

AN EXPERIMENTAL STUDY OF MEMORY.

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A complete act of memory requires that impressions shall be retained, recalled, and recognized as familiar and as belonging with certain other impressions. The perfectness of any act of memory depends upon the kind and intensity of the impressions and of the associations between them. Impressions are of six kinds, visual, auditory, motor, tactual, gustatory, olfactory, but the three first named are of most importance in memory. The following experiments were made to determine which of these three kinds of impressions are best retained, and to discover the relation existing between recall and recognition.

Method.—Thirty names of common objects were chosen and arranged in three columns as follows, care being taken not to put together words commonly associated :

I.	II.	III.
box	door	pen
desk	stool	spoon
thumb	slate	pencil
chain	rug	knife
cap	hinge	shears
broom	corn	spool
sock	peach	bottle
bird	shoe	thimble
axe	hat	spectacles
post	watch	book

The test was made upon the pupils of a typical school and college in all grades from the third primary up. The words in Column I. were pronounced to them at the rate of about one every two seconds ; those of Column II, having been previously written upon the board, were uncovered one at a time, and

rubbed out at about the same rate; while the objects named in Column III were shown at the same rate. In each case after the ten words were given the pupils wrote as many of them as they could remember. Three days later (in a few cases two days), at the same hour, the pupils were asked to write as many words of each column as they could remember. They were then given orally the following lists of words:

IV.	V.	VI.
loud	black	rat
bang	sparkle	spade
whisper	yellow	sheep
boom	red	rake
splash	gloom	nest
hiss	bright	mouse
buzz	green	leaf
whiz	white	hen
tinkle	shadow	cat
ring	pink	coat

They were asked to think of the sound of the first, of the visual appearance suggested by the second list, and of the objects named in the third. How closely they followed these directions it is impossible to say, but their faces indicated that they were trying to do so. There were a few indications in the papers of attempts to guess the words in Columns IV and V that they could not recall, but this was true of only a few.

Results.—The following table shows the average number of words in each list of ten recalled.

	Primary.		Gram. Sch.		High School		College.		Average.		Av. of Both Sexes.
	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	
Sex.....											
Number.....	15	15	39	47	58	53	50	102	162	217	379
Column I.....	5.46	4.33	6.48	6.17	7.29	6.94	7.20	7.38	6.90	6.79	6.85
“ II.....	5.66	3.86	6.57	5.72	7.09	7.26	7.28	7.81	6.88	6.95	6.92
“ III.....	7.26	6.80	8.28	7.85	8.38	8.83	8.56	8.60	8.18	8.36	8.28
“ IV.....	5.64	5.43	6.25	6.17	7.57	6.56	7.65	7.59	7.25	6.79	6.98
“ V.....	6.64	5.00	7.97	7.32	8.26	7.49	8.45	8.12	8.37	7.58	7.91
“ VI.....	5.71	5.56	7.25	7.22	7.57	7.35	7.90	7.85	7.59	7.40	7.48
Average.....	6.06	5.16	7.13	6.74	7.69	7.40	7.86	7.89	7.53	7.31	7.40

Reproduced after 3 days.

I.	No. of words recalled.....	....	....	1.51	1.20	1.23	.97	1.79	.95	1.47	1.10	1.25
	Placed in the right column..	....	....	1.20	.79	1.00	.76	1.29	.70	1.14	.74	.91
II.	Recalled. ....	....	....	2.89	2.05	2.51	1.53	3.22	1.95	2.75	1.86	2.23
	Correctly placed	....	....	2.58	1.71	2.35	1.36	2.24	1.55	2.38	1.53	1.89
III.	Recalled.....	....	....	6.46	6.33	6.67	6.29	5.44	6.58	6.23	6.44	6.35
	Correctly placed	....	....	6.23	6.33	6.66	6.27	5.44	6.47	6.16	6.39	6.29
	Recalled.....	....	....	3.62	3.19	3.47	3.06	3.48	3.16	3.45	3.13	3.27
	Average correctly placed ..	....	....	3.33	2.94	3.30	2.79	3.32	2.57	3.22	2.88	3.03

The averages for the first three lists of words, 6.85, 6.92, and 8.28 respectively, show that objects were remembered better than the written names, and the latter better than the spoken names. Doubtless some when they saw the written words thought of the sounds and perhaps retained them as auditory words, while others thought of the visual appearance of the spoken words and retained them as visual words. Many repeated softly the words both oral and written, thus getting motor sensations; and probably many formed mental pictures of the objects named. But, however differently they may have stored the words in memory, the difference in reproducing them, since they are all of the same character, must have been due mainly to the different ways in which they were impressed. The difference would probably have been greater had the conditions for seeing the written words and the objects shown been as good for all the pupils as they were for the spoken words.

The averages for the last three lists of words, 6.98, 7.91, and 7.48 respectively, show that the visual qualities are remembered better than sounds and also better than objects imaged. In this case the impressions were all auditory, but in so far as the pupils followed directions the method of storing was different in each case. The attempt to store as directed doubtless helped reproduction in some cases and hindered in others, but in general the pupils were helped by storing in visual images, as will be seen by comparing the reproduction of the names stored in their own way with those stored as a visual image.

The results of the reproduction after three days were rather surprising. Probably the most enthusiastic advocate of object teaching would hardly have dared assert that if the names of ten common objects were pronounced to and written by pupils they would after three days remember but one seventh as many of them as they would if they were allowed to look at each of the objects a fraction over a second and write the names, yet the numbers .91 and 6.29 indicate that such would be the result. These figures indicate also that the authors of memory systems in which the kinds of associations formed are the only things considered are at fault. Some ground is found for saying, "Make the impressions vivid and the associations will take care of themselves." It is worthy of note also that there were few mistakes in recalling and recognizing the names of the objects seen. If two papers in which all the names were in the wrong column, probably because the pupils made a mistake in the column, had been omitted in averaging, the number recalled and the number in the right column would have been practically the same. This and the fact that mental images of objects are remembered better than their names is of great pedagogical significance, indicating that if objects are shown children, or when that is impracticable, if they are led to form mental images of them, they can obtain a genuine knowledge of things more readily than they can be crammed with the verbal appearance of knowledge.

The table shows an increase, from the primary department up, in the power of immediate reproduction of words of all kinds, but the difference of only about two words between primary pupils and college students is not very great when we remember that it is not so much a matter of memory as it is of mental grasp, and that the younger pupils required longer time to write the words and hence would be more likely to let some of the words drop out of consciousness. In the reproduction after three days the college students show no superiority over the children. One reason for this may be because the experiment was more of an event to the younger pupils so that the words were more deeply impressed. (In one room they discussed it afterwards, each telling how many

words he remembered.) I noticed that the third day when I told them what was wanted, the grammar-school pupils began to write at once, while the college students hesitated, apparently making an effort to recall the words. This suggests, and many other facts make it probable, that children are equal or superior to educated adults in impressibility, in retention, and in spontaneous recollection, while the latter have gained more power of *voluntary* acquisition and recollection; hence culture of the memory is not so much an increase in the power to remember as in the power to determine *what* shall be remembered. It is interesting to note that in memory of spoken words, as compared with written, the younger pupils are superior, evidently because they have not had so much practice in dealing with visual as with spoken words.

This experiment, like others that have been made, indicates that females are superior to males in both immediate and delayed reproduction of words. This difference is most marked in the spoken words of sounds, while in memory of the objects seen the boys are slightly superior.

Individual differences were very marked both as to general memory-power and memory for the different kinds of words. Only two—a ninth-grade boy and a senior girl—reproduced all of the thirty words given at one time. Nearly all remembered objects better than words, and a few who remembered words poorly were as good as or better than the average in recalling the names of the objects. Some remembered written words very well and spoken words very poorly, and others the reverse; but quite a number reproduced them equally well, and sometimes the names of objects seen also. It seemed as if they could grasp just so many words and no more, whatever, the mode of presentation. Very few gave the words in order, and it was quite noticeable that the first and last words were less frequently omitted than any others.

Some months later, in order to supplement the above experiments, the following test was made upon 180 normal-school students, the first three lists of words being used. They wrote as many of the first list as they remembered, but for the second list they were requested to simply make a mark for each word they recalled. When the third list was

given they were requested to form a mental picture of the objects named. The averages were as follows :

I. 7.33, II. 7.80, III. 8.01.

To make sure that III was not easier to remember than I the experiment was reversed with thirty-four eighth-grade pupils. The averages were :

III. 7.56, I. 8.56.

Which showed beyond doubt that the names of objects are remembered better where mental images of the objects are formed.

Three days later the normal students were asked to write all of the words they could recall, putting them so far as possible in the right columns. The average numbers recalled were :

I. 2.61, II. 1.61, III. 4.22.

And the numbers correctly placed (recognized) were

I. 1.76, II. .53, III. 3.52.

The act of writing evidently had a very marked effect especially upon recognition, since but little more than one twentieth of the words not written were recalled and recognized. How much of this effect was due to motor sensations and how much to the more prolonged attention necessarily given to the words written it is impossible to say. Movements of the vocal organs were probably also an important factor in the retention of all the words, for inquiry revealed the fact that 77 students repeated all of the words after me ; and of those who did not, 32 repeated I, 26 II, and 18 III.

In order to determine to what extent the power to recognize completely or partially might remain when the limit of the power to recall has been reached, the thirty words originally given mixed haphazard with fifteen other names of common objects were read and the pupils told to write those that they thought were in the original lists, putting them in the right column as far as possible. The average numbers written were :

I. 7.43, II. 6.05, III. 8.49.

And the numbers placed in the right columns:

I. 3.75, II. 2.74, III. 6.02.

Adding it would seem that on an average 21.97 of the thirty were at least partially recognized. Since, however, on an average three of the fifteen new words were falsely recognized as being of the thirty, it would seem that six of the words apparently recognized were really guessed, leaving 15.97 as the number actually recognized. Probably the proportion was for the majority greater than this, for 47 students put down none of the new words and 30 but one. The high average of words falsely recognized was produced by a few students who depended entirely upon guessing, 18 of them putting in ten or more of the fifteen new words. The power to recognize appears therefore to be for the average student nearly double that of recall.

In individuals the difference is often much greater. One young lady that I had often noticed as able to recognize the correctness of discussions of topics that she herself could not recall was, in this test, able to recall but two words in the second list and none in the first. When the words were read, however, she correctly recognized seven of the first list and five of the second and wrote none of the fifteen new words. There were other students who recalled a great many words, but placed but very few of them in the right lists.

There were some incidental illustrations of false recognition. About a week previously in experimenting upon mental imagery I had pronounced to the normal students ten common words. Many of these were recalled and placed with the memory list. Again, it appears that when such words as 'spool,' 'thimble,' 'knife,' were pronounced many students at once thought of 'thread,' 'needle,' 'fork,' which are so frequently associated with them. The result was that many gave those words as belonging to the list. This is an excellent illustration of how things suggested to a person by an experience may be honestly reported by him as a part of the experience.

The results of these experiments are of more special interest to those concerned with pedagogical problems. They

reveal very clearly the absurdity of the common assumption that any subject that requires memorizing gives valuable memory-training, and suggest for further observation and experiment questions which when answered will enable teachers to intelligently direct the exercise of the memory of pupils in general and to correct special defects in individuals.