12	mosquito--fever	91.5	83.0	90.7
13	pepper--sneeze	98.3	96.6	98.3
14	poison--agony	91.5	41.9	38.3
15	spank--bawl	95.7	69.6	72.7
16	sunshine--tan	87.0	73.9	85.0
17	thorn--scratch	69.5	42.4	61.0
18	thunder--startle	70.2	46.8	66.7
19	torpedo--shipwreck	89.4	74.5	83.3
20	whirl--dizzy	84.8	80.4	94.9
Av.		80.6	64.3	78.4*

*Discrepant

Table 12

Order of Merit for Recall Values---

Data Scored for Accuracy

I. Synonyms

No.	Immediate Recall Value	Delayed Recall Value
1	<u>climb--ascend</u> 95.7	<u>climb--ascend</u> 89.4
2	calm--quiet 93.6	bashful--shy 87.2
3	moist--damp 88.1	jeer--scoff 82.6
4	bashful--shy 85.1	ordinary--common 81.4
5	cure--heal 85.1	moist--damp 78.0
6	ordinary--common 84.8	calm--quiet 74.5
7	gather--collect 83.0	gather--collect 68.1
8	jeer--scoff 82.6	famous--renowned 63.8
9	lazy--indolent 80.4	necessary--essential 62.7
10	<u>avoid--shun</u> 74.5	<u>avoid--shun</u> 61.7
11	necessary--essential 64.4	<u>cure--heal</u> 61.7
12	famous--renowned 59.6	lazy--indolent 56.5
13	rapid--swift 57.5	rapid--swift 46.8
14	brave--fearless 51.1	distant--remote 45.7
15	dangerous--risky 47.8	dangerous--risky 43.5
16	distant--remote 47.8	pleasant--agreeable 37.3
17	pleasant--agreeable 47.5	furnish--provide 31.9
18	furnish--provide 40.4	sad--dejected 26.1
19	sad--dejected 34.8	accurate--exact 23.7
20	accurate--exact 33.9	brave--fearless 19.2
Med.	69.4	61.7

Table 12 (cont.)

I. Synonyms (cont.)

No.	Relative Recall Value	
1	<u>famous--renowned</u>	107.1
2	bashful--shy	102.5
3	jeer--scoff	100.0
4	necessary--essential	97.4
5	ordinary--common	96.0
6	distant--remote	95.5
7	climb--ascend	93.3
8	dangerous--risky	90.9
9	<u>moist--damp</u>	88.5
10	<u>avoid--shun</u>	82.9
11	gather--collect	82.1
12	rapid--swift	81.5
13	calm--quiet	79.6
14	furnish--provide	79.0
15	pleasant--agreeable	78.6
16	sad--dejected	75.0
17	cure--heal	72.5
18	lazy--indolent	70.3
19	accurate--exact	70.0
20	brave--fearless	37.5
Av.		82.5

Table 12 (cont.)

II. Antonyms

No.	Immediate Recall Value	Delayed Recall Value
1	<u>beautiful--ugly</u> 97.9	beautiful--ugly 97.9
2	dry--wet 95.7	dry--wet 95.7
3	clean--dirty 93.6	clean--dirty 93.6
4	giant--dwarf 93.6	giant--dwarf 93.6
5	guilty--innocent 93.6	<u>smooth--rough</u> 93.6
6	smooth--rough 89.4	guilty--innocent 89.4
7	failure--success 88.1	failure--success 88.1
8	easy--difficult 87.0	sharp--dull 87.2
9	joy--sorrow 85.1	joy--sorrow 85.1
10	<u>strength--weakness</u> 80.4	<u>easy--difficult</u> 73.9
11	indulge--abstain 78.7	strength--weakness 73.9
12	create--destroy 78.0	create--destroy 71.2
13	sharp--dull 74.5	indulge--abstain 63.8
14	<u>kindness--cruelty</u> 71.7	<u>kindness--cruelty</u> 60.9
15	idle--busy 68.1	idle--busy 57.5
16	intelligent--stupid 66.1	doubt--trust 45.7
17	slow--rapid 52.5	scarce--abundant 45.7
18	scarce--abundant 47.8	intelligent--stupid 42.4
19	honest--deceitful 45.8	slow--rapid 42.4
20	doubt--trust 41.3	honest--deceitful 22.0
Med.	79.6	73.9

Table 12 (cont.)

II. Antonyms (cont.)

No.	Relative Recall Value	
1	sharp--dull	117.1
2	<u>doubt--trust</u>	<u>110.5</u>
3	smooth--rough	104.8
4	beautiful--ugly	100.0
5	clean--dirty	100.0
6	dry--wet	100.0
7	failure--success	100.0
8	giant--dwarf	100.0
9	joy--sorrow	100.0
10	guilty--innocent	95.5
11	scarce--abundant	95.5
12	strength--weakness	91.9
13	create--destroy	91.3
14	easy--difficult	85.0
15	kindness--cruelty	84.9
16	<u>idle--busy</u>	<u>84.4</u>
17	indulge--abstain	81.1
18	slow--rapid	80.7
19	intelligent	64.1
20	honest--deceitful	48.2
Med.		95.5

Table 12 (cont.)

III. Object--Attribute

No.	Immediate Recall Value	Delayed Recall Value
1	quinine--bitter 100.0	vinegar--sour 96.6
2	razor--sharp 100.0	fox--sly 94.9
3	vinegar--sour 100.0	quinine--bitter 93.6
4	fox--sly 98.3	<u>glue--sticky 91.5</u>
5	<u>deck--flat 97.9</u>	kitten--playful 87.2
6	glue--sticky 95.7	deck--flat 83.0
7	bee--industrious 93.2	rabbit--timid 83.0
8	kitten--playful 89.4	razor--sharp 80.4
9	glass--brittle 87.2	tiger--ferocious 80.4
10	<u>ice--slippery 87.2</u>	<u>butter--greasy 78.3</u>
11	rabbit--timid 87.2	glass--brittle 72.3
12	tiger--ferocious 87.0	oak--sturdy 71.7
13	diamond--sparkling 83.1	plate--circular 71.2
14	orange--juicy 83.0	desert--barren 66.0
15	desert--barren 83.0	ice--slippery 66.0
16	oak--sturdy 82.6	bee--industrious 62.7
17	beach--sandy 73.9	diamond--sparkling 62.7
18	butter--greasy 73.9	orange--juicy 59.6
19	<u>plate--circular 71.2</u>	<u>beach--sandy 58.7</u>
20	hermit--solitary 36.2	hermit--solitary 29.8
Med.	87.2	75.3

Table 12 (cont.)

III. Object--Attribute (cont.)

No.	Relative Recall Value
1	<u>butter--greasy</u> 105.9
2	plate--circular 100.0
3	kitten--playful 97.6
4	vinegar--sour 96.6
5	fox--sly 96.6
6	glue--sticky 95.6
7	rabbit--timid 95.1
8	quinine--bitter 93.6
9	tiger--ferocious 92.5
10	<u>oak--sturdy</u> 86.8
11	<u>deck--flat</u> 84.8
12	glass--brittle 82.9
13	hermit--solitary 82.4
14	razor--sharp 80.4
15	desert--barren 79.5
16	beach--sandy 79.4
17	ice--slippery 75.6
18	diamond--sparkling 75.5
19	orange--juicy 71.8
20	bee--industrious 67.3
Med.	85.8

Table 12 (cont.)

IV. Whole--Part

No.	Immediate Recall Value	Delayed Recall Value
1	wheel--spoke 100.0	cupboard--shelf 97.9
2	<u>elephant--trunk 97.9</u>	elephant--trunk 95.7
3	lion--mane 95.7	wheel--spoke 93.6
4	banjo--string 95.7	<u>stool--leg 93.2</u>
5	comb--tooth 93.5	ladder--rung 89.4
6	stool--leg 93.2	lion--mane 89.4
7	poem--stanza 91.5	banjo--string 89.1
8	ladder--rung 91.5	barrel--hoop 87.2
9	rat--tail 91.5	rat--tail 87.2
10	<u>volume--chapter 91.5</u>	<u>comb--tooth 87.0</u>
11	box--lid 89.8	box--lid 86.4
12	dinner--soup 89.4	volume--chapter 85.1
13	cow--horn 89.1	poem--stanza 84.8
14	bicycle--seat 88.1	cow--horn 80.4
15	barrel--hoop 87.2	hen--feather 79.7
16	cupboard--shelf 87.2	basket--handle 76.7
17	hen--feather 86.4	dinner--soup 76.6
18	automobile--fender 84.8	bicycle--seat 74.6
19	basket--handle 83.0	automobile--fender 73.9
20	<u>band--drummer 69.6</u>	<u>band--drummer 58.7</u>
Med.	90.7	86.7

Table 12 (cont.)

IV. Whole--Part (cont.)

No.	Relative Recall Value	
1	<u>cupboard--shelf</u>	112.2
2	barrel--hoop	100.0
3	stool--leg	100.0
4	elephant--trunk	97.8
5	ladder--rung	97.6
6	box--lid	96.2
7	rat--tail	95.4
8	basket--handle	94.9
9	wheel--spoke	93.6
10	<u>lion--mane</u>	93.3
11	banjo--string	93.2
12	comb--tooth	93.0
13	volume--chapter	93.0
14	poem--stanza	92.6
15	hen--feather	92.2
16	cow--horn	90.2
17	automobile--fender	87.2
18	dinner--soup	85.7
19	bicycle--seat	84.6
20	<u>band--drummer</u>	84.4
Med.		93.3

Table 12 (cont.)

V. Cause--Effect

No.	Immediate Recall Value	Delayed Recall Value
1	<u>pepper--sneeze</u> 98.3	Pepper--sneeze 96.6
2	spank--bawl 95.7	<u>electricity--shock</u> 95.7
3	dynamite--explosion 94.9	dynamite--explosion 86.4
4	match--flame 93.6	mosquito--fever 83.0
5	mosquito--fever 91.5	exercise-perspiration 80.9
6	poison--agony 91.5	match--flame 80.9
7	electricity--shock 91.3	whirl--dizzy 80.4
8	torpedo--shipwreck 89.4	torpedo--shipwreck 74.5
9	sunshine--tan 87.0	sunshine--tan 73.9
10	<u>whirl--dizzy</u> 84.8	<u>spank--bawl</u> 69.6
11	alcohol--intoxication 83.0	cloud--shadow 67.8
12	exercise--perspiration 83.0	<u>germ--epidemic</u> 66.1
13	cloud--shadow 79.7	bomb--destruction 56.5
14	germ--epidemic 79.7	alcohol--intoxication 55.3
15	bomb--destruction 71.7	thunder--startle 46.8
16	<u>thunder--startle</u> 70.2	thorn--scratch 42.4
17	thorn--scratch 69.5	poison--agony 38.3
18	freeze--burst 65.8	freeze--burst 34.0
19	insult--anger 55.3	insult--anger 29.8
20	mistake--wreck 38.3	mistake--wreck 27.7
Med.	83.9	68.7

Table 12 (cont.)

V. Cause--Effect (cont.)

No.	Relative Recall Value
1	electricity--shock 104.8
2	pepper--sneeze 98.3
3	exercise--perspiration 97.4
4	whirl--dizzy 94.9
5	dynamite--explosion 91.1
6	mosquito--fever 90.7
7	match--flame 86.4
8	cloud--shadow 85.1
9	<u>sunshine--tan 85.0</u>
10	<u>torpedo--shipwreck 83.3</u>
11	germ--epidemic 83.0
12	bomb--destruction 78.9
13	spank--bawl 72.7
14	mistake--wreck 72.2
15	alcohol--intoxication 66.7
16	thunder--startle 66.7
17	thorn--scratch 61.0
18	insult--anger 53.9
19	freeze--burst 53.3
20	poison--agony 41.9
Med.	83.2

Discussion

The most surprising feature of the results is the discrepancy between the ease of learning and the ease of retention of the pairs representing the various categories. Antonyms were next to the hardest to learn, but next to the easiest, or the easiest, to retain. On the other hand, cause--effects stand in the middle of the rankings with regard to learning, but are forgotten the most rapidly of all.

The results from a preliminary experiment of similar nature suggest that the discrepancy is due either directly or indirectly to the commonness of the words used in forming the pairs. In the experiment mentioned no attempt was made to standardize the words in familiarity value. The antonyms were much more common than the cause--effect pairs. The results indicated that antonyms were both easiest to learn and easiest to retain, while cause--effect pairs were hardest to learn and hardest to retain. In this experiment, the antonyms are still somewhat more familiar than cause--effects (Table 6, p. 25) and much more easily retained, but they were harder to learn. This fact makes it almost necessary to distinguish between the effective factors operating in immediate and delayed recall.

An analogous or possibly more fundamental connection with the results from the "transposition" experiments

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with animals suggests itself. Kohler* discusses certain experiments in which chickens were trained to choose one side of a pair, for instance, the darker of two grays. Later they were tested with a "transposed pair" consisting of the darker of the two grays and a third still darker gray. When the interval of time between the training period and the first trials with the new pair was fairly long the chickens chose more often, not the "right" gray, but the one which was now the darker of the two. However, if the interval was short, the animals did choose the "right" gray quite as often as the new one. Kohler supposes that the reactions of the chickens during the learning period have distinguishable functional aspects. They "see" that one gray is darker than the other, but at the same time each stimulus is seen as a more or less definite nuance of gray. He supposed, further, that these functional aspects form "traces" in the organism which do not fade equally fast with time. The trace of the organization of grays is more stable than the traces of the particular nuances as such. Hence, after a comparatively long interval, the reaction of the animal is determined by the relationship of the grays rather than by the grays themselves.

*Kohler, Wolfgang, Gestalt Psychology, 1929, pp. 302-304.

Some such hypothesis affords a plausible interpretation of our results. We may suppose that immediate recall depends more upon the nature of the individual words forming a pair. Perhaps the most important factor is not the mere commonness of the words, but the degree to which they suggest concrete situations. When the attempt is made to standardize the words in familiarity the antonyms and synonyms tend to become abstract sooner than those forming the pairs of the other three categories. An inspection of the whole--part, object--attribute, and cause--effect relationships shows that they are more vivid or pictorial. It follows that these categories should be more easily learned as, in fact, they seem to be. After one week has elapsed, however, the cues from imagery are probably less effective. We may suppose that the response is now determined largely by the "logical" nature of the relationship. This factor will be considered in more detail later. But it would seem that when the two factors reenforce each other, as in the whole--part relationship, the pairs are both easily learned and retained.

III. Check Experiments

The major experiment raised a number of questions to some of which an answer was sought by means of various check experiments. The procedure in these experiments was similar to that used before. Any exceptions are noted in connection with the experiment in question. The instructions were somewhat modified. A copy may be seen on page 68. It will be seen that more emphasis was given to the avoidance of various possible sources of error. The subjects were informed of a delayed recall, but not until after the immediate recall. It was felt that this was necessary in order to explain the need for the subject's initials and, especially, that of refraining from any communication concerning the words of the list. The time at which the delayed recall would be required was left indefinite. The data from the check experiments was scored for accuracy only.

Instructions No. II.

Before Presentation

In this experiment you will be shown two words on a card e. g., bird--robin. Your task is to learn these words in such a way that if one is presented alone, e. g., bird, you will be able to recall the other, robin.

In the first part of the experiment, (25) pairs of words will be presented at intervals of 5 seconds. During this time you are simply to watch the screen and learn the pairs as they appear. This part may be called the learning period.

In the second part of the experiment, one word of each pair will be presented alone and you will be asked to write the others on a slip of paper provided for the purpose. This is the recall period. It will begin a few minutes after the learning period.

Please attend to the following points which lead to error in the results unless carefully observed:

- (1) Regard each pair of words as a separate lesson. It will probably be impossible to do this completely, but you can at least avoid making a deliberate effort to learn the list as such. It will not help to learn the order of the words, for example, because the order

will be changed for the recall. Failure to keep the pairs separate will lead to confusion.

(2) Confine the learning period to the 5 seconds during which the pair is exposed. It is important that no more effort be given to one pair than any other. Furthermore, we are as much interested in the words you forget as in those you remember. Hence, if a word is forgotten, do not obscure the fact by checking up with your neighbor.

(3) Work individually, influenced as little as possible by any attempt to compete or cooperate with your neighbor. I do not wish to imply that you would deliberately try to beat the game. Certainly nothing is to be gained by doing so, since the work you do will count neither for nor against you as long as it indicates that you have taken the experiment seriously. But I know that it is hard to keep from glancing at your neighbor's work and being influenced by it, and urge you to avoid this as far as possible. Try to maintain a scientific rather than a personal attitude during the experiment. If you find this impossible I would prefer that you do not hand in a paper.

Are there any questions?

At the signal "ready" a white card will appear in the window of the screen followed by the first pair of

the series. This will serve to indicate the length of time which you will have for the learning of each pair.

Before Immediate Recall

When each word appears on the screen write the other member of the pair on your slip. Write the word which occurs to you whether you are certain that it is correct or not. If you leave out a word draw a line in the space to help keep the words in proper order. You will have 10 seconds in which to write each one.

Are there any questions?

The "ready" signal will be the same as before.

After Immediate Recall

Write your complete initials at the top of your slip. This is not for the purpose of checking up on you personally, but is necessary in order to identify each paper for comparison with others from the same person. Since one or more delayed recalls will be taken it is important that you do not discuss the experiment with anyone until you are told that it is completed.

Before Delayed Recall

If you took part in the experiment last week take one of these slips and write your initials at the top.

As each word appears on the screen you are to write the paired-word on your paper. Write the word which occurs to you whether you are certain that it is correct or not. If you leave out a word draw a line in the space to help keep the words in the proper order. You will have (10) seconds in which to write each one.

Are there any questions?

Begin to watch the screen at the signal "ready".

Check Experiment 1

Problem

A puzzling feature of the results from the major experiment was the fact that, although relatively few antonyms and synonyms were learned, they were retained more easily than some of the other categories. The responses for these categories indicated a tendency to substitute a synonym for an antonym and vice versa. We wondered if the presence of these two categories in the same list reduced the ease with which they could be learned. Check Exp. 1 was devised to answer this question.

Method

The material consisted of six pairs from each category selected in such a way that the immediate recall values averaged the grand average for the respective categories. Table 13 (p. 74) shows the standardizing values of the pairs chosen to represent each category. Although no attempt was made to equate the familiarity and classification averages to those of the general averages it can be seen that the differences are not large.

Two lists of twenty-four pairs were prepared by putting the synonyms, object--attribute, whole--part, and cause--effect pairs in one list and antonyms, object--attribute, whole--part, and cause--effect pairs in the other. List E (p.75) was learned by Group V numbering 23 subjects, and List F (p.76) by Group VI, 28 in number. Information concerning these groups is listed in Table 8 (p. 37). The majority of the subjects were upper-classmen in the College and School of Education. The regular procedure was followed with both groups except that only 5 seconds was allowed for each response in immediate recall.

Table 13
Standardizing Values of Material for Check Exp. 1

No.	I. Synonyms	Famil. Value	Class. Value	Immed. Rec. Val.
1	avoid--shun (2)	25.0	91.4	74.5
2	famous--renowned (10)	55.0	97.9	59.6
3	jeer--scoff (13)	8.0	95.5	82.6
4	lazy--indolent (14)	15.5	93.8	80.4
5	necessary--essential (16)	34.0	89.1	64.4
6	rapid--swift (19)	49.0	92.6	57.5
Average		27.8	92.4	69.8
Grand Average		31.6	92.5	66.9
II. Antonyms				
7	create--destroy (3)	39.0	89.1	78.0
8	idle--busy (11)	46.0	86.7	68.1
9	indulge--abstain (12)	7.5	94.2	78.7
10	kindness--cruelty (15)	25.0	85.4	71.7
11	sharp--dull (17)	37.0	96.5	74.5
12	strength--weakness (20)	40.0	83.3	80.4
Average		32.1	90.8	75.2
Grand Average		38.5	90.0	76.5
III. Object--Attribute				
13	diamond--sparkling (6)	30.5	96.5	83.1
14	glass--brittle (8)	38.0	100.0	87.2
15	ice--slippery (11)	38.5	94.8	87.2
16	orange--juicy (14)	25.0	98.2	83.0
17	rabbit--timid (17)	23.5	100.0	87.2
18	tiger--ferocious (19)	10.0	96.2	87.0
Average		27.6	97.6	85.8
Grand Average		27.6	96.0	85.5
IV. Whole--Part				
19	bicycle--seat (6)	43.5	92.7	88.1
20	box--lid (7)	47.0	93.0	89.3
21	cow--horn (9)	50.0	83.3	89.1
22	dinner--soup (11)	47.5	79.6	89.4
23	rat--tail (17)	43.0	95.8	91.5
24	volume--chapter (19)	23.0	93.1	91.5
Average		42.3	89.6	89.9
Grand Average		33.5	91.8	89.8
V. Cause--Effect				
25	alcohol--intoxication (1)	6.0	91.1	83.0
26	cloud--shadow (3)	57.0	83.6	79.7
27	exercise--perspiration (6)	27.5	79.3	83.0
28	germ--epidemic (8)	7.0	92.7	79.7
29	sunshine--tan (16)	23.5	79.2	87.0
30	whirl--dizzy (20)	15.5	75.0	84.8
Average		22.8	83.5	82.8
Grand Average		21.1	81.5	80.6

List E

No.	Presentation Order	Immed. Recall Value	Delayed Recall Order
1	rapid--swift (I,19)	16	3
2	ice--slippery (III,11)	12	5
3	dinner--soup (IV,11)	13	15
4	cloud--shadow (V,3)	4	14
5	tiger--ferocious (III,19)	15	20
6	sunshine--tan (V,16)	24	23
7	volume--chapter (IV,19)	10	7
8	lazy--indolent (I,14)	9	18
9	glass--brittle (III,8)	21	13
10	famous--renowned (I,10)	18	16
11	alcohol--intoxication (V,1)	14	11
12	bicycle--seat (IV,6)	20	2
13	whirl--dizzy (V,20)	19	8
14	rabbit--timid (III,17)	2	1
15	necessary--essential (I,16)	1	12
16	cow--horn (IV,9)	3	24
17	exercise--perspiration (V,6)	8	4
18	box--lid (IV,7)	23	19
19	avoid--shun (I,2)	22	21
20	orange--juicy (III,14)	17	22
21	jeer--scoff (I,13)	6	6
22	rat--tail (IV,17)	7	10
23	germ--epidemic (V,8)	11	17
24	diamond--sparkling (III,6)	5	9

List F

No.	Presentation Order	Immed. Recall Order	Delayed Recall Order
1	sharp--dull (II,17)	8	15
2	glass--brittle (III,8)	22	8
3	cloud--shadow (V,3)	17	13
4	cow--horn (IV,9)	4	14
5	dinner--soup (IV,11)	7	5
6	tiger--ferocious (III,19)	13	11
7	sunshine--tan (V,16)	3	18
8	create--destroy (II,3)	12	24
9	volume--chapter (IV,10)	20	1
10	orange--juicy (III,14)	1	16
11	kindness--cruelty (II,15)	2	6
12	whirl--dizzy (V,20)	10	9
13	bicycle--seat (IV,6)	21	19
14	diamond--sparkling (III,6)	5	2
15	strength--weakness (II,20)	19	3
16	alcohol--intoxication (V,1)	14	22
17	idle--busy (II,11)	23	10
18	rabbit--timid (III,17)	18	21
19	germ--epidemic (V,8)	24	4
20	rat--tail (IV,17)	9	12
21	ice--slippery (III,11)	11	20
22	indulge--abstain (II,12)	15	17
23	box--lid (IV,7)	16	23
24	exercise--perspiration(V,6)	6	7

Results

The results are summarized in Table 14 (p. 78).

The differences shown are those between the averages for Lists E and F. It should be noted that the averages for synonyms and antonyms are not as reliable as those for the other three categories since they are based on only about half the number of cases. Diagram 6^(p. 79) shows a comparison of the rankings obtained in this experiment with those obtained in the major experiment when the data was scored for accuracy. Since the rankings in immediate recall are the same, the mere presence of synonyms and antonyms in the same list probably does not affect the ease with which they can be learned. However, a study of the responses in general indicate that if the ideas expressed by two pairs are similar there is a tendency to confuse the terms. Hence the measures are undoubtedly to that extent a function of the list in which the pairs occur.

Table 14

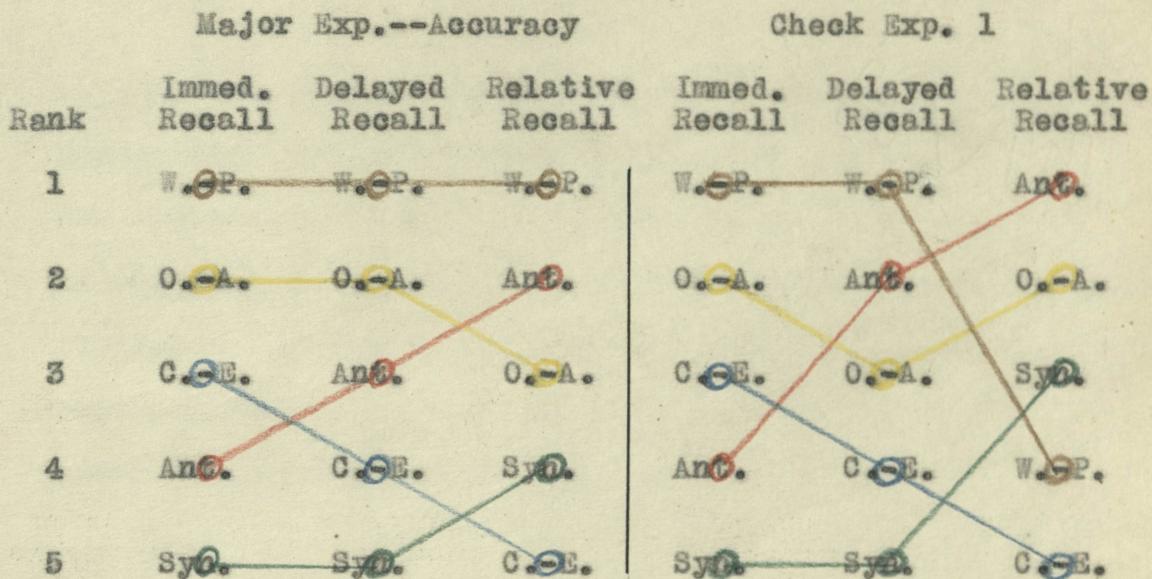
Summary of Results for Check Experiment 1

Rank	Category	List E.	List F.	Av.	Diff.
A. Immediate Recall					
1	Whole--Part	86.2	89.9	88.1	9.6
2	Obj.--Attribute	78.3	78.6	78.5	8.2
3	Cause--Effect	66.7	73.8	70.3	0.7
4	Antonyms		69.6	69.6	4.4
5	Synonyms	65.2		65.2	
	Total Difference				22.9
B. Delayed Recall					
1	Whole--Part	75.4	72.0	73.7	1.1
2	Antonyms		72.6	72.6	5.1
3	Obj.--Attribute	68.8	66.1	67.5	11.7
4	Cause--Effect	54.4	57.1	55.8	0.7
5	Synonyms	50.1		55.1	
	Total Difference				18.6
C. Relative Recall					
1	Antonyms		104.3	104.3	16.2
2	Obj.--Attribute	88.0	84.1	86.1	1.7
3	Synonyms	84.4		84.4	0.6
4	Whole--Part	87.4	80.1	83.8	4.3
5	Cause--Effect	81.5	77.4	79.5	
	Total Difference				24.8

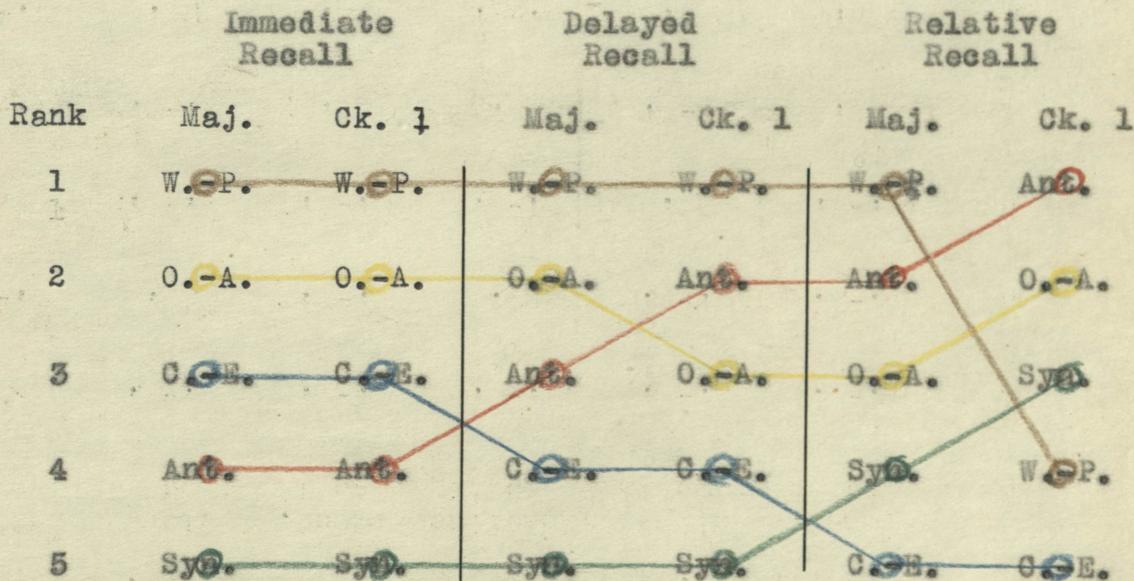
Diagram 6

Comparison Of Ranks--Check Exp. 1

A. By Experiments



B. By Measures Of Recall



Check Experiment 2

Problem

It was noted that the ease with which the categories were retained was positively correlated with the averages of their familiarity values. We wondered if the average familiarity value of a category was sufficient to determine the ease with which the pairs representing it could be recalled. An answer to this query was sought in Check Exp. 2.

Method

Five pairs were selected from each category in such a way as to reverse the averages of their familiarity values from those of the grand averages. Thus:

Category	Grand Famil. Average	Famil. Average for List G
Antonyms	38.5	18.7
Whole--Part	33.5	22.1
Synonyms	31.6	32.5
Object--Attribute	27.6	34.8
Cause--Effect	21.1	36.7

The pairs and their standardizing values are listed in Table 15 (p. 82). No attempt was made to control the classification and immediate recall values.

List G (p. 83) was prepared and presented to two groups totaling 45 subjects (See p.37). The majority were upper-classmen in the College and School of Education. Group VII had 5 seconds for each response in immediate recall and Group VIII, 10 seconds. Ten seconds per response was allowed for both groups in delayed recall.

Table 15

Standardizing Values of Material for Check Exp. 2

No.	I. Synonyms	Famil. Value	Class. Value	Immed. Rec. Val.
1	brave--fearless (4)	33.0	95.8	51.1
2	climb--ascend (6)	35.5	90.7	95.7
3	cure--heal (7)	27.0	89.3	85.1
4	famous--renowned (10)	55.0	97.9	59.6
5	necessary--essential (16)	34.0	89.1	64.4
Average		32.5	92.6	71.3
Grand Average		31.6	92.5	66.9
II. Antonyms				
6	giant--dwarf (8)	26.0	86.7	95.6
7	guilty--innocent (9)	24.5	90.4	95.6
8	indulge--abstain (12)	17.5	94.2	76.7
9	intelligent--stupid (15)	12.5	93.2	66.1
10	kindness--cruelty (15)	23.0	85.4	71.7
Average		18.7	90.0	80.8
Grand Average		38.5	90.0	76.5
III. Object--Attribute				
11	bee--industrious (2)	57.5	94.1	93.2
12	deck--flat (4)	38.5	92.1	97.9
13	diamond--sparkling (6)	30.5	96.5	85.1
14	ice--slippery (11)	38.5	94.8	87.2
15	razor--sharp (18)	29.0	95.5	100.0
Average		34.8	94.8	92.3
Grand Average		27.6	96.0	85.5
IV. Whole--Part				
16	banjo--string (3)	14.5	92.0	95.7
17	barrel--hoop (4)	18.0	90.4	87.2
18	comb--tooth (8)	23.0	92.3	93.5
19	lion--mane (15)	32.0	98.1	95.7
20	volume--chapter (19)	23.0	93.1	91.5
Average		22.1	93.2	92.7
Grand Average		33.5	91.8	89.8
V. Cause--Effect				
21	cloud--shadow (3)	57.0	83.6	79.7
22	freeze--burst (7)	35.0	80.4	63.8
23	insult--anger (9)	26.5	82.1	55.3
24	match--flame (10)	38.5	75.0	93.6
25	thorn--scratch (17)	26.5	70.2	69.6
Average		36.7	78.3	72.4
Grand Average		21.1	81.5	80.6

Table G

No.	Presentation Order	Immed. Recall Value	Delayed Recall Value
1	cure--heal (I,7)	8	15
2	ice--slippery (III,11)	16	16
3	indulge--abstain (II,12)	5	13
4	volume--chapter (IV,19)	19 *	12
5	match--flame (V,10)	21	3
6	famous--renowned (I,10)	12	7
7	comb--tooth (IV,8)	9	5
8	guilty--innocent (II,9)	18	17
9	diamond--sparkling (III,6)	23	1
10	insult--anger (V,9)	1	14
11	brave--fearless (I,4)	2	20
12	barrel--hoop (IV,4)	24	9
13	thorn--scratch (V,17)	17	8
14	giant--dwarf (II,8)	10	10
15	bee--industrious (III,2)	4	24
16	climb--ascend (I,6)	25	2
17	deck--flat (III,4)	11	11
18	cloud--shadow (V,3)	7	19
19	lion--mane (IV,15)	3	18
20	intelligent--stupid (II,13)	14	4
21	freeze--burst (V,7)	13	23
22	razor--sharp (III,18)	6	6
23	kindness--cruelty (II,15)	22	25
24	banjo--string (IV,3)	15	21
25	necessary--essential (I,16)	20	22

Results

The results are summarized in Table 16 (p. 85).

The response of two groups to the same list is fairly constant. The higher relative recall averages for Group VIII may be due to the fact that this group had a longer period for each response during immediate recall. The five second period may hurry the response too much, or the longer period may lead to some relearning even though the subject is not expecting a delayed recall. The differences shown are those between the averages for the two groups.

Diagram 7 (p. 86) shows a comparison of the rankings obtained in this experiment with those occurring in the major experiment--data scored for accuracy. Lowering the familiarity value of antonyms affects the position of this category in the series more than raising the corresponding value of cause--effects influences its position. Antonyms become even harder to learn than synonyms. The ease with which the antonyms are retained, however, is not changed so much. It is suggested that, since the antonyms are composed largely of adjectives, they tend to become abstract as the familiarity value is lowered. And that this abstractness makes the relationship more difficult to grasp.

Table 16

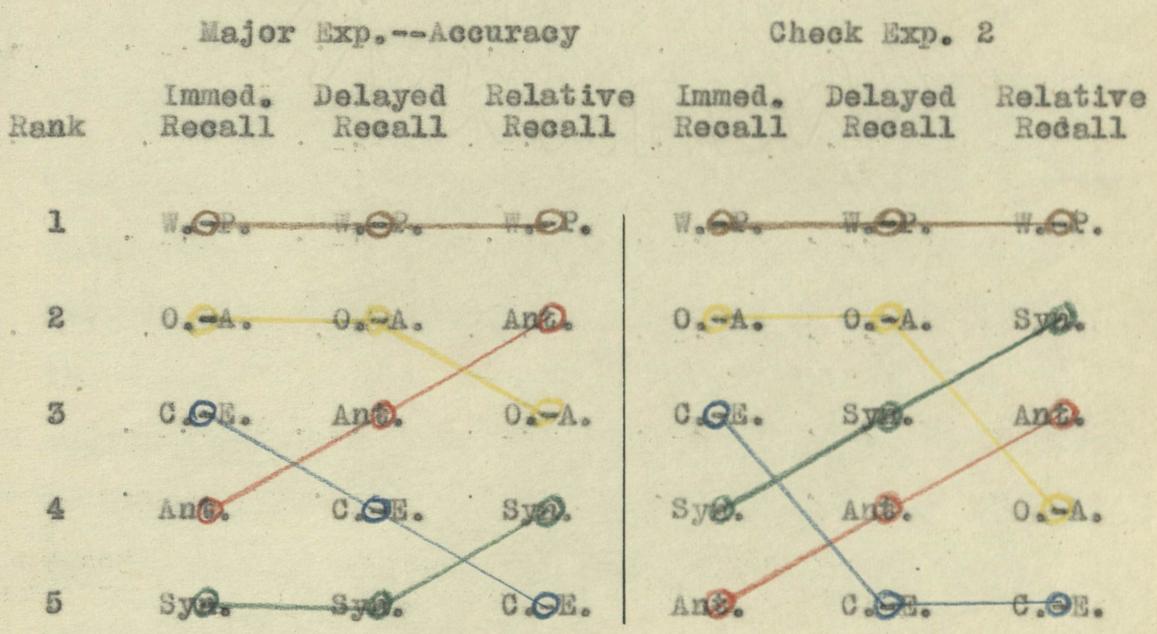
Summary of Results
for
Check Experiment 2

Rank	Category	Gr.VII.	Gr. VIII.	Av.	Diff.
A. Immediate Recall					
1	Whole--Part	90.4	95.5	93.0	7.6
2	Object--Attribute	85.2	85.5	85.4	14.7
3	Cause--Effect	72.2	69.1	70.7	2.2
4	Synonyms	68.7	68.2	68.5	0.5
5	Antonyms	70.4	65.5	68.0	25.0
	Total Difference				
B. Delayed Recall					
1	Whole--Part	85.5	94.5	89.0	19.1
2	Object--Attribute	66.1	73.6	69.9	12.5
3	Synonyms	57.4	57.3	57.4	1.4
4	Antonyms	58.3	55.6	56.0	4.8
5	Cause--Effect	47.8	54.5	61.2	37.8
	Total Difference				
C. Relative Recall					
1	Whole--Part	92.3	99.0	95.7	11.9
2	Synonyms	83.5	84.0	83.8	1.5
3	Antonyms	82.7	81.9	82.3	0.4
4	Object--Attribute	77.6	86.2	81.9	9.3
5	Cause--Effect	66.3	78.9	72.6	23.1
	Total Difference				

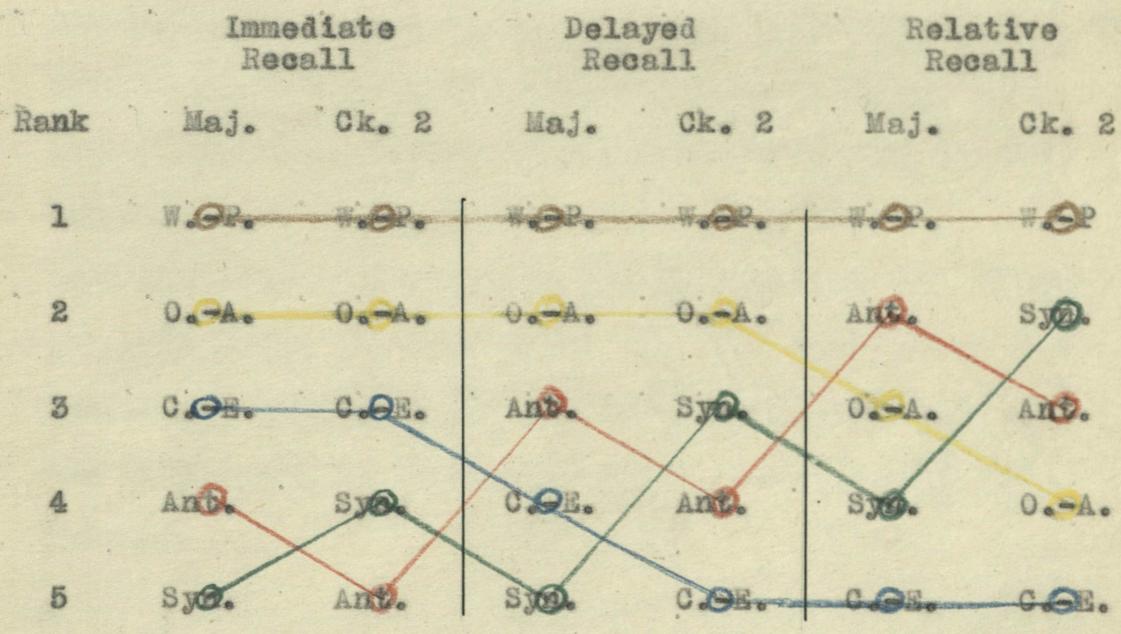
Diagram 7

Comparison Of Ranks--Check Exp. 2

A. By Experiments



B. By Measures Of Recall



Check Experiment 3

Problem and Method

In this experiment we prepared a list composed of those pairs which most adequately represented the various categories, i. e., which had the highest classification values. The pairs were further chosen so as to equate the immediate recall averages. No attempt was made to control the familiarity values. The standardizing values of the material are listed in Table 17 (p. 89). List H (p. 90) shows the order in which the pairs and recall words were presented.

Presumably, according to associationistic principles, the immediate recall value of a pair measures the frequency with which the two words have appeared together in the past. If, then, a list is prepared in the way we have described and the categories still vary uniformly in the ease with which their pairs can be retained, the evidence can only favor the conclusion that the differences are due to the nature of the cognized relation rather than any mechanical or quasi-mechanical connection between the terms.

The regular procedure was followed during the experimental periods. Ten seconds was allowed for the responses in both immediate and delayed recall. The list was presented to one group (Group IX, p. 37) numbering 54 subjects. The majority were upper--classmen in the College and School of Business.

Table 17

Standardizing Values for Material

Used in Check Experiment 3

I. Synonyms	Famil. Value	Class Value	Immed. Recall Value
1. calm--quiet (5)	48.5	90.3	95.6
2. climb--ascend (6)	35.5	90.7	95.7
3. jeer--scoff (13)	8.0	95.5	82.6
4. lazy--indolent (14)	15.5	93.8	80.4
5. ordinary--common (17)	44.5	94.1	84.8
Average	30.4	92.9	87.4
II. Antonyms			
6. clean--dirty (2)	44.0	98.2	93.6
7. easy--difficult (6)	52.5	91.7	87.0
8. indulge--abstain (12)	7.5	94.2	78.7
9. sharp--dull (17)	37.0	96.3	74.5
10. smooth--rough (19)	48.0	98.1	89.4
Average	37.8	95.7	84.6
III. Object--Attribute			
11. butter--greasy (3)	33.0	98.1	73.9
12. fox--sly (7)	28.0	98.0	98.5
13. glass--brittle (8)	38.0	100.0	87.2
14. orange--juicy (14)	25.0	98.2	83.0
15. rabbit--timid (17)	23.5	100.0	87.2
Average	29.5	98.9	85.9
IV. Whole--Part			
16. automobile--gender (1)	19.0	95.8	84.8
17. band--drummer (2)	45.0	98.1	69.6
18. box--lid (7)	47.0	93.0	89.8
19. lion--mane (15)	32.0	98.1	95.7
20. rat--tail (17)	43.0	95.8	91.5
Average	37.2	96.2	86.3
V. Cause--Effect			
21. alcohol--intoxication(1)	6.0	91.1	83.0
22. germ--epidemic (8)	7.0	92.7	79.7
23. mosquito--fever (12)	19.0	86.5	91.5
24. poison--agony (14)	20.5	88.3	91.5
25. torpedo--shipwreck (19)	5.5	88.9	89.4
Average	11.6	89.5	87.0

		List H	
No.	Presentation Order	Immed. Recall Value	Delayed Recall Value
1	rat--tail (IV,17)	16	5
2	easy--difficult (II,6)	17	25
3	mosquito--fever (V,12)	20	13
4	ordinary--common (I,17)	19	4
5	fox--sly (III,7)	18	24
6	calm--quiet (I,5)	2	8
7	automobile--fender (IV,1)	3	12
8	torpedo--shipwreck (V,19)	1	7
9	smooth--rough (II,19)	4	6
10	butter--greasy (III,5)	5	3
11	band--drummer (IV,2)	7	10
12	climb--ascend (I,6)	8	23
13	poison--agony (V,14)	10	1
14	rabbit--timid (III,17)	9	9
15	sharp--dull (II,17)	6	2
16	box--lid (IV,7)	25	22
17	orange--juicy (III,14)	24	18
18	jeer--scoff (I,13)	21	17
19	alcohol--intoxication	22	21
20	indulge--abstain (II,12)	23	11
21	glass--brittle (III,8)	13	15
22	lazy--indolent (I,14)	15	14
23	germ--epidemic (V,8)	14	16
24	lion--mane (IV,15)	11	20
25	clean--dirty (II,2)	12	19

Results

Diagram 8 (p. 93) summarizes the results obtained in this experiment. The immediate recall averages of the categories are not equal, but the differences are considerably reduced. What difference remains is probably due to such uncontrolled factors as the familiarity averages and the composition of the list from which the measures were secured. The responses indicated a tendency to confuse the terms of "germ--epidemic" with those of "mosquito--fever". The similarity in the ideas expressed by these two cause--effects was overlooked when the list was prepared. Diagram 9 (p. 94) shows that the rankings in relative recall are the same as those of the major experiment when the results were scored for relationship thus: (1) antonyms, (2) whole--parts, (3) synonyms, (4) object--attributes, (5) cause--effects.

Further analysis of the data reveals the fact that over 16% of the subjects made a better score in delayed recall than in immediate recall. Moreover, as shown by Table 18 (p. 95) the same phenomenon occurred in differential amounts for each category. The order of the percentages from largest to smallest is about the same as that for relative recall. It is evident that the rate

of forgetting measures, not simply the number of items lost, but the balance between items lost, retained, and gained. This factor probably operated in all the experiments and may account for the relative recall values obtained in the major experiment which were more than 100%.

Diagram 8
 Summary Of Results
 For
 Check Experiment 3

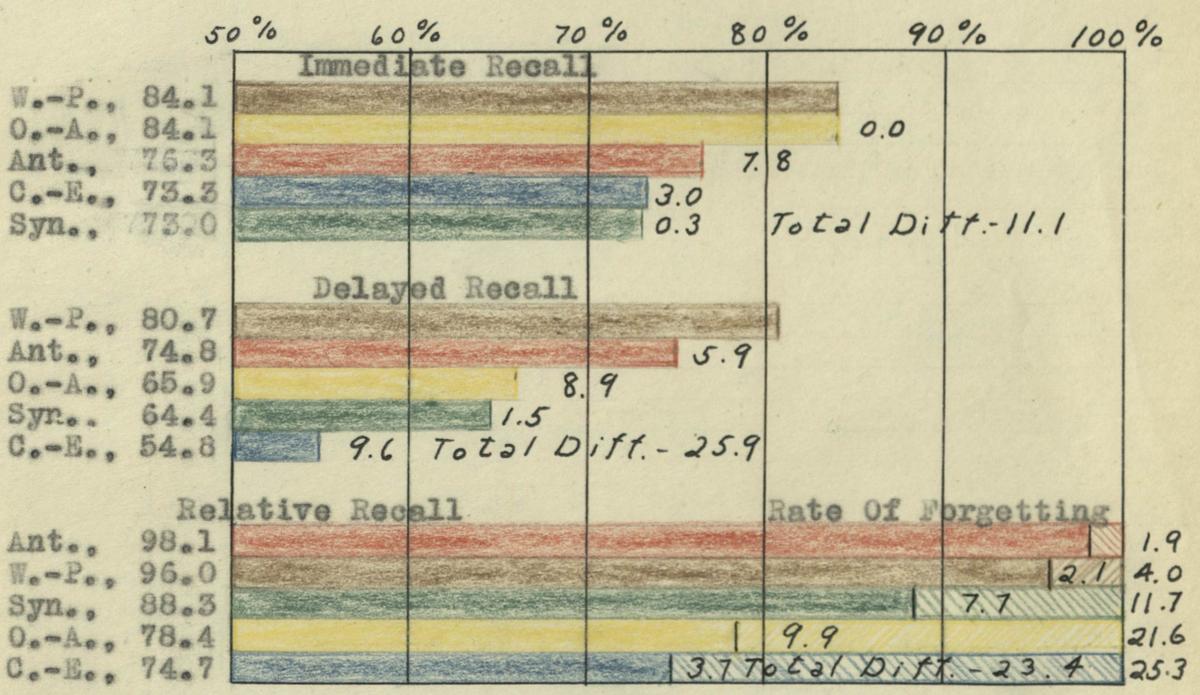
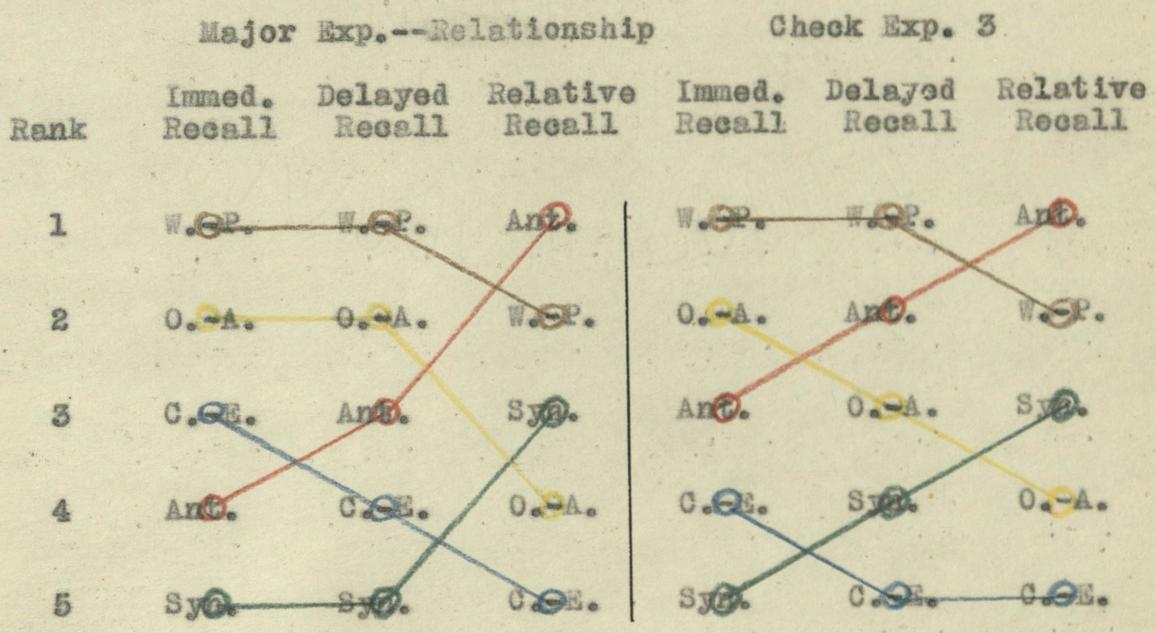


Diagram 9

Comparison Of Ranks--Check Exp. 3

A. By Experiments



B. By Measures Of Recall

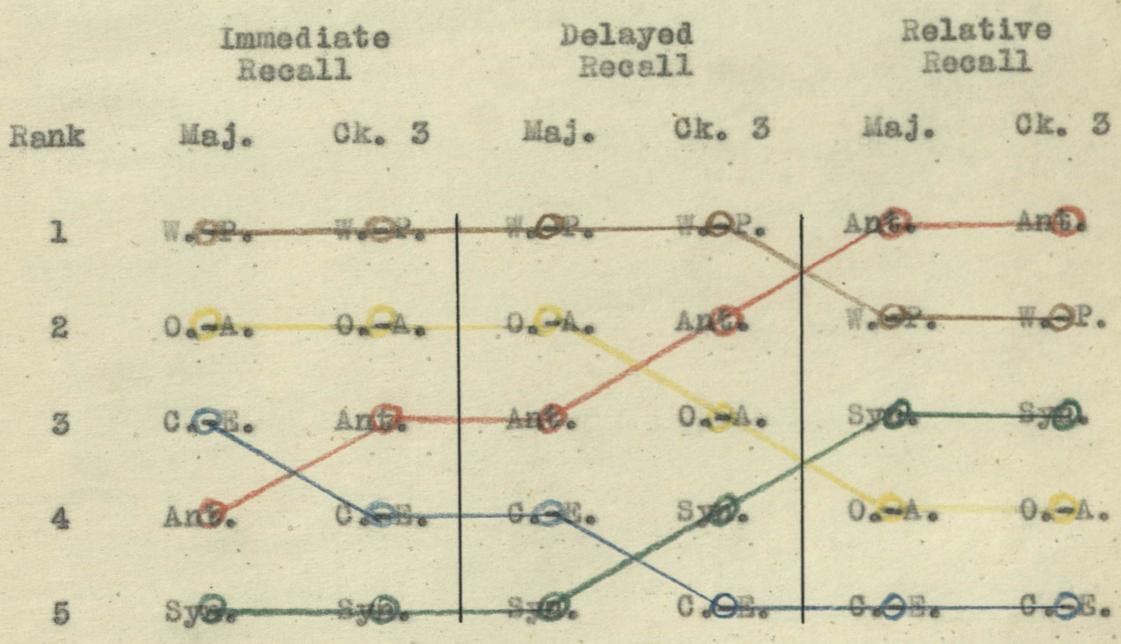


Table 18

Percentage of Subjects Who Responded With More, Same and Less Correct Items in Delayed Recall Than in Immediate Recall for the Categories Indicated and the Total List.

Category	More	Same	Less
Antonyms	31.5	37.0	31.5
Whole--Part	20.4	53.7	25.9
Synonyms	14.8	38.9	46.3
Cause--Effect	14.8	24.1	61.1
Total List	16.7	11.1	72.2

Discussion

The phenomenon technically known as "reminiscence" was first reported and named by Ballard* in 1913. He allowed children to partially learn various selections of poetry. An immediate recall was taken and also several unexpected delayed recalls at different intervals for different groups. The results show that about 28 to 55 per cent of the children reproduced more items in delayed than in immediate recall. The size of the percentage varies with the interval of time, the nature of the material, and the age of the subjects. The younger children learned least and showed the greatest gain on the second reproduction. Other investigators have obtained similar results. Brown# found some signs of reminiscence in adults, but so far the age of the subject has been the outstanding condition.

Hunter" after summarizing the literature on the subject reports that no adequate explanation for reminiscence

*Ballard, P. B. Obliviscence and reminiscence. Brit. J. Psychol., Monog. Suppl., 1913, 1, No. 2.

#Brown, W. To what extent is memory measured by a single recall? J. Exper. Psychol., 1923, 6, 377-382.

"Hunter, W. S. Experimental studies of learning. In the Foundations of Experimental Psychology (1929), edited by C. Murchison, 608-610.

is at present established. Both a theory of inhibition and a theory of neural growth have been advanced. Ballard favors the latter. Hunter points out that some items are lost as well as some recovered in the second test, and that Ballard's theory would account for the recovery but not for the loss.

The evidence for reminiscence, although entirely unexpected, is one of the most interesting results of this investigation. The fact that it occurs in different amounts for the various categories suggests that it is partially dependent on the nature of the relationships involved. The logical character of the relation may be descriptive of some functional aspect which permits greater "neural growth" in one case than another. This would help account for the lost items; it would also explain the more frequent occurrence of the phenomenon in meaningful than in nonsense material.

It is, perhaps, unfortunate for the reliability of our evidence that the subjects were informed of a delayed recall. On the other hand, it is not likely that "goal tendencies" can be ignored. The dearth of positive evidence for the occurrence of reminiscence in adults may be partially due to the absence of this factor. A selection of poetry the meaning of which was obvious and promptly forgotten by adults might occasion

considerable effort at understanding on the part of children. Whether this effort is conscious or not is aside from the point since its functional aspects are probably alike in both cases.

Check Experiment 4

Problem and Method

In the preceding experiments no introspections were secured. It was felt that some observations regarding the methods used in learning and recall might be helpful in interpreting the results. Accordingly, List A (p.) was presented to a group of ten advanced students in the Department of Psychology (Group X, P.). Time was allowed for recording introspections following the learning period and the presentation of each word during immediate and delayed recall. Eleven days elapsed between the two experimental periods.

Results

A few of the subjects knew too much about the experiment to make the best of observers. Their reports, however, were not much different from those of the others. All subjects reported the perception of relations and in some cases particular kinds were mentioned, especially antonyms and synonyms. Most of the subjects reported the use of concrete situations as memory aids and thought that those pairs were most easily learned which lent

themselves to such devices. A tendency to associate some of the pairs was observed. One subject mentioned that the more obscure pairs were repeated several times and one the attempt to use the length of the word as a cue. On being questioned this observer said that he had just recently read an article which mentioned the use of this cue in material presented tachistoscopically.

The detailed introspections on recall give little hint as to why one pair should be more easily retained than another. In general, however, the better learners made use of more concrete imagery. In delayed recall this imagery had faded. In many cases the word simply "popped" into mind.

The group was too small to give much reliance to the quantitative results. They were similar, however, to those obtained for List A in the major experiment. Fifty percent of the subjects made a better score on the second test than on the first. This group could have had no reason for disregarding the instructions about communication.

IV. Summary and Interpretation

Summary

We may summarize the experimental results of this investigation as follows:

(1) Relationships were more easily recalled than the exact words by which they were expressed.

(2) The categories were recalled with different degrees of facility when scored for both accuracy and relationship. The differences were less for the latter method of scoring than for the former.

(3) There was a lack of correlation between the ease with which a category could be learned and that with which it could be retained. The relative position of the categories for either learning and retention, however, varied little for the different methods of scoring.

(4) Antonyms were harder to learn than the cause--effect pairs, but much more easily retained. When the familiarity average of antonyms was made lower than that of cause--effect category, antonyms became more difficult to learn than before but were still retained better than the cause--effect pairs.

(5) The mere presence of antonyms and synonyms in the same list probably does not affect the ease with which they can be learned and retained.

(6) The more adequately the categories were represented by the pairs selected and the more nearly the immediate recall averages were equated, the greater became the differences in the ease with which they were retained.

(7) Correct items appeared in delayed recall which were omitted or incorrect in immediate recall. The percentages of persons responding with reminiscent items for the various categories were in approximately the same order as the relative recall averages.

(8) Introspective data indicated that the better learners "embodied" the relation in a concrete situation.

Interpretation

The writer has been unable to explain the results of this study on the basis of a mechanical "association" formed either directly or indirectly between two processes in the nervous system. It would be granted at once, no doubt, that we have to deal, not with the formation of connections, but with their reinstatement. Furthermore, the immediate conditions of the investigation usually considered as significant could not account for the variability in the functional strength of the associations classified under the various categories. Such

conditions as contiguity or simultaneity, frequency, length of material, ordinal position in a series, and recency were practically the same for all categories. It seems necessary to assume, then, that immediate recall measures the relative strength of associations already formed.

The chief difficulty arises when we try to account for the changed variability in the strength of the associations at the time of delayed recall. The external conditions were approximately the same during the two recalls. And it is difficult to see how any change in the health or attitude of the subjects could influence the response to the categories unequally and in so much the same manner from group to group.

It might be supposed that the associations were of different ages and that, following Jost's law, the single repetition increased the strength of the older more than that of the younger. Since the connection between antonyms is apparently strengthened more than that between the pairs of any other type, it would follow that they are the oldest. But it has been found that children respond less frequently with antonyms than with other types of associations (p. 7). Hence the possibility of using this law is precluded.

Retroactive inhibition might account for the change in the rate of forgetting some categories. For instance, the interpolated activity between the presentation and immediate recall involved "light" conversation. Cause--effects may be retained fairly well because the interpolated activity is quite dissimilar. After the immediate recall regular class work is resumed which, presumably, is of a more causal nature. Hence, retroactive inhibition may so operate that cause--effects are forgotten quite rapidly.

But, while this factor might account for the variability in the rate of forgetting the items of some categories, it certainly could not explain the appearance of reminiscent items. For this, we must assume quite a different factor--a facilitating rather than an inhibiting process. A memory review could hardly be supposed to occur unless an item was originally remembered. And, furthermore, the phenomenon occurred with subjects who could have no possible motive for disregarding the instructions regarding communication.

If some one better versed in the principles of associationistic psychology could present a solution of our problem we would be glad to hear it. But, if

it is relegated to the limbo of those problems too complex for solution in the present state of the science, then surely no proper objection can be made if, in the meantime, we seek other types of explanation.

The principles enunciated by Spearman in *The Nature of Intelligence and the Principles of Cognition*, if not entirely adequate for our problem, are certainly more satisfactory than the traditional "laws of learning". The paragraph most relevant is the following (p. 146): "Suppose...that any person has at some previous time apprehended any two items as mutually related. Consider what can ensue when the same person happens to present to mind one of these two items again, but now alone. As the immediate result, the previously presented relation may be re-evoked; and for this purpose, nothing can possibly serve except a process of reproductive kind. But when once this much has been effected, then either a reproduction, or an eduction, or both coincidentally, can proceed to re-evoke the other of the two previous items."

It has been suggested that these principles be applied somewhat as follows: Suppose that during the presentation the relation intended for the pairs representing each category is cognized with about the same degree of facility. The fact that the differences

between the categories become considerably reduced when scored for relationship lends some support to this assumption. During the recall period, then, when one word of the pair is presented alone, the previously cognized relation is reproduced. This relation, in turn, brings to mind the other word of the pair either by a process of reproduction, or of "eduction", or both together. These processes are not infallible, of course, but if the relation is correctly cognized and reproduced we might say that the correct word has two chances of being re-evoked instead of only one.

During immediate recall the reproductive processes would be more likely to predominate. The differences in their strength would account for the differences in the categories during this period. At the time of delayed recall, however, we may assume that the eductive processes are most effective. These processes are of a more selective or inferential sort than the ordinary associative processes. Presumably, such a process would operate with the greatest effectiveness where the alternatives are fewest in number. This would seem to be true in the case of antonyms. Most words have only one or a few antonyms. In the case

of the object--attribute relationship, on the other hand, any one of a number of attributes might be educed. The chances, then, would be more favorable for the selection of the correct antonym than for that of the correct attribute. If this held true in relative degree for the other categories we could account for the rankings in delayed recall. As mentioned in the introduction (p. 5), Wreschner used a similar explanation in accounting for the differences in reaction time to various types of controlled associations.

The chief difficulty with the above explanation is with regard to the reproductive processes. Why should the reproduction of a relation be more stable than the reproduction of a "correlate"? In other words, why should the rankings change from immediate to delayed recall and thus make it necessary to call the eductive processes to our aid? Furthermore, how shall we account for the appearance of reminiscent items? Why should a relation reproduce or educe a correlate in delayed recall which did not appear during the immediate recall? It would seem that some more dynamic process is needed which will account, at once, for the phenomena of reproduction, eduction, and reminiscence.

Gestalt or "organismic" psychology has much to say about such a process. Psychologists of this school would deny the validity of distinguishing between reproductive and eductive processes or, indeed, that of making any real distinction between relations and the terms related. All conscious processes are regarded as being of the eductive or "insightful" variety. Furthermore, such a phenomenon as that of reminiscence is not extraneous to the system, but is regarded as typical of the nature of all learning. We may, therefore, turn to organismic principles with some hope of resolving our difficulties.

Assuming that the same effort is expended in learning the pairs of all categories, it is necessary to account for the variability in the ease with which the second member of the pair is recalled on the presentation of the first. Even though we admit that the logical interpretation given any pair is merely descriptive, it may nevertheless point to something inherent in the nature of the psychophysical pattern involved which will aid us in explaining the relative ease with which it is retained. Let us consider synonyms and antonyms. Here the difference is not altogether that of similarity and contrast. Two synonyms such as "rapid--swift" have a certain identity of meaning: both refer to similar degrees of speed. Two antonyms, however, also have a

certain identity of meaning. "Slow--rapid", for example, both refer to degrees of speed, but to opposite or extreme degrees. The system is, so to speak, "closed"; we have two extremes of an identity. In the case of synonyms, on the other hand, we have identity but little difference. It is difficult if not impossible to form a system without some difference as well as identity. The system in this case is more "open". It is suggested that the degree of "openness" or "closedness" of the pattern evoked by a pair accounts for the ease of its retention, at least, when the interval is comparatively long. It would seem that two words are more adequate for the expression of opposition than for any other relation. It is doubtful if one can think of an object and a part or attribute without imagining other parts or attributes. And before two words can suggest causality it is necessary to build up a rather elaborate imaginal situation. These other aspects of the pattern may become so outstanding as to replace the original item in recall. The more aspects the pattern possesses the greater are the chances for substitution.

It has already been suggested (p.66) that these imaginal aspects may be an aid rather than a hindrance in immediate recall. But in delayed recall the closed pattern is more stable and hence more easily retained.

Furthermore, we must assume that learning, in some sense, continues at least as long as the subject feels the need of retaining the words. The patterns undergo a process of maturation even to the extent, perhaps, of permitting the "differentiation" of some items in delayed recall which did not appear before. Here, again there appears to be a positive correlation between the "closeness" of a pattern and the degree to which it leads to the production of reminiscent items. This interpretation, however, is more open to question.

V. Suggestions for Further Study

We will conclude by making some suggestions for further experimentation.

(1) The standardization of the pairs in familiarity is of doubtful value. Their "imaginal value" would seem to be a more significant factor. If this could be measured the immediate recall values of the pairs might become more subject to control.

(2) Suggestive data might be secured by presenting the second member of each pair in recall instead of the first.

(3) It would be interesting to determine the effect of presenting the name of the category before each pair by which it was represented. This would make the perception of the intended relation more certain.

(4) A comparative study of the categories with respect to reminiscence and "oblivescence" over a longer period of time would be interesting.

(5) The applicability of Spearman's principles could be tested further by determining the variability of the responses to the first member of each pair in controlled association.

(6) An extended and careful introspective study

might yield data which would lead to a more psychological classification of the pairs.