

Per cent	A		B		C	
	Without scale.	With scale	Without scale.	With scale.	Without scale	With scale.
100 . .	..	..	..	..	..	..
90 . .	2	2	2	..	..	..
80 . .	8	26	13	5	..	..
70 . .	12	4	8	6	..	..
60 . .	10	4	8	25	..	..
50 . .	3	1	5	1	1	..
40 . .	2	..	1	..	8	9
30 . .	..	..	..	..	16	20
20 . .	..	..	..	..	11	8
10 . .	..	..	..	..	1	..
0 . .	..	..	..	..	..	..
	37	37	37	37	37	37

From such figures students will readily draw conclusions as to the need of a scale in their estimations of handwriting. In the case of Sample A, the value is evidently 80 per cent. Without the scale only 8 of 37 students in training for teachers who have had considerable practice in estimating the handwriting of school pupils assigned to the sample the correct value, whereas with the scale 26 assigned the correct value. The figures in the cases of B and C demonstrate that when, even with the help of the scale, the correct values are not assigned to the samples, these values, nevertheless, vary less from the correct values when the scale is employed.

Results like the above, worked out from the students' own judgments, impress students more than references to authorities, however distinguished; and if the conclusions viewed for experiments in education are to be incorporated into the practice of the ordinary class teacher, it must be through some such demonstration as the above.

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IDEATIONAL TYPES IN ARITHMETIC.

In 1908 the following experiments were made on 494 children of the male sex of the various grades from the first to the eighth, inclusive, of one of the public schools of New York City. The ages ranged from 7 to 15 years.

Purposes—To determine—

- A. Whether there are distinct ideational types in arithmetic.
- B. The relation of these types to the immediate memory of numbers.

- C. The distribution and development of these types in the grades.
- D. The relation of intelligence to the types of mental imagery.

Experiments.

Three series of numbers varying in length from 2 to 10 were given to the children in the following manner:

- A. The numbers were read to the children, and they were required to write the ones they remembered.
- B. The numbers were placed on the blackboard and covered. The children were asked to reproduce them.
- C. The numbers were read and the children repeated them aloud. They were then reproduced.
- D. The numbers were placed on the blackboard and read aloud by the children. They were then reproduced.

Results.

- A. Are there ideational types in arithmetic?
 - 1. If we mean by this question that children are visual only or auditory only, then our results answer in the negative. Among 494 children, there were about 10 children who relied exclusively upon one kind of reproduction—that is, children who produced absolutely no results in any form of presentation except one. The vast majority of children returned some results in all forms of presentation; except that they did best in some particular form. We must conclude, therefore, that nearly all school children belong to a mixed type and possess greater ability in absorbing and retaining numerical facts in one direction than in another.
 - 2. Although most children are of the mixed type, yet certain methods of presentation will produce better results than other methods.
- B. The relation of these types to immediate memory of numbers.
 - 1. The best results in early years of school life are obtained from auditory presentation, in later years from visual and visual motor presentation.
 - 2. The best results in all forms of presentation are obtained in the fifth and sixth years of a school child's life.
 - 3. The auditory motor presentation gives very poor results throughout the grades, showing that loud speech move-

ments are a hindrance instead of a help to immediate memory.

4. The child's retentive power for number is greatest about the fifth or sixth years of its school life—that is, memory, without regard for content or for logical connections, is strongest in the eleventh or twelfth year of the life of the individual.
- C. The distribution and development of the types in the grades.
1. The vast majority of the children are of the mixed type in arithmetic. There are no types in number imagery in the sense that children think exclusively in one kind of imagery.
 2. In every class more than one-fourth of the children are visual motor; in the third and fourth grades, more than one-half of the children belong to this type.
 3. From one-fifth to one-half of the children in the various grades are visual, except in the first grade, where only one-twentieth of the children are of this type.
 4. The auditory type predominates in the first and second grades. The visual or the visual motor in all the other grades.
 5. There is a rapid increase in the visual type from the first to the fifth grade.
 6. There are more children of the visual motor type in the grades than any one of the other types. This is the predominant type among our children.
- D. The relation of intelligence to the types of mental imagery.
1. In general, bright pupils seem to use the visual type of imagery in preference to the auditory type. It is found also that visual or visual motor presentations of arithmetical subject-matter are a decided help for bright pupils. Auditory presentations act as a hindrance to the imagery of bright pupils.
 2. Dull pupils do not seem to belong to any pronounced visual or auditory type.
 3. Children of a pronounced auditory type, whether bright or dull, find the addition of the motor element, in this case loud speaking, a distinct hindrance to their type of imagery. This is contrary to what is generally be-

lieved to be the case. It has been accepted that the addition of the motor element acts as a help to any type of imagery, whether visual or auditory.

Conclusions.

1. The results of our investigations as to the distribution of mental types in the grades may be utilized in the partial solution of the problem of retardation. It is highly probable that a teacher may be of a predominantly auditory type and yet have before her children who belong to a predominantly visual type. As a result, we find her adopting methods which are largely auditory and thus failing to reach the vast majority of her children. A careful investigation of retarded pupils will no doubt show that there are many children in our schools who have failed to comprehend instruction, who have not succeeded in keeping up with their grades, because their mental type of imagery has not been understood, recognized and taken into account by the teacher in the presentation of the subject-matter of the curriculum.

2. We have found that immediate memory is at its best in the fifth and sixth grades. We have found that children in these grades can retain and reproduce longer series of numbers than those in the seventh and eighth grades. It can readily be seen that since the mechanical memory seems to be strongest in these grades, it would be decidedly unpedagogical to leave to the seventh and eighth grades tables that have to be committed to memory. Therefore, in the making of a course of study it would be well to have all facts which are to be retained by the mechanical memory as such disposed of during the first six years. Should this be an indication of the general process of the mind in acquiring knowledge in every subject, then the teaching of languages, and especially the time of beginning them, must undergo a change. Instead of making French and German electives in the eighth year of school, it would be better for them to be introduced before the seventh year. The plasticity of the memory, being greater at that period, a greater economy of learning would follow. The good results obtained in the German Gymnasium in the study of Latin are no doubt due to the fact that the language is commenced and studied in the fifth and sixth years of the child's school life.

3. A current educational maxim, which has never been ques-

tioned, has been, "In teaching, appeal to all the senses possible." We have noted that all children who are of a pronounced auditory type find the addition of the motor element as actually hampering them in their intellectual operations. Hence, if we attempt to carry out the maxim, we find that we are hindering some children instead of assisting them. So that we might well consider other educational maxims which as the result of the experience of some teachers find their way into educational practice and examine them in the light of experimental investigations as to their general truth. We are too prone, in pedagogy, to adopt methods of procedure which are promulgated as the result of experience or unscientific observation, and it is probable that in many instances we are actually hampering the pupils instead of enabling them to acquire knowledge economically.

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