THE DEVELOPMENT OF IMAGINATION IN SCHOOL CHILDREN AND THE RELATION BETWEEN IDEATIONAL TYPES AND THE RETENTIVITY OF MATERIAL APPEALING TO VARIOUS SENSE DEPARTMENTS.

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CONTENTS.

INTRODUCTORY STATEMENT.

During the winter and spring of 1907 an experiment to determine the ideational type of school children and the development of these types during the school years was performed on five hundred and twenty children in the public schools of Champaign, Ill. The ages ranged from eight to twenty. Later the experiment was supplemented by conducting a similar investigation with about seventy-five students, members of the elementary classes in psychology, in the University of Illinois, and still later with about two hundred such students. These tests were directed towards discovering whether the subjects were predominatingly of a visual, motor, auditory or of a mixed type. The subjects were presented both visually and orally with cards containing angles and nonsense characters, and with nonsense syllables. During some of the tests the motor memory was aided by supplementing the ordinary method of learning by tracing the visually or orally presented words with the blunt end of a pencil on the desk; during others the learning was impeded by the subject holding his tongue between his

teeth while studying the words. The memory was then tested for immediate recall and in some instances for recall twenty-four hours later.

A second part of this experiment aimed to discover the relation existing between the various types of imagination and the learning of material appealing to the three chief sense departments (visual, motor, auditory). More especially, the question was asked, " Does the visually minded subject learn more readily material with a visual content, the motor minded material with a motor content, the auditory minded material with an auditory content, or can the visually minded learn as well material with a motor content, etc.? " To test this a simple story, interesting to all grades, was composed which had in it an equal number of words and phrases suggesting the three different types of ideation. The test was here made for both immediate and for delayed recall. A detailed statement of the method and results of these experiments follows.

The tests were all given in the same period of the day, from 9:00 A.M. to 11:30 A.M., and under similar conditions. This period was selected because it was considered to be the time when the children are least fatigued and most liable to put forth their best efforts. The tests were given to the pupils in their own rooms in the school building. The conditions of the rooms were much the same. All were neat, well lighted and ventilated, well governed and had from thirty to forty pupils in a room.

In making the investigation, two things were guarded against. First, care was taken that no suggestions or helps should be given unintentionally by the person making the test; and second, that the pupils should not be fatigued. To avoid errors that might arise from these two sources the writer (M) gave the tests without assistance from the teachers. To overcome the danger of timidity on the part of the pupils, a few moments were taken in which the experimenter sought to gain their confidence.

The condition sought was such as would insure the maximum effort from all. The room was closely watched and in case a pupil did not try, or received help, which was rare, his

paper was quietly discarded. The tests were alternated, in such a manner that they would not become tiresome.

I. Résumé of Previous Experiments in this Field.

The determination of the particular ideational type of children has already been made, directly and indirectly, the subject of several investigations in the psychology and pedagogy of the learning process. Among the most extensive studies is that of Netschajeff who tested the development of memory in 687 children in the schools of St. Petersburg. He presented to them various visual objects, tones and noises, numbers, words appealing particularly to the visual imagination (such as pencil, bottle), likewise words with an auditory content (such as noise, song); he further presented words signifying emotions (such as joy, hope, sorrow) and finally words standing for abstract ideas (such as cause and effect). Lobsien repeated these experiments with a modified and slightly improved method, using as subjects 461 children in the schools of Kiel. Netschajeff's subjects ranged in age from nine to eighteen years; Lobsien's from eight to fourteen.

The results of these two experiments agree in general and indicate that the various kinds of memory in their development show periods of fluctuation, the most marked being at the onset of puberty. Lobsien found the greatest relative increase between the ages of ten and twelve. Memory for emotional states remains undeveloped until puberty, then it sets in and grows rapidly, but more rapidly with the girls than with the boys. About the same time begins a rapid development of memory for touch and movement and also the memory for numbers.

Boys in the lower grades have the best memory for concrete objects, for words with a visual content and then for sound, touch and movement. Later come memories for numbers, abstract concepts and emotional states. Girls differ slightly, visual words coming first, then concrete objects, sound, numbers, concepts and acoustic words; later still, touch and movement.

Meumann, commenting on these results and on others ob-

tained by himself and his students, concludes that young children are realists, particularly visualists. The mental processes of the adults are more in terms of the general idea.

S. S. Colvin and I. F. Meyer during the year 1904–05 performed on three thousand school children in the State of Illinois an experiment specifically intended to test the development of imagination. The method employed was quite different from that used by the two previous investigators but the results in many instances agree with the foregoing.

The data for this investigation consisted of compositions written on certain selected subjects, and done as a part of the regular school work. A record was made of words and phrases in these compositions indicating visual, auditory, motor, tactile, pain, olfactory, gustatory and organic images. In the same way the compositions were studied to discover evidence of some of the more complex forms of imagination under the head of scientific imagination, the fairy story, the nature myth, the heroic, the dramatic, the religious and melancholic forms of imagination.

It was found that the four highest forms of mental imagery (for both sexes) stood in the following order: (1) Visual, (2) auditory, (3) motor, (4) tactile. Much lower than these and in the order named came pain images, gustatory, organic and olfactory. The most striking feature of the curves representing the development of imagination is the sudden decline at about the age of puberty of most of the types. This is not true of the visual imagination, however, which has its most rapid rise for both sexes at about the fourteenth year. This growth does not, however, mean that there is a constant increase in concrete visual imagery; it rather indicates that the young person uses words more and more in an abstract and symbolic way.

Pfeiffer investigated carefully for three successive years the ideational types of fifteen girls and found that 44.6 per cent. were visual, 25.3 per cent. were acoustic and 30.1 per cent. motor. Pentschew from his investigations concluded, on the other hand, that for children the motor element forms the basis of memory, while the visual is a secondary factor. Pohl-

mann thinks that auditory imagery predominates in the mind of the child.

Lay, who conducted extensive experiments to determine the correct method of teaching spelling, concludes that children are especially motor in their tendency and that vocalization is especially prominent in their thinking.

The chief criticism to a large number of these experiments seems to lie in the fact that no thoroughly adequate method has been employed in determining the various memory types for large groups of children. The following experiment has attempted to obviate this difficulty as far as the visual and the acoustic-motor types are concerned.

The second problem on which the present investigation attempts to throw some light, namely, the relation between memory types and the reproduction of material appealing to these various types, has received up to the present time even less consideration by investigators than has the first. An investigation by Segal bears indirectly upon the question. His particular problem was to test memory types in relation to the learning and the immediate reproduction of material. Among other things he concludes that when presentation and learning are in accord with the memory type, the condition for accurate reproduction is most favorable. For example, visual presentation is most favorable to the visual type and acoustic material to the acoustic type.

II. Methods of Determining Ideational Types.

As has already been said one of the great difficulties in the study of ideational types has been the unsatisfactory methods for determining these types. The method to be adequate for determining the memory type of children must be simple and yet accurate. It must be simple and easily comprehended, because the experiment is to be made with inexperienced observers taken in groups, not with persons accustomed to the laboratory and familiar with the use of psychological terms. The importance of this requisite should not be overlooked as many methods produce excellent results when used with trained observers, but are valueless when used with children. The

test must also be accurate, that is, it must be such as will indicate at once the actual mental processes of the subject. This is especially necessary in an experiment dealing with children in groups. An adult who has been trained in analyzing his own experience, may be relied upon for his introspections, but the same is not true with children who have had no training. This inability of children to report accurately concerning their mental processes was clearly shown in a series of tests made at the beginning of the present study. A test that involved certain distractions was given to a hundred school children in the fourth and fifth grades. Together with the tests was given a list of questions inquiring concerning the effect of the distractions upon their power to memorize. Of the answers given only a little over fifty per cent. agreed with the actual results received from the tests. The children were not accustomed to analyzing their states of consciousness, neither did they clearly comprehend when asked concerning their experiences. Their answers were merely their idea of what they thought was wanted; not an account of their experiences.

Among the best known methods for determining memory types are the ' questionnaire method ' first used by Galton; the ' word method ' used by Kraepelin; a modification of the ' word method ' used by Secor; Binet's method with the letter squares; and various forms of the ' distraction method ' used by Meumann and others. These are methods devised in most part for the skilled observer and not for children.

The ' questionnaire method ' places much stress on introspection. Two objections to using this method in the present experiment suggested themselves. First, as was said before, children are not capable of accurate introspection.[1] The second objection to the ' questionnaire method ' applies to the device as a method both for the experienced and the inexperienced observer. The presence of imagery depends on different factors, such as vividness of stimulus, recency of the experience, repetition of the observation, etc. In the laboratory these factors are carefully noted in the conditions for experimenta-

[1] Compare in this connection Titchener's criticism of the method in his *Experimental Psychology,* Vol. I., Instructor's Manual, p. 389.

tion. They are nearly as important as the reports of the observer. In the 'questionnaire method,' these factors are ignored. A set of questions is asked an observer concerning certain experiences, and the one who asks them may know nothing about the time, place or conditions under which the observer came into possession of those experiences. Suppose a list of questions were given a child in the winter time concerning a garden of roses. He has not been in such a garden for nearly a year where he could smell the odor of the flowers, feel their petals and hear the hum of the bees. He has, however, seen such a garden every day as he passed the greenhouse on his way to school. Under these conditions, other things being equal, the observer's report will be more favorable to the visual than to the auditory or olfactory types. The method may or may not be a fair test for memory type. Much depends on the immediate environment.

The 'word method' used by Kraepelin is no less difficult from the standpoint of the present experiment than the questionnaire method, nor it is less free from criticism. According to this method the observer is required to write down a list of objects characterized by their color; again a list characterized by their sound, etc., it being assumed that the visually minded person will succeed better with the first test, the auditory minded with the second and so on. It would be nearly impossible to use this method with children in a place where color is everywhere to be seen. However, where conditions are such that the observer would be placed where objects of color could not be seen, the method would still be open to the same criticism as the questionnaire method, namely, the past experiences upon which the observer must draw for his material in the experiment would not be taken into account. For instance, had the observer just visited a park or a picture gallery, he could readily name objects of color. The error is that the method assumes a normal environment where color, sound and motion have an equal part in one's experience, which may or may not be true.

A modification of this method was employed by Secor who presented a list of printed words to the observer, who was to

note the imagery that developed in his mind as he glanced at each of the words. This is clearly a method for trained observers and not for school children.

Binet used the letter squares in which, for example, twelve letters of the alphabet were arranged as follows:

P X K B
Y Q H A
F T C V

The observer, after looking at the card with the letter squares for ten seconds, laid it down and attempted to reproduce it from memory, his type of imagery being determined by his introspection. The first part of the method, the reproduction of the letter square, suggests a valuable test for visual memory. Especially is this true in testing the observer's sense of position for the various letters. A modification of this method was used as a test for visual memory in the series finally adopted for this experiment.[2] (See tests Nos. 2 and 3, pages 96 and 97.)

Binet had the observer hold the tongue between the teeth while memorizing syllables in order to impede the kinæsthetic sensations of the speech organs. This was not intended to eliminate motor impressions entirely, but to so weaken them that the loss would be quite noticeable if the observer were strongly of the motor type, the loss being determined by comparing the results of this test with a previous one in which the tongue was free. The method has many advantages over other methods in determining motor memory especially with children. Other forms of the distraction method in which, for example, memory is impeded by having the observer sing or repeat the letters of the alphabet while memorizing the syllables, are too difficult for the average child. Few persons can divide their attention so as to repeat the letters of the alphabet and memorize syllables at the same time. The advocates of this method contend that by constant practice this difficulty may be obviated, the repetition of the syllables

[2] The above described tests together with several others are presented and discussed by Titchener in his *Experimental Psychology,* Vol. I., Instructor's Manual, Chapter XII.

becoming almost automatic, thus eliminating much of the distraction. This may be true with the trained observer, but it is too much to be expected from a group of children. This test was attempted with a class of fifty, who sang the syllable *la,* while memorizing ten syllables. This distraction caused by the noise and the division of attention, was so great that the results could not be relied upon. Binet's method has the advantage in that there is no noise and there is but one thing to attend to.

Meumann advocates the method of distractions (*Methode der Störungen*), on the assumption that the acoustic type is more easily disturbed by auditory stimuli, the visual by visual stimuli, and the motor when the " inner-speech " is hindered.

In connection with this last-named method may also be mentioned the method of aids (*Methode der Hilfen*). Here aids to the various types are used and the type determined by the effectiveness of the aids. This method was used in connection with the method of distraction in determining the motor type in the present investigation.

It has further been noted that the visual type confuses like appearing, but different sounding letters, while the auditory type confuses like sounding but different appearing letters. An attempt was made in the present investigation to apply this as a method of distinguishing between the visual and the auditory types, but the success obtained was so slight and the results so equivocal that it was soon abandoned as impractical.

It has been suggested by several writers that the visually minded person is aided greatly by localization and hence visual memory shows its superiority over the auditory or motor types when such a localization is involved. This principle was made use of in several of the tests made in the present investigation. (See Figs. 1, 2 and 3.)

This principle of localization appears in the recognition of variously placed angles as a test of visual memory. According to this test a series of angles is exposed for the observer to fix in mind. Afterwards, in a promiscuous set of angles, he is expected to recognize the angles previously seen and indicate them my number. The plan assumed that the person having

the most distinct image would most readily recognize the angles on the card. A similar plan is to have a series of letter placed at special angles and then exposed to the observer. After exposing the screen ten seconds the observer is to put the proper letters in angles, which are arranged on a card before him. From those two suggestion came test No. 1 in the present series of tests for visual imagery.

Another test suggested for visual memory was to expose nonsense characters or unfamiliar symbols, such as Hebrew letters, the observer later reproducing the same from memory. The objection to this plan is that the characters, since they are exposed for some time, will probably suggest names, and thus the results will be those of auditory and verbal memory as well as visual. This test, however, suggested the nonsense characters, which combined with the idea of spatial relations formed another test of the series for visual memory.

Various other methods for detecting different types of memory were devised, discussed and modified, which together with these already described, resulted in the series of seven tests for ideational types that were used in this study.

III. The Test with Nonsense Material.

For convenience, the series of tests were divided into two groups. The first group was composed of three tests, each of which was intended to appeal to visual memory. They were composed of characters and spatial relations which eliminated as far as possible any auditory or motor aids. The second group contained five tests in which nonsense syllables were used. These syllables were memorized by visual, auditory and motor methods. The tests with their description follow:

Test No. 1.—The children were seated at their desks in an easy position with pencil and paper. On the paper was a series of four letters duplicated five times. They were arranged in promiscuous order in four lines of five letters in a line. (See Fig. 1, *a*.) On a screen, 22 x 28 inches, there were two lines intersecting at right angles, forming four angles. (See Fig. 1, *b*.) In these angles were placed the four letters found duplicated on the papers that were in

the hands of the children. The object of this test was to determine who could put the proper angles around the largest number of letters taken in order as they appeared on the paper, in a given period of time. The proper angle was the angle in which the letter was found on the screen. After careful instruction, the screen was exposed to view twenty seconds. As soon as the screen was removed, thirty seconds were given for placing the angles around the letters.

The assumption in using this test was that the strongly visually minded person would carry the image of the relationship between letter and angle with him and that consequently as soon as he saw a letter he would also see the angle it was

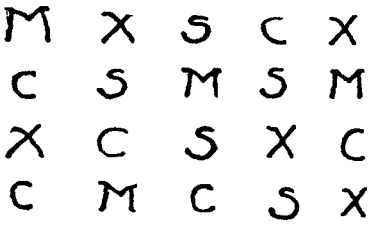

FIG. 1*a*.

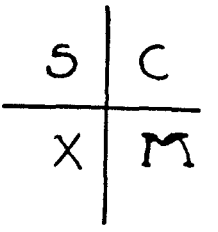

FIG. 1*b*.

in from the mental picture. This would give him a decided advantage, and, other things being equal, his power of visualizing could be estimated from his speed and accuracy in placing the angles. This test worked fairly well in the more advanced grades, but was in general too difficult for younger pupils. There was a decided advantage in favor of the rapid working pupil, since speed was largely the standard of judgment, so that often a person might be classed as visual from the results when his success was due to a larger extent to his rapidity of movement and not to the advantage gained from carrying the image with him.

Test No. 2.—In the second test, the children were given pieces of paper on which were four right angles with sides respectively parallel and with convenient distances between them. (See Fig. 2, *a*.) This served as a device for the correct placing of characters. On a screen, 22 x 28 inches, was a similar figure and in each of the angles and spaces were

meaningless characters. (See Fig. 2, *b*.) These characters were used because they appealed to the eye and at the same time did not readily appeal to the auditory, motor and verbal memory. The screen was exposed five seconds, after which the pupils were to reproduce these characters, putting them in their proper place. In other words, the pupils were to make their paper look like the screen. The short time of exposure allowed very few to associate names with the characters, not more than one in five according to introspections that they gave in answer to questions concerning the naming of the characters. This test, on account of its simplicity and ease of grasp, was of especial value to the children of the lower

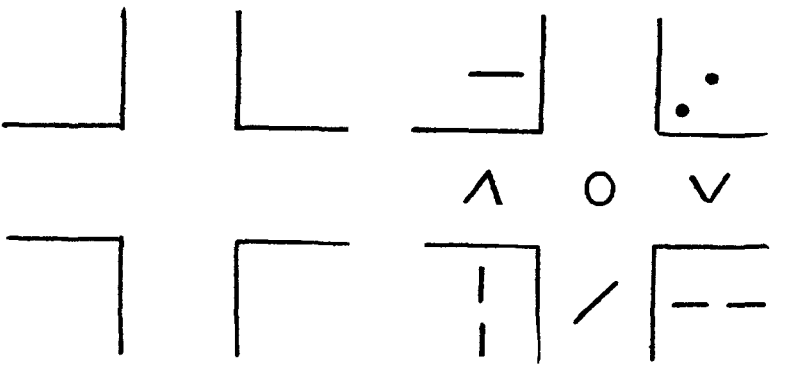

FIG. 2*a*. FIG. 2*b*.

grade. It was a test which appealed to all alike and there was no misunderstanding as to what was expected. In recording the results, three different methods of estimating their accuracy were employed; one on the numbers of characters attempted, one on the number of correct characters, and a third on the number correctly placed.

Test No. 3.—The third test of this group was similar to the second. The pupils were provided with papers ruled like the first. This time a screen was exposed which had letters and figures in the spaces instead of nonsense material. These characters were employed that all might have the use of sense symbols. These letters and figures were of different forms. Some letters were capitals, some were small, some were script

and some were printed. The figures were Roman and Arabic and all characters had a specific place. Ten seconds were given for observing, after which thirty seconds were given for reproduction.

This test, though more complex, was used as a complement to the second test. In the second test no one was supposed to name the characters, though there was nothing to prevent some name being attached to them. In this test, all the characters had names familiar to all. The letters were black, bold and of different size, while the angles were red, as was the case in the second test. The form and spatial relation were

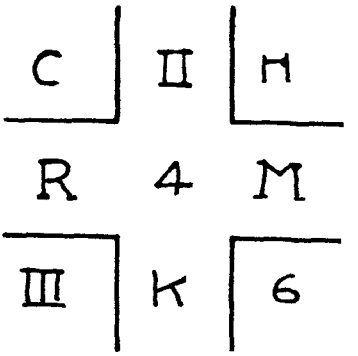

FIG. 3.

the dominating elements considered. There were three grades given, one grade on the number of characters correct, one grade on the number of characters having the exact form in which they were written and a third grade on position. By a comparison of the results here obtained with those of the second test, a fair idea of a person's visual powers might be had.

In the second group of the series, four tests in number, nonsense syllables were used. The results of this group were quite satisfactory. The tests were clear, easily understood and but slightly different from the regular school work. The following are the tests of this group given in their respective order, but numbered as they occurred in the series.

Test No. 4.—Upon a piece of white cardboard, eight by

twenty inches, was placed, one above the other, a row of six nonsense syllables. These syllables were composed of three letters (two consonants and a vowel) and were made of black gummed letters, one and one-fourth inches high. The children were seated at their desks with pencil and paper. Upon a given signal the screen was exposed and twenty seconds were given to commit the syllables. At the close of twenty seconds the screen was removed and the children asked to write the syllables. As this was the first test with nonsense syllables, it was after a few moments repeated with different syllables, and the average of the two was taken as the initial test for the group.

Test No. 5.—In the fifth test a screen similar to the fourth was used but with different syllables. The only difference was in the manner of memorizing. As soon as the screen was exposed, the children took the blunt end of their pencils and wrote each syllable on their desk once. After this they were allowed the remainder of the twenty seconds to memorize the syllables as they chose. By comparing tests No. 4 and No. 5 some indication of the motor memory of the forearm was given, but not necessarily for other parts of the body.

Test No. 6.—After a rest from the first two tests, a third was given. The conditions were the same as in No. 4 and No. 5, and the same test was used only with different syllables. This test was to determine the value of the movements of the lips, tongue and throat, to the memory. In test No. 4, which was used as the standard, these organs were allowed absolute freedom in the process of memorizing. In test No. 6 these movements were impeded by catching the tongue between the teeth and holding it there during the test. Care was taken that the tongue was well extended and held both while learning and writing, so that there was little aid from this source. This method did not completely remove the motor sensations of the speech organs, but it did so impede them that any one strongly dependent on these sensations as an aid to memory could be readily detected. The results from this test compared with those of the initial test gave evidence of the extent to which the memory was aided by the sensations from the speech organs.

Test No. 7.—The seventh test was intended to appeal to the auditory type. While it is by no means certain that a person will employ auditory imagery in remembering syllables given in auditory presentation (it being quite possible for him to translate them directly into motor or visual symbols), it is fair to assume that the person who is distinctly of visual type will be somewhat at a disadvantage in remembering material thus presented. For persons of the motor type, the disadvantage will not be so great; still the distinctively auditory type should succeed better than the motor in such a test. The six nonsense syllables were used as before but this time were read and not exposed to vision. These syllables were pronounced and spelled slowly and distinctly to the pupils and then repeated. This took twenty second, the time of the other tests of this group of the series. At the close of the second reading the syllables were reproduced. Here the visual elements were at the minimum and the auditory at the maximum.

IV. The Test with Sense Material.

The series of tests described above dealt largely with material without meaning. The matter of interest was eliminated, and association was reduced in effectiveness. The test now to be described employed sense material appealing to interest and involving associations of considerable complexity. The purpose of this part of the investigation, as has been said above, was to discover, if possible, whether a given ideational type tends to retain better material suited particularly to this type, or whether the nature of the material is a matter of indifference. The test consisted of a story constructed with the purpose of appealing in its various parts to the three chief types of mental imagery (visual, auditory, motor). It was further constructed so as to gain as far as possible the attention and interest of the pupils of the various grades in which it was presented. This story was as follows:

Walter Brown, a young man who lives in Trenton, N. J., had an exciting time one night a few weeks ago.

A short time after he had gone to bed and when he was

just about falling asleep, he heard the (fire whistle blow loud and sharp); then an (engine and hose cart came dashing over the pavement) followed by a (crowd of shouting boys). Soon it was (quiet again and for a time very still); then he heard (the slow tramp, tramp, of the policeman) on the beat and listened for the (ring of his club as he struck it against the iron lamp post) at the corner. Mr. Brown was almost asleep again, when he heard (the sharp clang of the motorman's bell) on the street car next block; then the (big clock down town struck with its deep tones). A minute later there came (a long, low whistle), (a step on the porch), then (a gentle tap, tap, tap), right under his window and then a (scraping sound) and (a whisper) and (the noise of falling glass).

Mr. Brown slowly (raised himself in bed), (bent forward) (and listened). Then (he carefully put one foot out of bed), (held it a moment) and then (stepped softly on the floor). (It was very dark), (and he felt his way with his hands stretched out to the door of his room).

Then he (slowly crept down stairs), (holding his breath). He (reached the lower hall) and (quickly turned the button) that threw on the electric lights. In a moment (all the rooms

were lighted), and (he saw standing near the door of the V–3
dining room) (a man with a red beard), (a black mask, partly V–4 V–5
covering his face). The man (wore a blue coat), (and dark V–6
trousers, spotted with mud). He had (a yellow cap on his V–7 V–8
head), and (in his right hand he carried a revolver) (that V–9
glistened in the light). (In his left hand he had a green V–10 V–11
bag), and on (the side-board was a heap of silver spoons just V–12
ready to be taken away). The burglar (gave a cry) and A–15
(turned off the lights). (It was totally dark again). (Then V–13 V–14
he sprang at Mr. Brown) and (pushed him to the door). M–12 M–13
Mr. Brown (tried hard to keep from falling) and (held the M–14
burgler tightly) around the waist. (Then he struck at him M–15 M–16
with his fist), (and cried out help, help as loud as he could). A–16
(Suddenly the lights were turned on again), and there were V–15
(two policemen standing in the hall way with their revolvers V–16
pointed at the burglar). So Mr. Brown's midnight adventure ended and he escaped unharmed.

The parts of the story enclosed in parentheses are those portions or elements intended particularly to appeal to the three principal ideational types. Each parenthesis contains one such portion. The capital letters A, M, V, indicate respectively those portions appealing to auditory, motor and visual imagery, and the numerals after each letter show the number of these elements for each type. It will be noticed that there are sixteen for each type, forty-eight in all.

The results were estimated in terms of the retentivity of the

subject for each of these elements and they were then correlated with the results of the first set of tests in such a way as to show the retentivity of the visual type for the three kinds of material and in a like manner of the auditory and motor type of subjects.

The story was given to the subjects in auditory presentation. The test was carried out under conditions similar to those under which the first series of tests were conducted. It was in the same rooms with the same pupils and at the same time of day. The parts of the story appealing to different types were emphasized with equal prominence. No comment was made on the story and no explanation made. The pupils were told the story was to be read to them and after it was finished they were to reproduce it, telling everything that was in it.

Immediately after the story was read the pupils wrote it out on paper that had previously been provided them. The papers were collected, marked and filed. The next day at the same time, a second reproduction of the story was taken. There had been no previous warning that this was to take place, nor were there any suggestions given concerning the story. These papers were likewise filed for grading. Two weeks later, at the same time of the day, a third reproduction was taken in the same manner.

These papers were graded and the grades recorded in a manner similar to that used in the first series of tests. Each set of papers was graded separately and afterwards the papers were rearranged so that the papers from each person were together and the grades recorded. Each paper had three distinct grades, one for visual memory, one for auditory and one for motor.

V. Analysis of Results.

The following two tables give a summary of the classification of the various ideational types as obtained by the first series of tests:

TABLE I.

	3	4	5	6	7	8	H	U
Visual	72	67	59	49	47	42	46	50
Auditory...	16	37	57	49	46	57	46	30
Motor	20	29	24	27	34	20	23	26
Balanced ...	20	20	10	21	19	24	28	20

TABLE II.

	3	4	5	6	7	8	H	U
Visual	58	51	45	24	26	23	31	45
Auditory...	11	11	40	36	34	32	31	18
Motor.....	11	18	5	19	21	21	10	17
Balanced ...	20	20	10	21	19	24	28	20

The above results were obtained by two different methods of classification of the data secured by the experiments. In the first table all subjects classed as partially visual, auditory or motor are represented under the appropriate type as indicated at the left. In the second table those classed as predominatingly of a particular type are classified under that type alone. For example a subject might be classed as visual-auditory. In the first table he would be represented in both the visual and the auditory columns, but in the second table he would be represented in the visual column alone. If the subject were on the other hand classed as auditory-visual, he would be recorded in the first table under both the auditory and visual groups; in the second table only under the auditory group. The numbers accompanying each group represent the per cent. of subjects classified under that group. Since in the first table a subject may be classified under two groups the total of each column is in every instance greater than 100. In the second table, since a single individual can be classified only under one group the total for each column is exactly 100. The numerals at the head of each column indicate the school grades from the third to the eighth inclusive. The letter H indicates the results for the high school students, and U the results for the university students.

By studying these two tables, the reader can see at a glance the preponderance of the visual type in the lower grades, and the gradual falling off of this type as the pupil advances in the grades, with a tendency to recover somewhat in the high school and university. The same fact is shown by another method of representing the results obtained in the first series of experiments.

These latter results are embodied in the curves of Fig. 4 found on page 104. These curves were obtained by plot-

ting the averages of correct results of the various tests in the first series, for the different grades and for the high school and the university. Curve *A* was obtained by averaging the results of tests No. 2 and No. 3, both of which were devised to test visual memory. Test No. 1 was not included in these averages because of the fact that the results were equivocal and on the whole unsatisfactory for most of the grades and particularly so for the university. Curve *B* em-

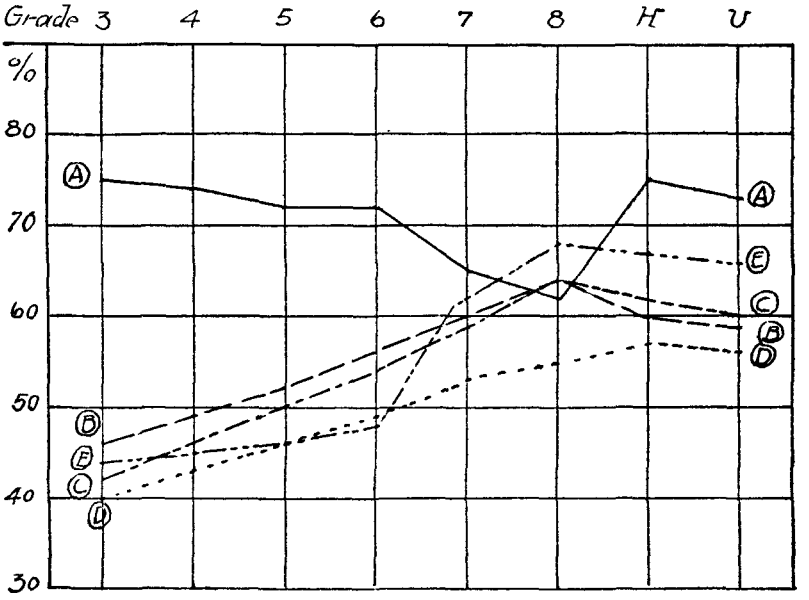

FIG. 4.

bodies the results of the test with the nonsense syllables visually presented; curve *C*, of the nonsense syllables visually presented and supplemented by tracing the syllables when exposed to view; curve *D*, of the nonsense syllables visually presented to the subject while he was inhibiting this tendency to vocalize by holding his tongue between his teeth, and curve *E*, of the nonsense syllables with auditory presentation.

It may be easily seen by this curve that the concrete visual imagery as indicated by the second and third tests is remarkably strong in the earlier years. In the third grade the pupils made an average of seventy-five per cent. of correct results with

these two tests; in the fourth grade of seventy-four; in the fifth of seventy-two; in the sixth grade of seventy-two; in the seventh of sixty-five; in the eighth of sixty-two; in the high school of seventy-five; and in the university of seventy-three. In other words, notwithstanding the fact that throughout the grades, the high school and the university, there is an ever-increasing ability to remember,[3] nevertheless the results of the third grade are higher in correctness than those of any other, with the single exception of the high school, in which an average of 75 per cent. of correctness was also obtained. The results of the tests in the university are two per cent. lower in correctness than those of the third grade for this test. These results clearly indicate an actual decline of concrete visual imagery during the school years.

On the other hand it appears from Fig. 4 that there is a fairly constant increase in verbal-visual memory throughout the years studied. This fact is particularly indicated by curve *B* (compiled from the results of the test with nonsense syllables visually presented). This curve begins in the third grade at 46 per cent. of correctness and rises in the main, being practically constant in the higher grades. In the lower grades it seems probable that a large part of the successful results with this test were obtained by the subjects holding a concrete visual image of the letters in their minds, while in the higher grades the *significance* of the syllables was the important element in retention. Undoubtedly here the visual imagery was assisted by the motor and auditory. The fact that the concrete visual imagery is strong in the lower grades and that there is a general tending toward the growth of a verbal type is also shown by certain facts noted incidentally during the course of the experiments.

In the earlier grades low averages were more often the result of the omission of characters than of an error in form or in place. In the higher grades, on the other hand, errors in form and place were more frequent, while omissions were far

[3] The results of Bolton, Bourdon, Hawkins, Winch, Binet and Henri, and others on the growth of memory in children have clearly established this fact. Meumann says that the adult learns various kinds of material in a much shorter time and with less repetitions and with less fatigue than do children. Young children, however, retain more exactly.

less. In these grades too an attempt was frequently made to assign names to the meaningless characters, a procedure reported less often in the lower grades. In the fourth grade thirteen per cent. of the pupils reported that they had attempted to name the characters, while in the seventh grade there were thirty-five out of a hundred that so reported. In the university it was the general procedure to assign some name to the characters, and to join the nonsense syllables together in some meaningful way.[4] It seems quite evident from these results that the undeveloped mind relies primarily on the impression for retaining its material while the more mature mind is greatly aided by holding the material through associations. Burnham, in his article on 'Retroactive Amnesia,' has pointed out the significance of the two elements in memory, the impression (*Einprägung*) and the association. The work of Müller and Pilzecker has clearly established the existence of the *Perseverationstendenz* as a factor in memory, and these results have been verified in other connections. This all goes to show that apart from the association of memory material by which it is retained and called up, there is also the factor of persistence that is due rather to the impression than the association. This sheer persistence seems to be a more important factor relatively in states of fatigue and mental disturbance than in normal conditions.[5]

It is likewise reasonable to assume that it is a more important element in the mind of the young child than in that of the more developed pupil. It is natural therefore to expect that concrete imagery will be more in evidence in the lower grades than in the higher, and since visual imagery is the most vivid and real of all imagery that it will be the predominating type among young children. This expectation the results of the present experiment seem to sustain.

The fact that mere impression is a more important element in the recall of young children than of older is further shown by the fact that where the nonsense element is the most marked

[4] An analysis of results seem to indicate that ninety per cent. of the university students did this to a greater or less extent.

[5] Heilbronner and Stransky working on abnormal subjects both assert that 'perseveration' is something that forces itself into the regular train of association, and it to be treated as an accident (*Ausfallerscheinung*).

(namely in tests No. 2 and No. 3) there is, as has been pointed out, an actual decline in correctness. This is not the case with the tests involving the nonsense syllables which permit a certain amount of association. Tests Nos. 4, 5, 6 and 7 all show some, though not great improvement in correctness as the age of the pupils increases.

Further, the steady increase of memory throughout the grades for visual auditory and motor material alike, when this material is connected in meaningful associations is shown in the results with the story. (See Figs. 5 and 6, page 109.) Here there is an increase in the per cent. of correctness in immediate recall for the visual elements of the story from twenty-four per cent. in the third grade, to seventy-four per cent. in the university; in the auditory element from twenty-three to sixty-nine per cent., and in the motor from forty-seven to sixty-eight per cent. The corresponding figures for the recall one day later (Fig. 6) are: Visual imagery, for the third grade twenty-four per cent., for the university seventy-four per cent.; auditory imagery, for the third grade twenty-two per cent., for the university sixty-six per cent.; motor imagery, for the third grade forty-four per cent., for the university seventy per cent.[6]

The marked decline of curve *A* representing the results of tests No. 2 and No. 3 in the seventh and eighth grades and its recovery in the high school and university is possibly to be explained as follows:

The chief element in the retention of the younger children is the impression represented by the concrete visual image; of the more mature child and the adult, the association. The rapid decline of the concrete image is not compensated for by a corresponding increase of the element of association until the high school and the university are reached. There is, therefore, an actual decline in memory for concrete visual material at about the onset of puberty. This decline has already been pointed out, as before stated, by previous investigators.

If we turn again to the tables on pages 102 and 103, we will notice the growing importance of auditory imagery as

[6] The preponderance of the motor element of the story in the recall in the lower grades is not out of harmony with the seemingly contradictory results obtained with the nonsense material. Its meaning will be discussed later.

determined by test No. 7. This test shows the relatively slight importance of this type of imagery in the lower grades and its growth in the last four years of the grammar grades. A somewhat similar development is shown by curve *E*, of Fig. 4. Here, however, the pronounced development of the auditory type is indicated as first manifesting itself in the seventh and eighth grades. How much the increase represented in the tables and in the rise of curve *E*, is due to a change in ideational type and how much of it is due to the fact that auditory presentation is more favorable for learning in the higher than in the lower grades is, however, a question.[7]

[7] A number of investigators have attempted to determine which mode of presentation (visual or auditory) gives the better result in the recall of the material presented. Hawkins, who presented visual and auditory words at the same rate to his subjects, concluded that auditory presentation was superior for children; visual for adults. Kirkpatrick found younger pupils superior in memory of spoken words. On the other hand, Miss Calkins found visual presentation superior to auditory. MacDougall, using nonsense syllables, agrees in this. Whitehead, also using nonsense syllables with adults, found visual presentation better. The most enlightening results in this field are by Pohlmann who found acoustic presentation better for significant material, visual for nonsense material. The fact is of special importance in connection with the results of test no. 7, which has to do with nonsense syllables. In the lower grades the nonsense syllables cannot be imaged well when pronounced to the pupils because they are unfamiliar. In the higher grades this significance can more readily be comprehended and therefore they do not put the older pupil to the disadvantage under which the younger suffers.

In this connection it may be well to point out the probable reason why the younger pupil more readily retains material that has meaning when presented in an auditory manner than in a visual. It is not because the younger pupil is of a less pronounced visual type than is the older pupil. Indeed the results of this and other studies show the reverse to be true. It is rather because auditory presentation is of necessity successive and visual generally simultaneous that the superiority of the auditory over the visual is shown. The young pupil attends better when he gives successive attention to the material presented in an auditory manner than he does to the visual material over which his eye may move at will and without plan. If he is visual minded the material presented in an auditory manner is quickly (for the most part unconsciously) translated into visual terms and what is lost in this translation is more than compensated for by the more effective attention secured through the successive presentation when the material is read to the pupil. With nonsense material, however, the visual presentation is a tremendous advantage in the earlier grades over the auditory presentation and the gain in successive auditory presentation is more than counterbalanced by the loss which the pupil suffers in not being able to form a distinct image of the spoken nonsense syllable.

It is probable that both the manner of the presentation and the type of the pupil are factors in the general result. Some further light is thrown upon this question when we examine the curves in Figs. 5 and 6. These curves, as has been previously stated, give the general results of correctness in the reproduction of the three different elements of the story. Here

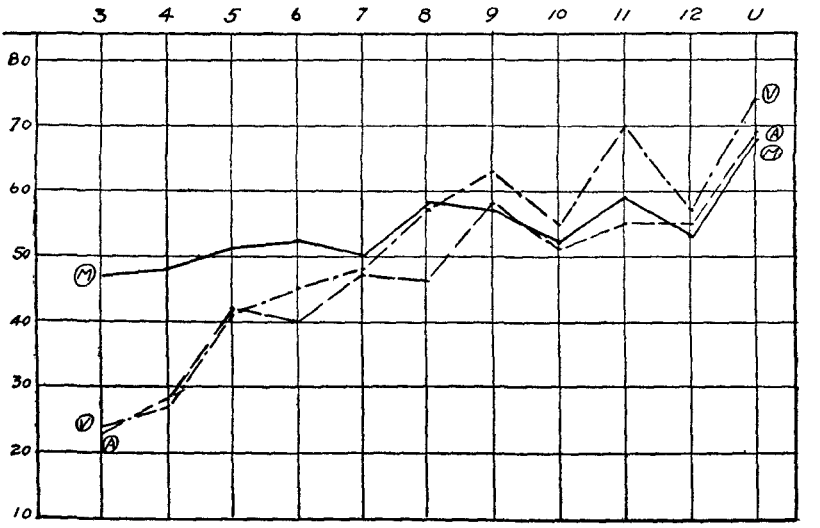

FIG. 5.

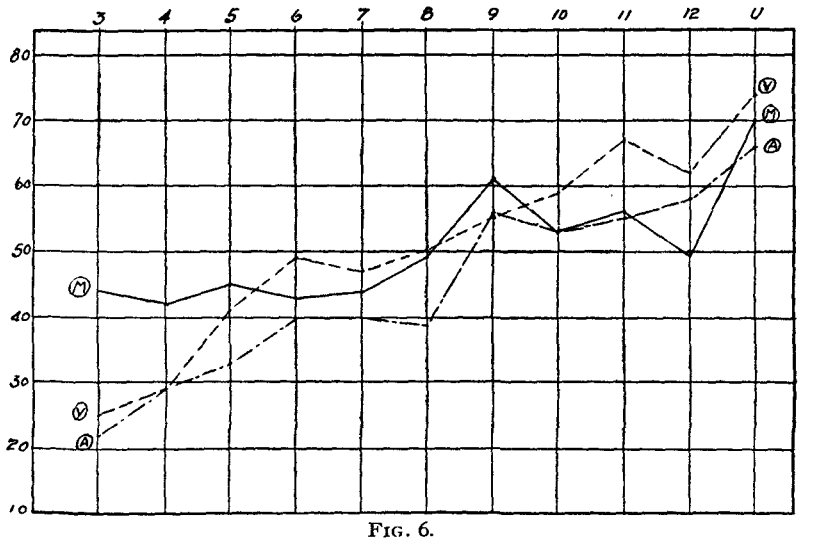

FIG. 6.

the manner of presentation is a negligible factor since it is throughout auditory. From these curves it will be seen that the auditory element is in general inferior to the visual.

On the whole it seems reasonable to conclude that the auditory type approaches maturity later in life than does the visual and it is probably much more closely associated with the motor, which as can be seen by the tables and by the curves of Fig. 4, is in general inferior to both visual and auditory. Probably both motor and auditory imagery are more closely allied with verbal imagery. There seems less tendency for the motor type to grow as the age of the pupil increases than for the auditory type. The curves of Fig. 4 show the slight importance of this type in recall. Curve *B*, as has been said, gives the results of the test with visually presented nonsense syllables; curve *C* of the visually presented nonsense syllables when the learning was accompanied by tracing the syllables seen, with the blunt end of the pencil, and curve *D* of the visually presented syllables learned and reproduced with the tongue between the teeth. It is a surprising result that the tracing is not an aid to the learning in the earlier grades. Indeed it is a hindrance until the eighth grade is reached. This is to be explained by the fact that the movements are an actual distraction and that the motor imagery is of so slight importance that the distraction is more of a hindrance to learning than the motor imagery is an aid. The relatively slight importance of the motor imagery of the speech organs is shown by curve *D*. While this curve is lower than curves *B* and *C* the difference is not great, and that difference may probably be attributed more to distraction than to dependence on motor imagery. It is slightly more pronounced in the upper than in the lower grades, however. This may indicate the increase of the 'inner-speech' as the age of the pupil increases.

The results from the motor tests were strikingly different from what might be expected from children in the lower grades. In the tests at this period action was strongly manifest. There was scarcely a child that did not move his lips and movements of the entire body were not infrequent, especially when interest was great.

In the fourth, fifth and sixth grades, especially in the last two, there seems a strong tendency for the child to attempt to employ his motor impressions to assist in memory. To do this he does not depend much on particular muscle sensations, but all the body seems to be active. When intensely interested he moves his arms, twists in his seat, strikes his fist into the palm of his hand, shifts his feet and goes through a variety of other movements, but does not use his pencil. No doubt he tries to bring these movements, in a general way, into coördination with his visual powers, but only in the most indefinite way. The muscles of the fingers are not used, as in the higher grades. It is quite probable, however, that if all the random movements had a direct bearing on the material in hand they would be of much value, but they are too general to be effective to any great extent.

In all the grades below the high school the lips were almost invariably used in memorizing syllables. So conspicuous and so common is this practice that it has been urged by educators, that lip movements should not be inhibited during study. Not ten per cent. of the pupils in the grades kept their lips motionless in the course of a test with syllables. Yet the actual assistance received from the motor sensations in the early period is not great. It is often over-estimated. It is probable that the motor impressions are not used during this period as an aid to memory. While the child moves much, the movements are not such as to be of value to the memory process. The child writes comparatively little before the sixth grade, and the use of the lips as a means of fixing impressions on the mind is probably more or less automatic. Other motor responses accompanying the learning process are general in character and so many and so diverse that the mind loses sight of them as a means of assistance. About the sixth grade, or seventh grade, writing becomes of much more importance as an aid to memory.

There seems to be some difference of opinion among investigators in regard to the value of motor aids in memorizing. Lay concludes from his experiments with children, to whom he presented both visually and orally nonsense words under

different conditions, that these aids are important. Itschner, who repeated Lay's experiments under more careful conditions, does not agree that the favorable effect of writing the words presented is due to the motor processes, but to factors of greater attention, etc., accompanying this procedure. Fuchs and Haggenmüller who worked with unfamliar Latin and German words, found on the whole that learning without vocalization or in a whisper was superior to pronouncing aloud. Writing in the air was a great hindrance, while copying and pronouncing in a whisper was an even greater distraction. Pohlmann says that the addition of the motor element is not favorable to memorizing. Miss Métral, in a recent study with boys and girls from seven to nine years, concludes that speech and arm-motor aids are valuable in learning to spell. The studies of Smith, of Cohn and of Fränkl also seem to indicate the value of motor aids in memorizing. (For reference to these three last named investigators see the bibliography at the conclusion of the fourth study in this monograph. The results of Lay, Itschner, Fuchs and Haggenmüller are discussed at some length in this latter study.)

The results discussed above show the way in which the mind develops rather than the cause for the particular tendencies in this development. Evidences are not lacking, however, to show that training[8] has much to do with the development of particular types of mind.

In the third and fourth grades the types were more distinctly marked. There were much wider individual differences in the results of tests. In these lower grades there is extreme variety in results, which is not so marked in the higher grades. While vision holds the predominance over other types, yet it was not an infrequent occurrence to find a person who showed

[8] In this connection the discussion of Segal in regard to memory types should be mentioned. He contends that these types are not so fixed and characteristic as the work of Charcot and other later investigators might lead us to suppose. The particular type that an individual possesses for a certain class of objects depends largely on the customary nature of the presentation of that class of objects; and it is not to be wondered at that the visual type is predominant when we remember that most of the objects to which we attend and which are of importance for us, come through visual sensations.

very strong auditory-motor type with poor visual powers. The circumstance that the visual power in general is strong at first is due to its being the first type of imagery to be effectively used and in the earlier years it is constantly being developed. In these early stages vision seems the natural avenue for gathering information and in this it has the advantage in the outset, which is shown in the first years of school life. From the fourth grade on to the eighth there is a growing tendency toward what might be called a balanced type in which the three types are more on a level.

As the pupil advances in the grades his attention is more and more taken from concrete visual objects and centered on reading and writing,[9] the auditory and motor sides thus being especially emphasized.

Before passing on from this part of the investigation, it may be worth while for us to consider a seemingly surprising fact that came out incidentally in connection with certain results, and which, while not being an integral part of the experiment itself, has an important bearing on the general problem of the psychology and pedagogy of learning.

During the course of the first part of the experiments in several instances, the tests with the nonsense syllables were repeated twenty-four hours later with the result that only a very slight falling off in the recall over the previous day was indicated. As this result was obtained toward the close of the series and as time did not permit an extension of this aspect of the experiment, not a sufficient amount of data was obtained in this connection to make any extensive generalizations.[10] The results of the second part of the experiment (the test with the story) were, however, even more striking in this particular and showed clearly that there was practically no loss in the recall twenty-four hours after, as compared with the immediate

[9] An extensive series of experiments recently concluded in the Urbana, Illinois, schools, show that the process of writing is not fully mechanized before the seventh or eighth grade.

[10] In the Urbana tests referred to above, and which were made with series of nonsense syllables, the average for the five upper grammar grades was as follows: Immediate recall (three different series of tests, 61.55 per cent.; 48.6 per cent.; 48.3. Recall after one hour, 56.9; 46.1; 50.1.

recall. By comparing Figs. No. 5 and No. 6, the reader can see that the falling off in memory after twenty-four hours is extremely slight. This fact can perhaps be better seen by glancing at the following table in which the figures at the left in each column indicate the per cent. of correctness for each grade in immediate recall of the story, and the figures at the right the per cent. of correctness for the recall twenty-four hours later.

	3	4	5	6	7	8	9	10	11	12	U
Visual Elements	24–25	27–29	41–41	45–49	48–47	57–50	63–55	55–59	70–67	57–62	74–74
Auditory Elements	23–22	28–29	42–33	40–40	47–40	46–39	58–56	51–53	55–55	55–58	69–66
Motor Elements	47–44	48–42	51–45	52–43	50–44	58–49	57–61	52–53	59–56	53–49	68–70

It can be seen from an inspection of this table that in the third and fourth grades the per cent. of correctness for recall after twenty-four hours is practically as high as that for immediate recall. This is likewise true of the high school (grades nine, ten, eleven and twelve) and for the university. Grades five and six show a somewhat more marked falling off in correctness after twenty-four hours than do grades three and four, and in the seventh and the eighth grades this difference is quite pronounced. The fact that the loss is the greatest at this latter period may possibly be explained in the same way as the decline in curve *A* (shown in Fig. 4, and representing tests No. 2 and No. 3 in the first series) was explained, namely, by the fact that the concrete imagery which is strong with young children, has become weakened in the latter years of the grammar grades, and that power of association has not at this time sufficiently developed to make good the loss of the concrete imagery. This slight falling off in the curve of forgetting after a period of twenty-four hours when a much greater decline would have been expected, has been noted by several investigators.

It will be recalled that Ebbinghaus in his pioneer experiments with nonsense syllables found that, tested by the *Ersparnismethode,* the rate of forgetting was proportional to the logarithm of the time. These results were later confirmed

in the recall of tones by Wolfe and others. On the other hand Boldt, in an experiment with thirteen normal and thirty-five pathological subjects, found that for the former an increase of the interval between the presentation and the recall resulted in an increasing accuracy. Reproduction after five minutes was not as good as after fifteen, and the best results of all were obtained after twenty-four hours. The fact that these results held good for normal subjects and not for those suffering from mental disease is significant and will be referred to again.

Lobsien likewise found in experimenting with twelve pictured objects that the repetition of the test without intervening recall indicated that memory in children increased in accuracy for from one to two days, and Binet reports that many scholars, eight days after learning, remembered more than immediately after. Experimenting with smaller intervals, Finzi found that the best reproduction does not come immediately after presentation, but somewhat later (from six to thirty seconds).

The explanation offered by Watt in commenting on Lobsien's experiment, that the children talked the matter over in the meantime, may in part explain some of these seemingly strange results, but is hardly sufficient to account for them as a whole.[11]

The discrepancy between the results of the present experiment and those of Ebbinghaus and of Wolfe may in part be explained by the fact that a different method of testing the recall was used by Ebbinghaus and by Wolfe than by the writers of the present paper. Ebbinghaus used the *Ersparnismethode,* as previously stated, and Wolfe the method of identification, while in the present experiment memory was tested by the amount retained in the recall. These differences in the method of testing the memory are not, however, sufficient to explain the great difference in the results. Ebbinghaus used nonsense syllables, Wolfe tones, while in the present experiment sense material (the story) was employed as a test for delayed recall in most instances, although as previously stated, a few results were taken with nonsense syllables.

[11] The tests in the Urbana schools were so conducted that the delayed recall excluded the possibility of communication in most cases.

The most reasonable explanation for the difference of the results in the experiments of Ebbinghaus and of Wolfe and in those of the present investigation is to be found in a fact already discussed, namely, that two factors are necessary for effective recall, namely, the impression and the association. The tones used by Wolfe offered but few opportunities for association and hence the chief means of recall was through the impression, which was probably not particularly vivid, especially for adults who had lost to a great extent their power of concrete imagery, if indeed, they had ever possessed it, for tones. Naturally then, there would be a somewhat rapid falling off in memory under such conditions. Ebbinghaus used himself as observer in his test with nonsense syllables. These he had trained himself to learn without bringing in tricks of association, something which the untrained observer has a constant tendency to employ. Ebbinghaus must, therefore, have relied largely in recall upon the impression and not on the association. Hence came the rapid falling off in the memory curve. Both with nonsense syllables and with the story in the present experiment there was doubtless a large rôle played by association in the recall, and as Dr. Burnham has pointed out in his article (previously cited in this paper) association requires some time to fix itself. Hence the length of the interval was an important factor in the accuracy of recall. In this connection the results of Boldt may again be cited. He found with normal subjects that an interval between learning and recall strengthened the memory, but this was not true with pathological subjects, whose associative processes were much weaker than those of the normal subjects. The pathological subjects were not able to retain the material presented, because they could not associate it. Goldstein, working also with pathological subjects, found a marked distinction between the *Einprägung* and the association. The subject might be successful in immediate recall, while showing great weakness in delayed recall.

It must be remembered that in the case of young children, while the associative element is not so important in recall as with the adult, the impression of the sense material is doubtless much stronger, and it is preserved in concrete visual imagery

for some time. It, therefore, does not fade from the mind as rapidly as the same sort of an impression would fade from the mind of an adult who has lost his power of concrete imagery to a great extent. For these reasons it is hardly to be expected that the memory curve of Ebbinghaus would hold good under the conditions of the present experiment, either for the child who relies largely on the vividness of the impression, or for the young person and adult who rely much more on association. Granted that the results of the present experiment are valid in the point now under discussion, these results by no means disprove those of Ebbinghaus; they do, however, indicate that his results have a much more limited application than has generally been supposed, and that they are not valid in general for learning under the usual conditions of the school.

These results suggested a parallel between the growth of memory and the acquisition of a skilful act by an individual. The study of Bryan and Harter in the learning of the telegraphic language, and other studies later made along similar lines, have shown the fact that plateaus develop at certain stages of the process of acquisition, and the individual must wait for a new set of coördinations to be perfected before an advance to a higher level can be made. It is true that here there is not actual loss, as there is when the concrete imagery becomes weakened in the child's mental development. On the other hand both in the development of memory and in the perfection of a skillful act an advance is conditioned on the perfection of new powers as yet imperfectly under control.[12]

The last part of this discussion brings us to the question of the relation between the various memory types and the learning of materials appealing to the different sense departments. As has already been said, but little attention has been paid to this problem by investigators. The work of Segal, which bears

[12] In this connection my colleague, Dr. J. W. Baird, suggests an interesting fact in the learning of the game of billiards. He informs me that the first shots made by beginners are the more simple carrom shots. Later when the cushion shots are tried, the ability to make the carrom falls off, and the novice, who has not as yet perfected his cushion shot sufficiently to make it of any great value to him, actually falls off in his play for the time. Thus there is a decline in the curve of efficiency.

somewhat directly on the subject here under discussion, has already been mentioned. Meumann agrees with Segal, that it is advantageous to fit the material presented to the ideational type of the learner, and not as Münsterberg and Bigham maintain, present the material through all possible avenues. In

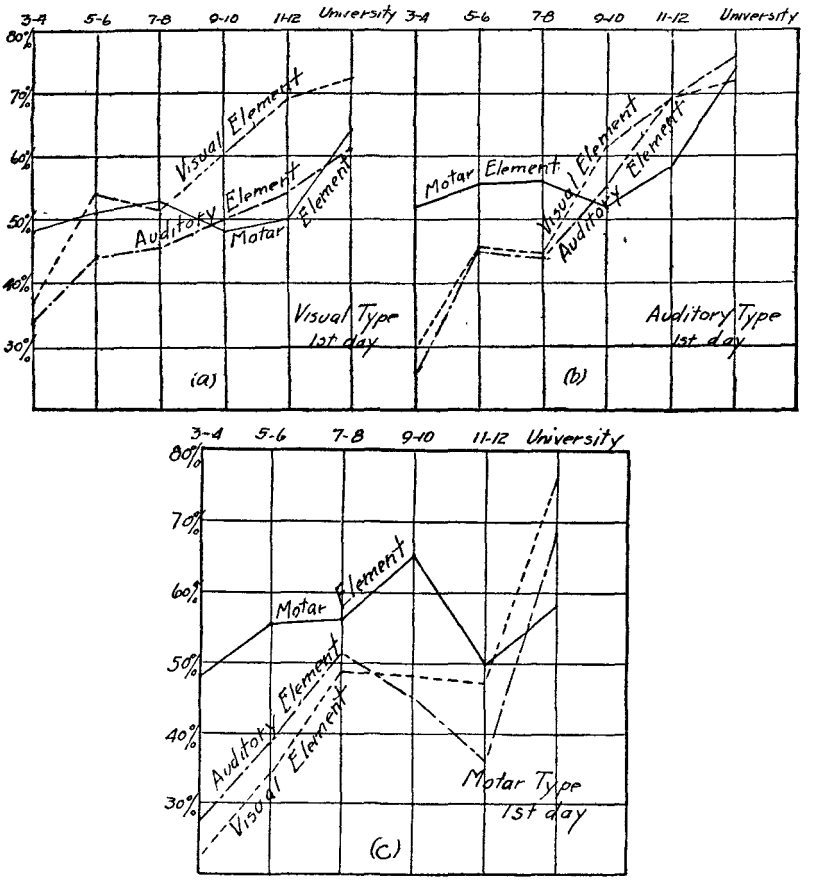

FIG. 7.

other words Meumann believes that the visually minded should as far as possible have the material presented so as to appeal to the visual type of learning, the auditory to the auditory type, and so on. The present experiment attempts to throw further light on this problem by studying the relation between the retention of the various elements in the story and the three idea-

tional types, as determined by the first series of tests with nonsense characters and syllables.

By means of these first tests all the subjects studied, as has been explained above, were classed under one or more of the three ideational types. In the test with the story the retentivity

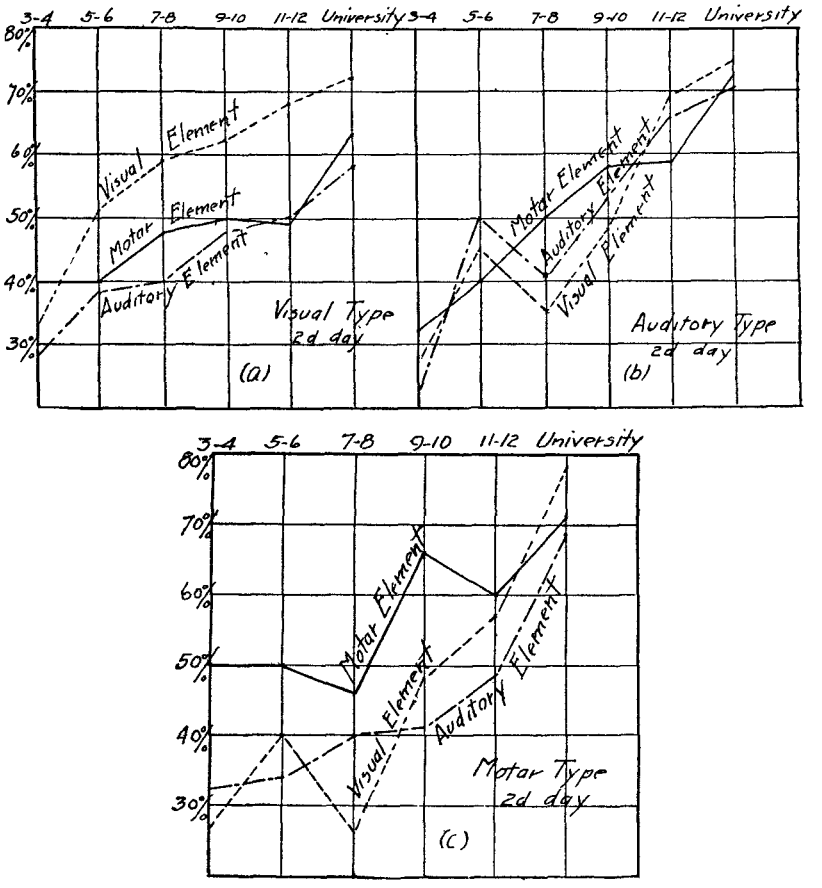

FIG. 8.

of all the subjects of each type for the three different elements of the story was determined. The visually minded subjects were studied for their memory for the visual, auditory and motor elements in the story; the auditory and the motor minded subjects were also considered from a like standpoint. The results of this tabulation are expressed graphically in Figs.

7, 8 and 9. Since the classification into visual, auditory and motor types separated each school grade into three groups, and these generally of unequal size, varying as the particular grade under consideration was strongly of one type or of another, some groups were small. For this reason, in

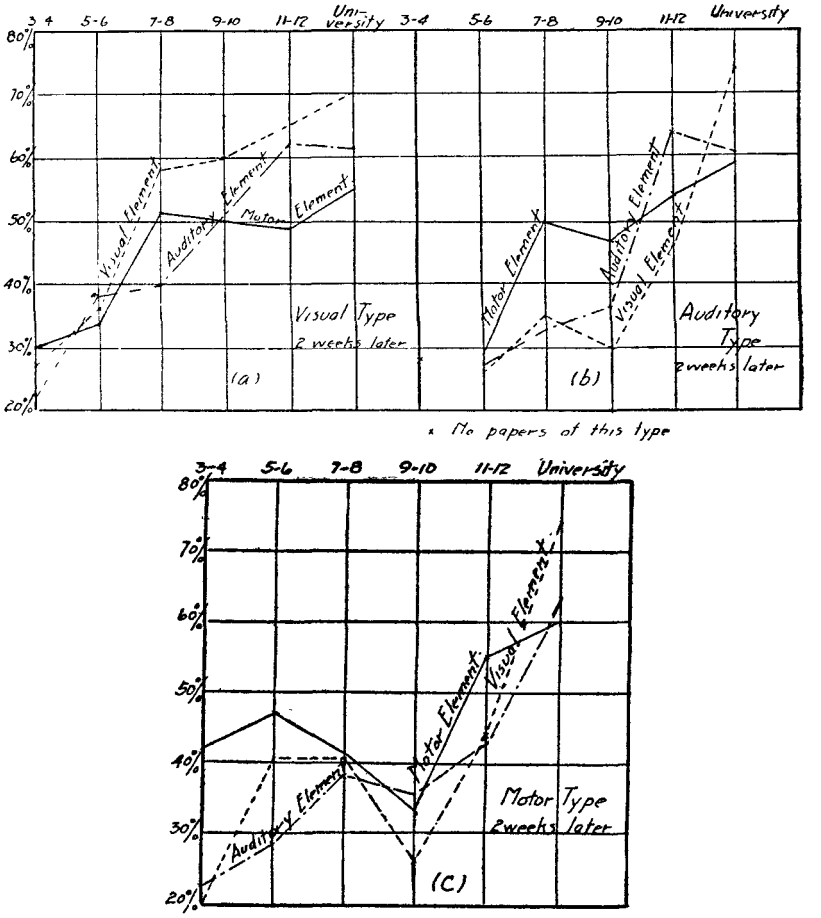

FIG. 9.

the tabulation of the results two grades were combined and the data of the third and the fourth, the fifth and the sixth, and the seventh and the eighth grades were averaged together. The curves represent the results for immediate recall, for recall after an interval of twenty-four hours, and for recall

after an interval of two weeks. These last named were not as satisfactory as those taken immediately after the reading of the story, or after a lapse of one day, since in some of the grades and in the high school especially, pupils were being examined at the end of the semester's work. This circumstance will explain some of the variations in the results recorded in Fig. 9.

The portions of Figs. 7, 8 and 9 marked (*a*), indicate the manner in which the visually minded subject recalled material appealing to the three sense departments (visual, auditory, motor); the portions marked (*b*) indicate the same for the auditory type, and the portions marked (*c*) for the motor type. Fig. 7 gives the results for immediate recall, Fig. 8 for recall after twenty-four hours and Fig. 9 after two weeks.

It can be seen at a glance that for the early grades the motor elements in the story are better retained than are the visual or auditory. This is true for the three ideational types, both in immediate and in delayed recall. On the other hand, the test with university students shows the superiority of the visual elements, with but one exception for all types, both for immediate and for delayed recall. The superiority of the motor elements of the story in the lower grades is to be explained doubtless in terms of attention and of interest. The narration of what was done by Mr. Jones and the other characters is the most vivid part of the story. It has been pointed out by several investigators that the securing of interest is one of the chief factors in the instruction of young children. This is the all-important thing in the earlier stages of development. By the time the university is reached, however, the mere matter of interest in the story has become much less important, and the tendency towards verbal-visual imagery strongly asserts itself.

Apart from the striking importance of the motor elements of the story in the earlier grades, it will be found in general that the visual elements of the narrative are best retained by the visual type both in immediate and in delayed recall, though the visual elements show their superiority more in delayed than they do in immediate recall, more particularly in the recall after twenty-four hours. The auditory elements are not, how-

ever, as well retained by the auditory type as are the motor elements except in the case of the higher grades and the university, and in many instances the visual elements show superiority over the auditory for the auditory type. It can, however, be seen that the auditory type in general retains auditory elements better than does the visual or the motor types. The motor type is at a very distinct advantage in retaining motor material over the visual type except in the university, and in general shows a superiority, though not so pronounced, over the auditory type, particularly for immediate recall and for recall after twenty-four hours. On the other hand both the auditory and the visual type retain motor material as well on the whole as does the motor type when the recall is delayed for two weeks. The curves seem to indicate in general that the visual type possesses a superior retentivity in delayed recall as compared with the motor type, and to an extent as compared with the auditory type. This circumstance tends to confirm in general Meumann's contention that the visual type has greater powers of retentivity than have either the auditory or the motor types. Finally it may be said that in general the visual ideational type is best suited to learn and retain material with a visual content, except in such instances as when material with a motor content appeals so strongly to the interests (particularly of young children) as to gain and hold the attention.[13] The auditory type on the whole and particularly in the lower grades, does not learn and retain material with an auditory content as well as with a motor content, though as a rule visual material is inferior to auditory, particularly in delayed recall. The motor type retains motor material better than it does visual or auditory except in the higher grades. It seems not an unwarranted conclusion (when the element of superior interest

[13] The factor of interest in movement may explain the results of Colvin and Meyer in the study cited above. Throughout the grades the boys found it their most powerful for of imagery. The girls also showed a highly developed motor imagination. For the boys words with a motor content predominated up to the high school, and for the girls the motor images were in excess of the visual up to the same period. In the grades words denoting both visual and auditory content are markedly lower than the words denoting a motor content, in the case of the boys.

in the motor material is removed) that each type of ideation is best suited to learn and retain material appealing to the particular sense department to which this type belongs. An exception to this is to be noted, however, in the higher grades and the university where visual material sems to be better learned and retained by all three types. Here doubtless the auditory and motor types rapidly and with practically no loss translate the material from one sense department to another. This can be readily done since concrete imagery has greatly fallen off and symbolic and verbal thinking has taken its place, a type of thinking to which visual imagery particularly lends itself.

VI. Summary and Conclusions.

The results of the above experiments may be summarized as follows:

1. It seems to be established beyond reasonable doubt that the young child thinks largely in concrete visual imagery, and that while auditory and motor imagery are present to some degree, they play a relatively unimportant rôle in the lower school grades. The child up to ten at least is predominantly a visualizer.

2. Concrete visual imagery, and probably all concrete imagery, tends to fall off in the more advanced grades, its place being taken by verbal imagery. The rise of the latter is probably closely connected with increase in ability to associate and to give meaning to memory material. This ability, however, at first does not compensate for the actual loss in vividness of the concrete imagery, hence there seems to be an actual decline in imagery about the onset of puberty. The subsequent recovery and advance is not due, however, to the recovery of concrete imagery, but to the growth of a power on the part of the adolescent to associate and group into meaningful relations his memory materials. The loss of concrete imagery should be taken into consideration in the schools, and while the pupils should be trained to associate and relate their materials, they should still be educated in such a way as to preserve their ability to think in concrete imagery when such thinking is de-

sirable; and this all the more because it is quite probable that most persons are not by nature predetermined to belong to a particular ideational type. Education has much to do in determining particular types and it is quite possible for a person to think in terms of verbal and symbolic imagery for one purpose and in terms of concrete imagery for another.

3. The importance of motor imagery, both for the hand and for the vocal organs, appears to be much less than has generally been supposed. Doubtless many have confused the interest that children have in movement with an ability or tendency on their part to think in motor terms. Except in pronounced cases where the child is extremely motor in his way of thinking, children seem to depend but little on their motor imagery; indeed, the kinæsthetic sensations from throat and hand may be a hindrance rather than an aid in learning.

4. Auditory imagery shows growth in the period of later childhood. It may, however, be doubted that there is any growth in concrete auditory imagery, which probably is not at any period of development nearly as important as concrete visual imagery. The growth of auditory imagery probably indicates the increase of the verbal type of imagery and its development may show the growing tendency to think in terms of the 'inner-speech.'

5. The rapid falling off of the memory curve as established by Ebbinghaus and confirmed by subsequent experiments does not seem to hold good in the present experiment. Recall after twenty-four hours seems to be as good on the whole as immediate recall, when tested by the method of parts retained, as was the case in the present experiment. This fact is extremely significant in the psychology of learning, and seems to be in harmony with the point of view of Dr. Burnham and the results of several recent investigators.

6. There seems to be a fairly definite relation between the effectiveness of memory in the case of a particular ideational type and the memory material which is most suited to that type. In particular the visual type retains best material with a visual content and the auditory and motor types, to a less degree, material with an auditory or motor content, as the case may be.

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