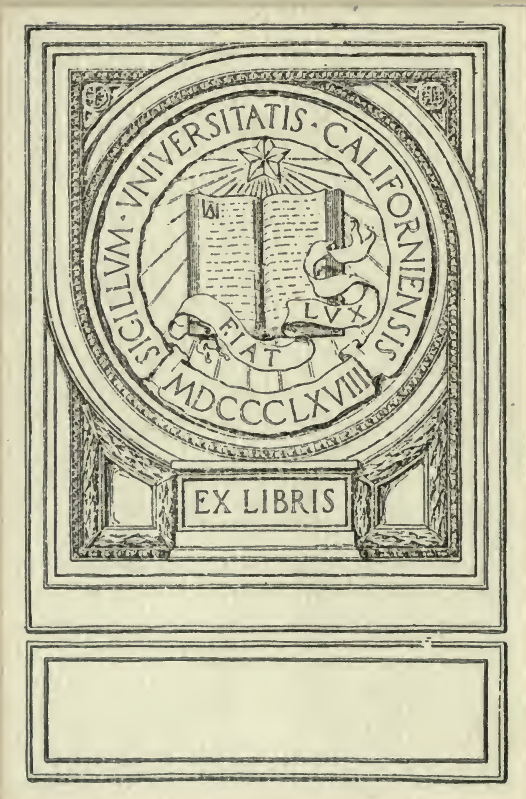
EXPERIMENTAL EDUCATION

ROBERT R. RUSK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BY

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PRINCIPAL LECTURER IN THEORY OF EDUCATION TO THE ST ANDREWS PROVINCIAL COMMITTEE FOR THE TRAINING OF TEACHERS
EXAMINER IN EXPERIMENTAL EDUCATION IN THE UNIVERSITY OF EDINBURGH
FORMERLY EXAMINER IN EDUCATION IN THE UNIVERSITY OF ST ANDREWS

LONGMANS, GREEN AND CO.
39 PATERNOSTER ROW, LONDON
FOURTH AVENUE AND 30TH STREET, NEW YORK
BOMBAY, CALCUTTA, AND MADRAS
1919

PREFACE

Two editions of two impressions each of his *Introduction to Experimental Education* being exhausted, the writer has availed himself of the opportunity to revise the work and to introduce such alterations and additions as could not conveniently be made when it was in stereotype.

The references now given are to the second, and final, edition of the late Ernst Meumann's *Vorlesungen zur Einführung in die experimentelle Pädagogik* (Engelmann, Leipzig, 3 volumes, 1911, 1913, 1914); to the three-volume edition of Thorndike's *Educational Psychology* (Teachers College, Columbia University, 1913, 1913, 1914); and to the second edition of Whipple's *Manual of Mental and Physical Tests* (Warwick & York, Baltimore, Part I. 1914, Part II. 1915). The list of publications suitable for further reading, appended to each chapter, is confined to the most suitable and accessible works published in, or translated into, English.

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EXPERIMENTAL EDUCATION

CHAPTER I

THE STANDPOINT OF EXPERIMENTAL EDUCATION

EXPERIMENTAL Education has within a brief period established its claim to be regarded as an independent science. The publication of numerous works dealing with various aspects of the subject and of journals solely devoted to it testifies to this. Originally dependent on Experimental Psychology for its methods and for many of its results, it now dictates problems to psychology. "At first," as Münsterberg explains, "the results of theoretical psychology were simply transplanted into the pedagogical field. Experiments which were carried on in the interest of pure theoretical science were made practical use of, but their application remained a mere chance by-product. Only slowly did the pedagogical problems begin to determine the experimental investigation. The methods of laboratory psychology were applied for the solving of these problems which originated in the school experience, and only when this point was reached could a truly experimental pedagogy be built on a psychological foundation. We stand in the midst of this vigorous and healthy movement, which has had a stimulating effect on theoretical psychology itself."[1] The situation was more comprehensively, and with greater succinctness, expressed by Professor Adams in his Presidential Address to the Educational Science Section of the British Association, 1912, when he said that Education had captured psychology.

[1] *Psychology and Industrial Efficiency*, p. 12.

Experimental Education is nevertheless not now restricted to questions which are mainly of psychological significance: it raises and investigates problems which are purely educational in origin, and the solutions of which have primarily didactic significance. It has likewise adopted methods of investigation and devised instruments which can be characterised only as pedagogical.

That the traditional pedagogy cannot be termed scientific will generally be admitted. When it did not rely wholly on experience without attaining to principles, it accepted principles without verifying them by appeal to experience. Many schemes of education have, for example, assumed the "recapitulation" principle without attempting to prove the parallelism, or to determine the points of correspondence, between racial and individual development. The classical school of educationists likewise adopted the doctrine of formal training, which implied that the power derived from pursuing a certain course of study could be applied indifferently in any sphere of mental life; but they omitted to determine to what extent a general improvement is secured by training a specific function, whether this general improvement is automatically transferred to other specific functions, or whether the improvement of the second specific function could not be attained more economically by direct training.

The new pedagogy, however, claims to be scientific. It seeks to present its data in exact quantitative terms. It is inductive rather than deductive. Instead of following the old *a priori* methods, it adopts the sure method of experiment.

The claim that Education should be founded on experiment is not new. In the Appendix to *Practical Education* [1] by Maria and R. L. Edgeworth (1798) there is quoted Mrs Honora Edgeworth's opinion that the art of education should be considered as an experimental science, and that many authors of great abilities had mistaken their road by following theory instead of practice. Pestalozzi [2] maintained that all branches of instruction demand analysis of their methods, and that the age at which each branch of instruction may be

[1] First Edition (1798), vol. ii. p. 734.
[2] *How Gertrude Teaches*, English trans., p. 126.

imparted to the child should be exactly determined. Kant [1] also asserted that experimental schools must first be established before we can establish normal schools.

The recent advance in Education has only been made possible by the progress of such other sciences as anthropology, psychology, etc., which have helped to provide Experimental Education with its methods. The way for this advance has also been prepared by the results of the Child-Study movement, although these are in themselves inadequate as a basis for the new method. Excellent studies of individual children have been made by Preyer, Perez, Darwin, Miss Shinn, and Dearborn, but these stop before school age —just when they would have been of most value to the educator. The other department of Child Study is mainly statistical, yet its results cannot always be regarded as scientific. In most Child-Study investigations the questions employed are ambiguous, owing to inadequate analysis, and the statistics are frequently vitiated by the factor of "selection," the answers recorded being given mainly by those to whom the questions happen to appeal.[2] It is sometimes assumed that these objections do not hold when the range of replies is very extensive; but to this Myers says, "I want to protest as strongly as I can against the notion that any useful purpose can be served, so far as psychology is concerned, by collecting masses of psychological data with the help of an army of untrained observers. I have heard it confidently asserted that the gross errors inevitably arising from inaccuracies and inconsistencies of procedure among different observers cancel one another in the long run of such vast numbers of measurements. Nothing, I think, can be more dangerous or false than this idea that the untrustworthiness of crude methods diminishes as the number of observers increases. It involves the assumption that in the long run errors occur to an equal extent in opposite directions—a most unlikely hypothesis." [3]

The vagueness of the Child-Study methods can be illus-

[1] *Kant on Education*, trans. by Annette Churton, p. 21.

[2] *Cf.* Thorndike, *Educational Psychology*, vol. i. pp. 28–37.

[3] C. S. Myers, "The Pitfalls of Mental Tests"—a paper communicated to the British Association at the Sheffield Meeting, 1910.

trated by the variety of the views expressed on such a subject as the reasoning powers of children. One writer asserts, "Before a bright child can talk, he is already a reasoning human being, who will rapidly develop from his inner consciousness such a power of logic as passes understanding."[1] King, in *The Psychology of Child Development*, states that some investigators conclude, from a study in children's inferences and reasonings, that there is at the end of the ninth year a marked increase in the logical faculty.[2] Mrs Barnes, from her investigation on "The Historic Sense among Children," declares that the results of her test go to show that the number of inferences made rises decidedly at the age of twelve for boys and thirteen for girls;[3] whereas another writer on "The Reasoning Powers of Children" maintains that a considerable portion of those who have received a sound education and have reached the age of fifteen, fail to show anything but the germs of thinking of a logical kind.[4] Such contradictory conclusions indicate that the methods employed are unscientific; the results are at best mere generalisations, suggesting hypotheses which require verification by more exact methods. Unfortunately, however, they are frequently set forth in statistical form, thus acquiring an absoluteness to which they have no claim.

The new Education consequently turns to Child Psychology rather than to Child Study for its methods. Experimental Education is not, however, to be regarded merely as applied psychology. It is without doubt an independent science, for, although to some extent deriving its data from other sciences, it regards such data from its own special standpoint. In this respect it is best comparable with the science of geography, which, although dependent on astronomy, geology, etc., has nevertheless its own peculiar point of view. The distinguishing feature of Experimental Education is its practice of analysing with scientific precision the problems concerning the child of school age.

The subject includes the investigation of the physical and mental development of the child and the discovery and im-

[1] *Paidologist*, vol. v. p. 164. [2] Page 187.

[3] *Studies in Education*, vol. i. pp. 47–53.

[4] *Paidologist*, vol. v. p. 159.

provement of appropriate means of measuring such development. In addition to weighing and measuring the child, Experimental Education treats of sensory acuity and sensory discrimination, the types of observation, the various forms of memory, the nature of the child's mental imagery, and the part which such imagery plays in the child's thinking. It even attempts to estimate quantitatively a function so complex as general intelligence and one so subtle as suggestibility. The individual differences in children, disclosed by investigations in these directions, together with the extent to which intellectual and moral differences are dependent on the original nature of the child, and the limitations which such endowment sets to the work of education—all provide fruitful fields of inquiry. The most economical modes of learning, the fatigue involved in various forms of mental work, and the effect of school organisation on the child, form a special section; and the psychological analysis of the efforts of the child in the various school subjects—reading, writing, etc.—is also a branch of Experimental Education of great practical importance.

Valuable as are the results already obtained, the justification for Experimental Education does not solely depend on these; rather is it to be found in the questions being raised in spheres where formerly there was apparently nothing in dispute.

It may be asked how the new method will affect the position of the teacher. It will deliver him from the tyranny of tradition and the caprice of the faddist, and bring him under the servitude of his science, since the scientific worker must ever submit to the method of his subject. If it removes him from the domination of an arbitrary authority, it requires his submission to a rational authority, one that can be questioned and whose dicta can be verified by experimentation.

Doubtless teachers will have but few opportunities of accomplishing original research work in Experimental Education. This requires a training which cannot form part of the ordinary professional course, and the time demanded by research work can hardly be given by one engaged in the routine duties of teacher. But, as Professor Dewey says,[1]

[1] *Educational Essays*, p. 158.

"unless our laboratory results are to give us artificialities, mere scientific curiosities, they must be subjected to interpretation by gradual reapproximation to conditions of life. . . . Now the school, for psychological purposes, stands in many respects midway between the extreme simplifications of the laboratory and the confused complexities of ordinary life. Its conditions are those of life at large; they are social and practical. But it approaches the laboratory in so far as the ends aimed at are reduced in number, are definite, and thus simplify the conditions; and their psychological phase is uppermost, while in ordinary life these are secondary and swallowed up." It is in the school, then, that the laboratory results must be put to the test. "The task of reviewing them is clearly one of great delicacy," and here the teachers will be able to render invaluable assistance to the new science.

Experimental Education, it may be added, does not profess to settle all the problems of education. It does not, for example, attempt to determine the general aim of education. Such determination falls within the sphere of social science or social philosophy. Professor Ward has said in his article on Educational Values: "The first thing the educator should be clear about is what he intends, what his end and aim is, or rather should be. To ascertain this ideal, he must turn not to psychology, but to life: it is a social and ethical, rather than a psychological problem."[1] It is, however, for Experimental Education to decide whether the aims are compatible with the child's nature and how these aims can best be attained. Thus Experimental Education, although it does not comprehend the whole of Education, provides the empirical groundwork of the subject.

REFERENCES FOR FURTHER READING.

SCHULZE, R. (trans. by R. Pintner), *Experimental Psychology and Pedagogy.*

CLAPARÈDE, E. (trans. by M. Lough and H. Holman), *Experimental Pedagogy and the Psychology of the Child.*

FREEMAN, F. N., *Experimental Education, Laboratory Manual, and Typical Results.*

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[1] *Journal of Education*, November 1890.

CHAPTER II

THE METHODS OF EXPERIMENTAL EDUCATION

EXPERIMENTAL Education employs the methods common to all the exact sciences, namely, systematic observation and experiment: their advantages over mere casual observation and opinion do not require enumeration here.

Experimental Education consists largely of the application of the methods of Experimental Psychology to the school child, and the very existence of the subject, therefore, depends on the possibility of an Experimental Psychology. The validity of the latter has frequently been questioned, but the time has probably arrived when we can apply the pragmatic test, and, in justification of Experimental Psychology, maintain that the results are a proof of the possibility of the subject and of the correctness of its principles. It now remains to be considered how far the methods of Experimental Psychology are capable of application to school children. Frequently it has been maintained that children are incapable of introspection; but recent tests in child psychology show that the school child, at least from six years of age upwards, is able to introspect quite satisfactorily in such simple experiments as the reproduction of presentations, and that, owing to the individual and concrete nature of his mental imagery, he can give more definite introspective detail than the adult.[1] The high degree of suggestibility in children is also urged as an objection to the application of the methods of Experi-

[1] *Cf.* Meumann, *Vorlesungen*, vol. i. pp. 385–387; also *British Journal of Psychology*, vol. vii. pp. 472–485.

mental Psychology, but with proper care this can be overcome, or its influence can be estimated and discounted. It is maintained, too, that the subject of an experiment should have some idea of the purpose of the test, and that this is impossible with young children. Undoubtedly, by reason of the age of the subjects, certain limits are set to the application of experimental methods with very young children, but in such cases simple experiments only need be attempted; there may nevertheless be certain advantages in the simplicity of the child's mental life and the *naïveté* of his outlook. Indeed, these factors sometimes make experiment easier with children than with adults, who are apt to introduce reflections and guesses as to the outcome of the test and thereby to modify their responses. An open mind, whatever it may be politically, can be of advantage psychologically.

No objection on methodological grounds is usually urged against the statistical methods employed by Experimental Education, provided the data are accurate.

The general methods can be divided into the two main classes, analytic and synthetic. The various educative processes may be analysed into their several factors and each considered in isolation; thereafter the factors may be combined by synthetic experiment into the original complex process. For example, the reading process may be analysed into the visual apprehension of the words in continuous reading and the eye movements involved therein; the comprehension of the words whereby we attain the meaning of what is visually apprehended; and the vocal process whereby the meaning is expressed. These factors may then be investigated independently, and thereafter the task is laid upon synthetic experiment of explaining how these partial processes co-operate in producing the original process of continuous reading.

For educational practice, synthetic experiment is undoubtedly the more important of the two methods; but it presupposes adequate analytic experimentation, and it is a misfortune, inevitable at this early stage of the development of the new science, that the investigations should be mainly analytic and consequently not so productive in practical applications as might otherwise be expected. Consequently, many of the methods and results at first sight appear to have but little bearing on school practice; but they should not on that account be ignored. In the early stage of the development of experimental psychology it was protested that nothing of value could possibly come from the simple reaction experiments then practised; yet it was by the development of these methods that a highly complex process like thinking at length yielded to experimental treatment. The seemingly unproductive process of memorising nonsense syllables likewise provides us with clues and methods by which we may hope to solve some of the difficulties in the training of the child's will—difficulties which the teacher at present cannot hope to overcome, if he even recognises their existence. Practical results alone should not at this stage be demanded, since hasty conclusions and applications will only bring the subject into discredit.

Experiments may be "individual," when the tests are applied separately, or "mass" or "group" experiments conducted in class. Each type has advantages and disadvantages. Individual experiments enable us not only to investigate individual differences but also to obtain the subject's introspection, and thus to check the objective results of tests. The value of such control has been emphasised by Myers in the article previously referred to: "To neglect introspection," he says, "is usually to court certain disaster. If we are in total ignorance of what has been going on in the mind of the subject during the experiment, it is rarely possible to argue from the objective data—from the measurements which it yields. For example, we may be trying to determine whether any correlation exists between sensory discrimination and general intelligence. A positive result may be simply due to the fact that the very nature of the test has compelled the subject to use his intelligence while carrying out sensory discriminations. We may be correlating mental ability with mental fatigue, and neglect the fact that sometimes we may not be measuring fatigue at all, that in some subjects the task becomes automatic, in others tedious, or that boredom may be in others overcome by motives of duty or ambition. We may be testing the visual acuity of two persons, and obtain a different result from each, despite the fact that really they have the same visual acuity. The result may be due to the fact that the one subject strains every effort to interpret what he but dimly sees, while the other only reads what he believes he can clearly see. Thus again we merely obtain a blurred or erroneous result from the blind applications of statistical methods to measurements which are really meaningless owing to our failure to analyse the conditions determining the character we are measuring."

Mass experiments, apart from the economy in time, may disclose uniformities which would otherwise escape notice. They should not, however, be undertaken without previous individual experiments to render the questions given in class quite unambiguous. Experimental Education has to determine what questions can be most appropriately investigated by the respective methods and how a proper balance between the two may be maintained.[1]

A method which has frequently been adopted by Winch,[2] and which is now extensively applied in educational experiments, is that known as the method of equivalent or parallel groups. When, for example, it is required to determine the effect of training a particular mental function, the following procedure is adopted. A test is applied to a class before the period of training is entered upon, and, on the basis of the results of this test, the class is divided into two groups, each containing pupils of approximately equal ability. One group is then trained in the exercise of the function in question, while the other is engaged upon different work. At the conclusion of the period of training, both groups are again subjected to a test. Should both show improvement over the original performance, and should the pupils of the trained group exhibit a greater improvement than their colleagues, we may ascribe the advance of the untrained group to natural development and endowment; and the difference between this and the degree of improvement of the

[1] For determination of the relative value of the two methods in certain typical tests, see "Experimental Tests of Higher Mental Processes and their Relation to General Intelligence," by C. Burt (*Journal of Experimental Pedagogy*, vol. i. pp. 104–105).

[2] For example, *British Journal of Psychology*, vol. ii. pp. 284–293.

practised group will give the measure of improvement due to training alone. When, however, a whole class is tested before training and again after training—without the control of an untrained group—it is impossible to estimate how much improvement is due to training and how much to natural development, or to determine whether the difference might not be accounted for by the final test being less difficult than the initial test.

As an instance of the application of the method of equivalent groups we may instance Winch's investigation into the relative merits of inductive and deductive methods of teaching.[1] The subject-matter selected was geometrical definition. The preliminary test required from the pupils spontaneous definitions of square, triangle, oblong, diameter. The answers were valued by allowing one mark for each correct point, and the class was divided into equivalent groups on the basis of the results of this preliminary test. The two groups were then taught, one deductively, the other inductively. The former had definitions written out for them with illustrative drawings underneath, and they were instructed to study and learn the definitions. The other group was taught inductively, being led to form the definitions for themselves under the guidance of the teacher. Both groups were finally subjected to three tests, one immediately the learning was concluded to test immediate reproduction, one a week later to test deferred reproduction, and a third test was applied to determine how far the teaching or learning by the respective methods affected the pupil's power to attack new material of an analogous kind.

The results, it may be stated, showed that when the test was made on precisely what the pupils had been taught, in three out of five schools the conclusion was unambiguously in favour of the deductive method. In two classes the inductive method was as successful as the deductive. There were some indications that the children inductively taught lost rather less of what they had known than those deductively taught when they were tested some time afterwards, but on the whole the tests of deferred reproduction gave the same comparative

[1] W. H. Winch, " Inductive *versus* Deductive Methods of Teaching " (*Educational Psychology Monographs*).

results as those of immediate reproduction. When, however, they were required to apply themselves to new material, the pupils who were taught inductively did better work in every case than those taught deductively.

Although it was doubtless unnecessary in this investigation, it would have been incumbent on the investigator if he had desired to conform to the conditions of an ideal test to divide the class into three equivalent groups, one to be taught deductively, one inductively, and one to have no teaching but to occupy the time which the others employed in learning in some other form of work, for it might conceivably happen that the teaching, instead of enlightening the pupils, would only have confused them, and the results of the third or control group would in such a case be necessary to reveal this.

The statistical methods common to Experimental Psychology and Experimental Education also call for brief mention. Results of tests expressed in numerical terms can be reduced in various ways, and for each series we must determine what is the most representative value by which it can be characterised.

There are three measures commonly employed to denote a series :—

1. The ordinary *arithmetical mean* or average is obtained by dividing the sum of the values by the number of cases; for example, the average height of a class is the sum of the individual heights divided by the number of pupils. Although it frequently involves a considerable amount of calculation, the method of finding the *a.m.* is simple. This measure is consequently the one most commonly adopted, but it is not always the most representative. In assessing the damages in a libel suit, for instance, the jury might agree to award the average of the amounts suggested by the various members, say £60, £60, £75, £100, £125, £150, £150, £150, £200, £200, £250, and £1000. The average in this case, £210, is clearly not representative, since ten of the twelve jurymen would have awarded less. In such circumstances a crank carries weight in proportion to his eccentricity, whereas a just estimate should, as far as possible, discount the verdict of such a person.

An average is also valueless unless the range of variations is given. Two places might, for example, have the same mean annual temperature and yet entirely different climates, one presenting extremes of heat and cold while the other had an equable temperature. To indicate the variability of a series of values represented by the arithmetical mean it is necessary to state what is termed the *mean variation*, symbolised by *m.v.* This is ascertained by finding the average of the differences between the arithmetical mean and the different values representing the series, all the deviations being regarded as positive. Thus in the case quoted above the series runs 60, 60, 75, 100, 125, 150, 150, 150, 200, 200, 250, 1000, and the arithmetical mean is 210.

The differences between the *a.m.* and the values are: 150, 150, 135, 110, 85, 60, 60, 60, 10, 10, 40, 790, and the average of these differences, the mean variation, or *m.v.*, is $\frac{1660}{12}=138 \cdot 3$, which represents the range of variability of the series.

Instead of the mean variation the standard deviation, usually symbolised by σ, is sometimes required. It is calculated from the formula

$$\sigma=\sqrt{\frac{\Sigma d^2}{n}}.$$

The standard deviation is thus the square root of the average of the squares of the deviations of the various values from the mean value of a series. As in calculating σ the deviations are squared, this measure gives more weight to extreme differences than does the *m.v.*, and for some purposes this is an advantage, as, for example, when we wish to determine whether the pupils of a school are properly classified.

A simple method of computing the standard deviation,[1] making unnecessary the subtraction of each measure from the representative value, is to subtract the square of the average of the values from the average of their squares and extract the square root. Thus:—

[1] Beardsley Ruml, "On the Computation of the Standard Deviation" (*Psychological Bulletin*, vol. xiii. pp. 444–446).

	Measures.	Squares of Measures.
	5	25
	6	36
	2	4
	8	64
	7	49
Σ	28	178
Average	5·6	35·6
Square of average		31·36
		$4{\cdot}24 = \sigma^2$.

Therefore $\sigma = \sqrt{4{\cdot}24}$, *i.e.* 2·05.

The standard deviation may be found correct to any desired number of decimal places, by carrying the average to that number of places.

2. When it is suspected that the extremes of a series are due to the presence of extraneous factors in the test, and it is considered desirable to eliminate these to obtain a representative value, the measure employed is that termed the *median*. To ascertain the median, the values are arranged in order of magnitude and the middle one selected as representative of the series. In the event of an even number of values in the series, the average of the two middle ones is regarded as the median.

The number of sums attempted, for example, by the pupils of a class of thirty-five might be scaled thus:

$$\overbrace{5, 5}^{2};\ \overbrace{7, 7, 7}^{3};\ \overbrace{8, 8}^{2};\ \overbrace{9, \mid 9 \mid 9, 9, 999}^{7};\ \overbrace{10, 10, 10, \parallel 10, \parallel 10}^{5};$$

$$\overbrace{11, 11, 11, 11, 11, 11, 11}^{7};\ \mid \overbrace{12, \mid 12, 12, 12, 12}^{5};\ \overbrace{14}^{1};$$

$$\overbrace{15, 15, 15}^{3}.$$

The median value of the sums attempted is that represented by the eighteenth pupil, namely, 10.

We can locate the median more definitely within a class, assuming that the items are equidistant and that the distribution takes the form of a straight line, by the use of the formula [1]

$$M = l + \frac{c(2i-1)}{2f},$$

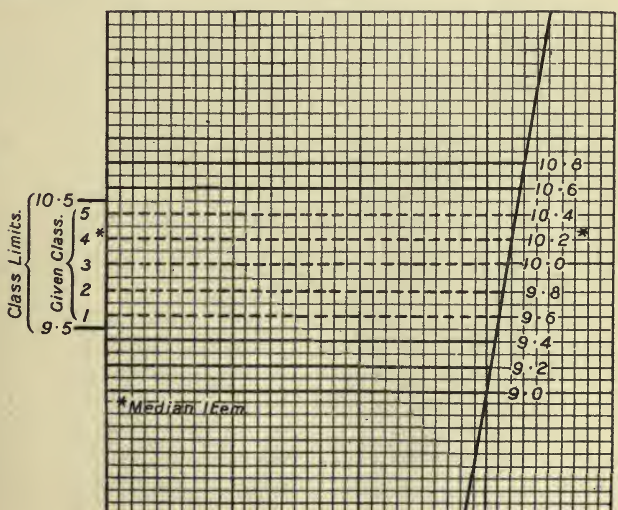
[1] Willford J. King, *Elements of Statistical Method*, p. 129. To the author of this work the writer is indebted for the example and illustration here given.

where M is the median, l the lower limit of the class, c the class interval of the class containing the median, i the number of items up from the lower limit of the class at which the median item occurs, f the number of items in the class.

When the integers progress as in the example (given above) of the number of sums worked by pupils 9, 10, 11, etc., the class interval is 1. The limits of the class of 10 would be 9·5 and 10·5, the lower limit being 9·5. If the median is the fourth of five items, then applying the above formula we get

$$\begin{aligned} M &= 9{\cdot}5 + \frac{1(2 \times 4 - 1)}{2 \times 5} \\ &= 9{\cdot}5 + \frac{1(7)}{10} \\ &= 9{\cdot}5 + \frac{7}{10} \\ &= 10{\cdot}2 \end{aligned}$$

This result can be obtained by inspection from the following diagram :—



To denote the range of variability in a series represented by the median, the semi-interquartile range is usually given; it is calculated by taking half the difference between the quartiles above and below the median, that is, in the case of the number of sums worked, half the difference between 9 and 12, or 1·5. Here again the extremes are eliminated.

3. The third measure used, the *mode*, is the value which occurs most frequently in the series. In the first illustration which we have used 150 occurs three times, and since no other value occurs more than twice, 150 would be taken as the representative measure. The defect of the mode is evident in the second example used above, namely, the number of sums worked, for it is not evident by inspection whether it is 9 or 11. In such a case the location of the mode has to be determined by a process of grouping,[1] and the claim of this measure to simplicity cannot consequently be maintained.

In experiments with numerous examples in the series the arithmetical mean may be employed, and the mean variation, or the standard variation, also given. To reduce the work of calculation, or when the examples are not numerous and it is conjectured that disturbing factors may be influencing some of the results, the median should be employed, in which case the series should comprise an odd number of examples in order to simplify reduction. When the semi-interquartile range has to be calculated, 15 or 19 will be found more convenient than 13 or 17. The mode is used to characterise a type, that is, to indicate the case most frequently recurring.

When a series of tests has been applied to a number of subjects and the results of the observations of the various individuals in the case of each test are reduced by any of the foregoing methods—the arithmetical mean (*a.m*) and mean variation (*m.v.*) being selected as representative—it may be considered desirable to determine also the degree of difficulty of the separate tests for all the subjects taken together. This may be accomplished by calculating the arithmetical mean and the mean variation of the representative values already computed; and to distinguish these measures from the ordinary

[1] For procedure, see King's *Elements of Statistical Method*, pp. 122–123.

a.m. and *m.v.* it has been suggested by Rivers that they should be symbolised by *A.M.* and *M.V.* respectively.[1]

To decide whether a sufficient number of cases has been examined to justify the use of an average or median as representative of the series, and to determine the significance to be attached to a representative value, another measure of deviation, namely, the "probable error," is employed. The probable error of a value representing a series may be said to be the deviation of such a measure as would lie midway between the representative value and the extreme values in either direction. It is calculated from the formula

$$\text{P.E.} = {\cdot}6745\sigma,$$

where σ, as before, represents the standard deviation, and a result to have significance should be at least two, or, better, three times the value of the "probable error." If the representative value only equals the "probable error," the chances that it is the true value are about even; if it is three times the probable error, the chances that it is the correct one are in some cases about a thousand to one.

Statistical methods have nowhere been more extensively applied than in the case of correlation; but the very ease with which the formula may be employed is apt to produce misleading results, owing to its application to data which have not been scientifically collected. Opinions on the natural affinities amongst the various mental functions and the various educational subjects have usually been vague and inconsistent, but the application of statistical methods now enables us to state in exact quantitative fashion the extent, if any, of such correlation. Several methods for ascertaining the degree of correlation are employed. Spearman's *Foot-Rule* for measuring correlation[2] is the simplest to apply, and is suitable when the number of cases does not exceed about thirty and a very high degree of accuracy is not required.

The following illustration given by Spearman[3] will indicate its simplicity:—

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[1] *British Journal of Psychology*, vol. i. pp. 354–355.
[2] *Ibid.*, vol. ii. p. 89.
[3] *Ibid.*, vol. ii. p. 95.

Subject.	Rank in First Test.	Rank in Second Test.	Gains in Rank in Second Test.
A . .	7	6	1
B . .	4	4½	..
C . .	10	10	..
D . .	1	3	..
E . .	6	11	..
F . .	9	8	1
G . .	11	7	4
H . .	3	1	2
I . . .	2	2	..
J . .	5	4½	½
K . .	8	9	..
Observed sum of gains (denoted by Σg) . .			8½

Spearman's method of calculating the correlation is as follows. Let the observed sum of gains be denoted by Σg, and the sum of gains to be expected on an average by mere chance be denoted by M; this amounts to $\frac{n^2-1}{6}$, where n is the number of cases in each series.[1] Then the correlational coefficient $R = 1 - \frac{\Sigma g}{M}$.

In the above example $n=11$, so that

$$M = \frac{121-1}{6} = 20.$$

Thus the correlation between Test 1 and Test 2—

$$R = 1 - \frac{\Sigma g}{M} = 1 - \frac{8 \cdot 5}{20} = 0 \cdot 57.$$

When there is a correspondence between the order of the subjects in the one test and the order in the other test we speak of a direct or positive correlation. When the correspondence is complete, the degree of correlation is represented

[1] For proof, see *British Journal of Psychology*, vol. ii. p. 105.

by +1. If, however, it is found that the subjects who do well in one test do badly in the other, the correlation becomes inverse or negative; and if the opposition is perfect, that is, the subject best in one is worst in the other and *vice versa*, and the same relation obtains throughout the series, the degree of inverse correlation is represented by −1. Should no relationship exist between the two series, the degree of correlation is represented by 0. Between −1 and +1 any value may be found.

A more elaborate method than that of Spearman of calculating the coefficient of correlation is that based on the Pearson formula

$$r=\frac{\Sigma xy}{n\sigma_1\sigma_2}.$$

The deviation, represented by x, of each value from the representative value of the first or "subject" series is multiplied by the corresponding deviation, y, in the second or "relative" series. This is done for all the respective members of the two series; the products are then added, and the result divided by the product $n\sigma_1\sigma_2$, where n represents the number of values, σ_1 the standard deviation of the one series and σ_2 that of the other series.[1]

The "probable-error" formula in this case is $\cdot 6745\frac{1-r^2}{\sqrt{n}}$. "A coefficient of correlation has little or no significance unless it is at least two to five times as great as its probable error. A coefficient five times as great as the probable error occurs by chance only once in 1000 trials; accordingly where a high correlation, such, for instance, as would give a coefficient $r=\cdot 50$, obtains between two functions, its existence may be satisfactorily demonstrated by about a dozen cases. A coefficient only twice as large as the probable error occurs about once in six times by mere chance. Hence such small coefficients can but suggest, not prove, the existence of real correspondences."[2]

[1] The "R" of the Spearman formula can be converted into the Pearson "r" according to the table given by Spearman in *British Journal of Psychology*, vol. ii. p. 104.

[2] *British Journal of Psychology*, vol. iii. p. 109.

The Pearson coefficient of correlation can also be calculated from the following formula,[1] which does not require the deviations to be computed, thus eliminating the plus and minus signs, which frequently lead to confusion :—

$$r=\frac{\Sigma(A\,.\,B)-n\,.\,m_a m_b}{\sqrt{\Sigma(A^2)-n\,.\,m_a{}^2}\sqrt{\Sigma(B^2)-nm_b{}^2}}.$$

A and B represent the original scores of the two series to be correlated, m_a being the mean of the first series and m_b the mean of the second.

The following example illustrates the method :—

No.	A.	B.	A^2.	B^2.	A, B.
1	4	7	16	49	28
2	13	9	169	81	117
3	8	6	64	36	48
4	3	5	9	25	15
5	13	6	169	36	78
6	15	10	225	100	150
7	12	5	144	25	60
8	18	8	324	64	144
9	20	15	400	225	300
10	12	9	144	81	108
11	8	7	64	49	56
12	14	9	196	81	126
13	17	13	289	169	221
14	9	11	81	121	99
15	7	4	49	16	28
16	2	1	4	1	2
17	12	7	144	49	84
18	14	8	196	64	112
19	9	8	81	64	72
20	14	11	196	121	154
21	15	8	225	64	120
22	19	10	361	100	190
23	12	12	144	144	144
24	7	5	49	25	35
25	1	3	1	9	3
26	13	8	169	64	104

[1] L. L. Thurstone, *Psychological Bulletin*, vol. xiv. pp. 28–32, from which the example here given is reproduced.

No.	A.	B.	A^2.	B^2.	A, B.
27	11	9	121	81	99
28	16	7	256	49	112
29	6	3	36	9	18
30	10	5	100	25	50
31	4	6	16	36	24
32	7	6	49	36	42
33	14	10	196	100	140
34	12	14	144	196	168
35	11	8	121	64	88
36	5	2	25	4	10
37	2	4	4	16	8
38	11	11	121	121	121
39	7	9	49	81	63
40	5	11	25	121	55
41	5	8	25	64	40
42	16	10	256	100	160
43	10	13	100	169	130
44	10	8	100	64	80
45	8	12	64	144	96
46	6	10	36	100	60
47	7	7	49	49	49
48	10	7	100	49	70
49	10	9	100	81	90
50	6	6	36	36	36
Σ	500	400	6042	3658	4407

Average . . . $m_a = 10$ $m_b = 8$
Square of average . . $m_a^2 = 100$ $m_b^2 = 64$

Substituting the sums of the columns and their means in the above formula, we obtain

$$r = \frac{4407 - 50 \times 10 \times 8}{\sqrt{6042 - 50 \times 100}\sqrt{3658 - 50 \times 64}}$$
$$= +0 \cdot 59.$$

Although the formula appears cumbersome, it diminishes the occasions of errors, and if an adding machine and a table of squares are employed, the calculation of the coefficient of correlation can be performed mechanically.

The advantage derived from the establishment of a positive correlation of high degree between two functions is that when the presence of one function is determined we can assume without further investigation the presence of the other. It does not, however, explain the cause of the concomitance, but merely suggests the existence of such a cause, affording thus a hypothesis which must be independently tested and verified.

Attempts have been made by means of the correlation formulæ to determine the natural affinities existing among the various school subjects.[1] Too much importance should not at present be attached to the results obtained, for they can be variously interpreted, and may be due to the smallness of the numbers tested; or to the system of grading adopted by the teachers; but the manner in which the question is approached is characteristic of the new methods in education.

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[1] *Cf.* W. Brown, *The Essentials of Mental Measurement*, p. 96. C. Burt, *The Distribution and Relation of Educational Abilities*, Memorandum III.

CHAPTER III

THE GENERAL DEVELOPMENT OF THE CHILD—PHYSICAL AND MENTAL

THE general development of the child, according to Meumann,[1] is conditioned by the innate disposition of the child, by a tendency to variation in the psycho-physical processes, this latter being counteracted by the strengthening and automatising effect on activities of repetition. The automatising influence simplifies the life of the child, whereas the tendency to variation enriches the life of the child; emphasis on the latter leads to the educational ideal of self-activity, on the former to practice or "drill." The mental as distinct from the physical development is also influenced by the synthetic or autonomous activity of the mind, whereby the individual fashions his life in accordance with self-imposed aims and ideals.

These inner factors are in their turn modified by the environmental conditions, physical and social, of the child and by all educative influences. The development of the child is thus highly complex, and cannot consequently be expressed, as some educationists have attempted to express it, in any single or simple formula.[2]

The fewest and simplest laws, according to Meumann, to which the conditions governing the child's development can be reduced are the following:—

1. The development of the individual is from the outset determined in a decisive fashion by his innate disposition.

[1] *Vorlesungen*, vol. i. pp. 666–704.

[2] *Cf.* Pestalozzi: "Intellectual development proceeds from immediate experience of objects to concepts."

2. The more necessary a function is for the life of the child, the earlier is that function developed.

3. The mental and physical development of the child does not proceed uniformly, but in periodic fluctuations. These fluctuations are displayed:

(*a*) In temporal periods, progress being at one time rapid, at another slow.

(*b*) In qualitative differentiation of these temporal periods. The irregularity affects not only general development, but even the development of the special physical and mental functions and efforts of the child. There are periods favourable to the development of certain forms of memory, of the emotions, etc., and periods when the development of these functions is arrested.

(*c*) In periods of special susceptibility of the child for the reception or development often of quite restricted groups of impressions or powers.

Examples of these principles will be found throughout the course of this work.

The life of the child for general purposes is probably best divided into the two periods:

1. Childhood—from birth to puberty, that is, to about fourteen years of age, or earlier in the case of girls.[1]

2. Adolescence—from onset of puberty to maturity.

Childhood, according to Vierordt, can be further subdivided into (*a*) infancy up to nine months old, (*b*) the early years of childhood until about eight, or better, perhaps, till nine years of age, (*c*) boyhood and girlhood up to puberty.

Adolescence divides into (*a*) early adolescence to sixteen with girls and eighteen with boys, (*b*) young manhood or womanhood, to the close of the period of development, which we may put at about twenty for females and twenty-five for males.

From the standpoint of sexual development Stratz has distinguished four periods: infancy, till about the end of the first year; the neutral stage of childhood from one to seven years of age; the undifferentiated or bisexual stage from eight to fifteen years, in which the direction of the sexual

[1] Fourteen is regarded as the legal age of a child in England under the Employment of Children Act, 1903.

impulse is not completely differentiated, but depends upon the external objects which happen to occur in the environment; the period of sexual maturity from between fifteen to twenty years onwards.

These ages are only roughly approximate, and possibly in the future, for purposes of school classification and also for legal requirements, what is known as the "physiological" age, based upon pubescence, will be the determining factor.[1]

The development of the physical organs and mental powers of the child does not usually proceed regularly, but displays a certain periodicity; there are stages of rapid growth alternating with stages of arrest and even of retrogression. The direction of the physical growth likewise varies, and during childhood four periods have again been distinguished: the age from one to four years being termed the first period of growth in girth; from the beginning of the fifth to the completion of the seventh year is the first period of growth in height; from eight to ten is the second period of growth in girth; and from the beginning of the eleventh to the completion of the fourteenth year is the second period of growth in height.

Of the various bodily measurements—height, weight, strength of grip, vital capacity, cephalic index[2]—that of height most faithfully indicates general physical development, weight being more dependent than height on variable and individual influences.

Measurements of height indicate that from six to nine years of age is a period of uniform and rapid development. At nine the irregularities appear. There is at this age a retardation with girls, and with boys a more decided retardation occurs at eleven years of age. An acceleration of growth accompanies the pubertal change, attaining its maximum with girls at thirteen and with boys at fifteen. Girls are shorter than boys except during the years eleven to fourteen, when they are taller; this is due to the earlier onset of

[1] For physiological age, see *Cyclopedia of Education*, edited by Munroe, vol. iv. pp. 715–716.

[2] For methods of determining these and for illustrations of instruments employed, see Whipple, *Manual of Mental and Physical Tests*, part i.; or Schulze, *Experimental Psychology and Pedagogy*, trans. by Pintner.

puberty of girls, giving them an accompanying advantage in growth during these years.

Similarly with weight, boys are heavier except during the years twelve to fifteen, when girls have the advantage. Again, at nine in the case of girls and at eleven with boys there is an arrest in weight. The greatest increase in weight with girls occurs at thirteen or fourteen, and with boys about sixteen years of age.

Measurements of vital capacity, estimated by the volume of air expired after taking a maximal inspiration, show that at all ages boys have greater vital capacity than girls. The increase with boys is greatest from twelve to sixteen years of age, with girls from eleven to fourteen, the maximal increase being attained about fifteen and thirteen years of age respectively.

There is, as tested by the dynamometer, an increase of strength with age, this increase culminating in the case of boys at sixteen, with girls at fourteen. Girls are at all ages inferior to boys in strength, the absolute increase between the ages of six and eighteen being only half that of boys.

From these measurements it is evident that the most important variation in development occurs immediately before and during puberty. The onset of puberty varies according to race, and differs with the sexes, coming earlier with girls than with boys. On the average the periods most affected by pubertal change are thirteen to fourteen years with girls and fourteen to seventeen with boys. These changes influence all the physical and mental functions of the child, and it is, consequently, eminently desirable that their significance and effects should be known and regard paid to them.

Entrance to school usually causes an arrest or retardation in physical development, especially when the school conditions are unfavourable, and the effect is greatest on the weaker children. Quirsfeld, at Rumburg (Bohemia), found [1] that with 21 per cent. of the pupils there was a decrease in weight during the first year of school life (six years of age), and with 25 per cent. there was no increase. At Halle, Schmid-Monnard found [2] that in the first three months of school attendance the weight of the girls of the primary

[1] Lay, *Experimentelle Pädagogik*, p. 30. [2] *Ibid.*, pp. 45–46.

school decreased, and that the children of seven years of age who attended school were lighter and smaller than those who did not attend school. The rate of mortality amongst children, it has been observed by several investigators, also increases during the first school year. These results, it should be noted, refer to children entering school at six or seven. What the physical consequences are in Britain, where the compulsory age of attendance at school is five, has not been determined.

The view held by most medical men, that the early period of school life is harmful, has been controverted by numerous educators. The child's natural freedom of movement, it is admitted, is undoubtedly restricted by his entrance to school, and the unaccustomed form of effort cannot affect his physical development favourably, since the child is easily fatigued and school does not provide adequate opportunities for recuperation. These objections, it is contended, can to some extent be overcome by improved school organisation. The compensating advantages claimed for attendance at school lie in the more regular mode of life, the habituation of the child to outward order, and in a certain self-control and self-reliance thereby acquired.

Winch has sought to determine what influence early entrance to school life has on school progress. His investigation was carried out in London, and covered various types of schools. He concluded that, judged by intellectual results, and in so far as they are measured by school progress, no advantages can be claimed for early entrance to school; that is, children who enter at three years of age progress neither more rapidly nor more decisively than those who enter at five.[1] This conclusion holds, whatever form of teaching is adopted, Kindergarten or formal. The early commencement of the formal subjects or the employment of Kindergarten methods does not guarantee any subsequent advantage over scholars who enter school at the legal age of five. There is likewise no advantage in early entry so far as the attainment of good behaviour and the development of attentiveness are concerned.[2]

It may be objected that the early entrants might come from poor homes, consequently suffer in mental and physical

[1] *When Should a Child Begin School?* p. 38. [2] *Ibid.*, pp. 89–93.

development, and thus make it easier for later entrants to overtake them. Winch's analysis, however, shows that this is not so. "Children from poor homes,"[1] he says, "not only do not exclusively form the early entering groups of Board School children, but they are fairly distributed over the various ages of entry, and, even in the poorest neighbourhoods, a fair proportion of them come after five years of age."

To determine the relation between entering age and progress the school histories of more than 25,000 pupils who had completed the primary course in a number of American city school systems were investigated by Ayres, the Director of Education of the Russell Sage Foundation, New York.[2] His conclusions are that the child who enters at an advanced age subsequently makes more rapid progress than one who enters younger, but not sufficient to enable him to overtake the latter in the school course. The entering age of six is the one which proves most satisfactory, as it results in a large proportion of the pupils making normal progress, and in a nearly even balance between the rapid and slow groups; it also results in the largest proportion of the pupils finishing the course at normal age, and likewise furnishes the most homogeneous group, judged on the basis of subsequent progress.

Early entrance to school, it would appear, has no advantage educationally, and is detrimental to the child physically. It should not, then, be made compulsory as it is at present in Britain. It may be urged that the homes of some of the children are not proper places for their development during this period. If that is the case, an institution intermediate between the home and the school may be necessary. The function of such an institution would be to attend primarily to the physical condition of the child and to the establishment of proper physical habits. These requirements are met to some extent by the Montessori "House of Childhood." We recommend a separate institution for this age in order to remove the temptation to formal instruction and to admit of the conditions being freer than they are at school. The cost of such institutions might be met by the money spent at present,

[1] *When Should a Child Begin School?* p. 86.

[2] Leonard P. Ayres, *The Relation between Entering Age and Subsequent Progress among School Children.*

evidently to no purpose, on the teaching of, and the provision of school places for, these pupils. The exact determination of the proper age for entrance to school is a social and economic, quite as much as a pedagogic, question.

A powerful influence affecting the physical development of the child is the social position of the parents. It has been both affirmed and denied that this is even greater than the effect of nationality. Meumann infers[1] that race evidently determines the absolute increase of growth, whereas the rate of growth at different periods of development is more influenced by the parents' position in life. With regard to children of the same race we may affirm that the higher the social status of the parents the better is the bodily development of the children. This is strikingly confirmed by the physical measurements of Glasgow school children considered in relation to the number of rooms in the home. If we take all the children of ages from five to eighteen, we find that the averages may be tabulated thus :—

HEIGHT.

	Boys.	Girls.
	inches.	inches.
One-roomed child . .	46·6	46·3
Two-roomed child . .	48·1	47·8
Three-roomed child . .	50·0	49·6
Four-roomed and over .	51·3	51·6

WEIGHT.

	Boys.	Girls.
	lbs.	lbs.
One-roomed child . .	52·6	51·5
Two-roomed child . .	56·1	54·8
Three-roomed child . .	60·6	59·4
Four-roomed and over .	64·3	65·5

[1] *Vorlesungen*, vol. i. pp. 82–83.

According to the Report,[1] these figures show that the one-roomed child, whether boy or girl, is invariably, on the average, distinctly smaller and lighter than the two-roomed ; the two-roomed than the three-roomed ; and the three-roomed than the four-roomed. The numbers examined are so large and the results so uniform that only one conclusion is possible, namely, the poorest child suffers most in nutrition and growth. It cannot be an accident that boys from one-roomed homes should be 11·9 lbs. lighter and 4·7 inches shorter than boys from four-roomed homes. Neither is it an accident that girls from one-roomed homes are 14 lbs. lighter and 5·3 inches shorter than their sisters from four-roomed homes. The difference, it will be noted, is greater with girls than with boys.[2]

An investigation into the physical and mental development of Cambridge school children,[3] in which 930 boys were examined—half from primary and half from secondary schools—showed that whereas the stature and weight of the secondary school pupils are well above the "general" figures published by the British Association Anthropometric Committee, only 36 per cent. failing to reach the standards, 72 per cent. of the pupils attending primary schools failed to reach the general standard. As the majority of these children must have been in satisfactory health, it is suggested that primary school pupils have a physical standard of their own, though a lower one than the general standard.

In regard to the relation between strength or gripping power and social standing the results are at variance. Schuyten from tests carried out at Antwerp concludes that the children of well-to-do parents are stronger than the children of poor parents; but MacDonald from tests on Washington children infers that the opposite is the case, the

[1] *Report on the Physical Condition of Children attending the Public Schools of the School Board of Glasgow* (1907), p. v.

That the average height and weight of the girl from the four-roomed home are greater than in the case of the boy appears to be due to the fact that of 3563 boys of this class investigated only 227 were over fourteen years of age, whereas of 3626 girls 324 were over fourteen years of age.

[2] *Cf*. Meumann, *Vorlesungen*, vol. i. p. 83.

[3] S. Slefrig, "The Physical and Mental Development of Cambridge Children." Thesis presented for B.A. degree by Research, 1908, and deposited in Cambridge University Library.

suggested explanation for the difference being the manual work done by poor children in partial self-support. In the Cambridge investigation, to which reference has just been made, the strength of the secondary school boys, as tested both with single-handed and double-handed pull, was found to be greater than that of the primary school pupils at any given year of age.

Correlations between the various aspects of physical development and general intellectual standing have been calculated, but an unanimous finding has not been reached in any one respect. Whipple, reviewing the evidence for the correlation between height and mental ability, concludes :[1] "The trend of evidence is to the effect that all such correlations, where found, are largely explicable as phenomena of growth, that is, as correlations with general maturity. This makes intelligible the fact that, in general, the positiveness of all such correlations lessens with age, and that many of them, indeed, become difficult or impossible of demonstration in adults."

Before proceeding to consider the general mental development of the child it may be advisable to ask what relation, if any, exists between general physical development and mental development. Meumann in the first edition of his *Vorlesungen* suggested that the results of some investigations might be so interpreted as to lend support to a relation of parallelism, and in his second edition he unhesitatingly advances the doctrine of the parallelism of bodily and mental development, the quantitative increase in mental growth corresponding with increase in general physical development and the qualitative changes in mental powers corresponding with development of the brain. From a comparison of the anthropometric investigations and of intelligence tests we must, he maintains,[2] assume that a perfect parallelism exists between physical and mental development, provided, he adds, that the parallels are rightly drawn. We must, that is to say, recognise that mental development is directly dependent on brain development and, where apparent exceptions occur, that brain development does not proceed exactly parallel to physical development.

[1] *Manual of Mental and Physical Tests*, part i. p. 71.
[2] Vol. i. p. 101.

The evidence does not, however, appear to be sufficient to warrant such a definite pronouncement, and the explanation of the exceptions by reference to lack of uniformity between brain and general physical development seems to be an evasion of the difficulty. The conclusions which he draws from the doctrine are likewise stated with so many qualifications as to raise suspicion as to the validity of the general principle.[1] The "not proven" verdict of the first edition is probably the more scientific.

The conditions affecting the mental endowment and development of children are still somewhat indefinite. The social status of the pupils, however, appears to affect their mental proficiency, even, it may be, their mental endowment just as it does their physical development, although the question whether the former is dependent on the latter is, as we have indicated, still best regarded as an open one. By comparing the examination results of pupils of the same class in the same school taught under exactly the same conditions and differing only in social status, Winch [2] found that the school work of pupils from the poorer homes was inferior to that of pupils from better-class homes, especially in such subjects as spelling and arithmetic. "There is no very satisfactory evidence from this research," he concludes, "as to the relative parts played by natural capacity and home environment in the production of the difference found between the higher and lower social classes. Both factors doubtless operate. The fact that one outstanding difference is in arithmetic seems to indicate that a difference in natural capacity is a very large factor, for children do not usually get much help at home, either directly or indirectly, in the subject."

Burt,[3] in his investigation at Oxford into the degree of correlation existing between the higher mental powers and general intelligence, employed as subjects boys from a superior primary school and a high-class preparatory school. In social status the pupils of the primary school were of the lower middle-

[1] *Cf. Vorlesungen*, vol. ii. pp. 315–319.

[2] W. H. Winch, "Social Class and Mental Proficiency in Elementary School Children" (*Journal of Experimental Pedagogy*, vol. i. pp. 9–18, 118–128).

[3] Cyril Burt, "Experimental Tests of General Intelligence" (*British Journal of Psychology*, vol. iii. pp. 94–177).

class, sons of local tradesmen. The boys from the preparatory school were in nearly every case sons of men of eminence in the intellectual world, that is to say, of Fellows of the Royal Society, University Professors, College Tutors, and Bishops. Between the pupils of the schools there was thus a considerable difference of parentage. In all the tests but two the average performances of the boys of the preparatory school were superior to those of the boys of the primary school, the two exceptions being tests which yielded negative correlations with intelligence. Burt consequently concluded—a conclusion that cannot be regarded as "conservative"—that the superior proficience at intelligence tests on the part of boys of superior parentage was inborn.

As the size of the home affects the physical condition of the child, and the social status of the parents the pupil's mental proficiency, the limitations set by social conditions to the work of education become strikingly obvious, as also the injustice of requiring the same standard of work from schools attended by pupils of different social status.

When we proceed to consider the general mental development of the child we find that, like the physical, it proceeds periodically or rhythmically, and is likewise subject to certain variations which appear, to a large extent, to coincide with the physical variations. In the years of tardy growth the mental development is slow, but there are certain exceptions to this parallelism. The eleventh year is especially unfavourable to mental development, and with girls the twelfth, thirteenth, or fourteenth years—according to race and country—with a certain postponement of this unfavourable period till later in the case of boys. This, however, will be more fully demonstrated when we consider the development of the special mental functions of the child.

Variations occur within the year.[1] For increase of height there is a favourable period from February to August, an unfavourable from September to January; for weight, an arrest during February to June and an increase from July to January. The seasonal changes in physical and in mental energy will be treated in connection with the conditions affecting mental work.

[1] *Cf.* Meumann, *Vorlesungen*, vol. i. pp. 126–131.

More important than the statement of the periods of mental development is the question, In what, strictly speaking, does the menta development of the child consist ? Is it in the evolution of new powers, or in a distribution of mental functions different from that of the adult ? Is the quality or character of certain processes typically different with the child, or does the difference lie merely in the fact that the child's capacity for work is quantitatively less than the adult's, the character of the work differing but little qualitatively ?

If we consider the school child only, it may be said that the adult possesses no mental powers which the child of seven does not possess, although in the child these are present in a weaker and less perfect form.

These powers are nevertheless distributed differently. In the sense-perception of the child, for example, the operation of apperceptive factors appears generally to preponderate largely over the given material of perception—that is, the perceptions of the child are much more subjective than those of the adult. This is evident from experiments on the testimony, and also on the reading, of the child. From such experiments we learn that the younger the child, the greater is the falsification of perception by reason of subjective conditions, and this falsification decreases uniformly with advancing years. In the ideation of the child two main differences from that of the adult are disclosed. The child thinks in concrete individual images ; the adult employs mainly verbal images. The child can think in words just as the adult sometimes uses concrete images, but the distribution of the two forms of imagery is typically different in each case. On this follows a second difference ; since the adult thinks chiefly in words he can attain more abstract thinking than the child, for words are essentially the forms in which our abstractions find embodiment. The child's thinking must be more concrete and particular than that of the adult ; but the child of six to fourteen years of age is capable of being trained in abstraction. The rate of the child's thinking is also slower, and this likewise may be due to a difference in the distribution of the types of imagery. A further consequence of the concrete nature of the child's mind is evident in volition. As the child thinks mainly in particular images, so he acts more on the impulse of the moment, whereas the adult acts on general principles or from rules of conduct.

The quality or character of the child's mental processes, especially the elementary processes, differs from the adult's until the child is well advanced in school life. The given factors constituting sense-perception and spatial and temporal apprehension are qualitatively different from such processes in the adult. The child, like adults of primitive races, discriminates fewer sense qualities, for example, colours, tones, etc., than the adult of civilised peoples. Possibly the sense organs of the child are not so finely differentiated. The same holds for space and time relations ; the immediate apprehension of short intervals of time, as well as the comprehension of complicated time relations, is imperfect, and the latter only appears at a late stage and develops very slowly. In its apperceptive aspect the sense-perception of the child is typically different from that of the adult. The adult perceives things according to certain leading points of view or according to definite categories. The perception and observation of the child are determined by other categories than those employed by the adult, the dominant category varying with the age of the child. We shall see later that this is of great importance in observation lessons.

The striking difference between the perception of the child and that of the adult lies in the fact that the child, in proportion to his age, lacks the ability to synthesise particular impressions into a whole. This is evident in the case of any object of perception. In describing pictures, the six-year-old child as a rule pays no attention to the situation represented ; he names and describes only isolated particulars. Not only with complicated objects like those used in observation lessons but with the simplest relations this can be demonstrated. Children of six or seven years of age, for example, cannot compare distances between given points, because their attention is fixed on the single points and they do not synthesise them and what intervenes into spatial wholes ; the difficulty of comparison is found to be increased by placing the points in various positions and requiring horizontal distances to be compared with vertical. The same inability to synthesise is evident in the child's apprehension of geometrical forms. It appears in drawing, more especially in the child's memory drawing. The synthesis of the represented particulars is very imperfect, and the apprehension of the child clings to the particular objects, reproducing these without much regard to their relation to the whole. The objects drawn are consequently not reproduced in relative proportion; each stands by itself, and its size varies according to the young artist's estimate of its importance. For instance, in sketching a house a child will draw a large keyhole and indicate the remainder by a few strokes.

A defect similar to inadequate synthesis in sense-perception is found in the child's volition. The child's actions are at the outset determined by isolated impulses of the moment, whereas the instinctive tendencies which are involved in the adult's actions have usually become more or less systematically organised about certain objects or ideas.

If we consider the capacity of the child for all forms of mental and physical activity in their merely quantitative or intensive aspect, we may state that the child can achieve less than the adult. This arises from the fact that the child is more liable to fatigue; and the younger the child, the greater is the degree of fatigue. We may be inclined to doubt this, however, because of the many activities which appear to be easier for the child—mechanical learning, for example. But the adult's apparent difficulty is only due to his reluctance to exert himself. For, when willing to apply himself to mechanical learning, the adult can accomplish much more—usually five or six times and, under certain conditions, even ten times more—than a child of the age when, according to the traditional view, his power of mechanical learning is thought to be at its best. We may conclude, therefore, that in all forms of mental activity the child remains quantitatively behind the adult.

Having so far considered the general physical and mental development of the child, we shall next proceed to the consideration of the special mental powers.

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CHAPTER IV

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD

ATTENTION

ATTENTION has always been regarded by teachers as the mental power of first importance, for if they can count on securing the pupil's attention, at least half the battle of teaching is in their opinion won. This belief at one time received scientific support from psychologists, who considered that attention was one of the fundamental factors in, and was highly correlated with, general intelligence; later investigation has, however, demonstrated that tests involving the higher powers of reasoning give a better correlation with general intelligence than do attention tests.

Attention was for long regarded as a "mental faculty," as a simple, indivisible, and unanalysable power which could be applied indifferently according to our wishes, and improvement in which could be secured by training upon any kind of material whatever; "to train the attention" thus became one of the ends of education. This faculty doctrine has no explanatory value psychologically;[1] it ignores the complex and developing nature of the attentive and other mental processes, and it reduces education to a gymnastic exercise which takes no account of the type of life for which the pupil has to be prepared.

Attention is now regarded as but an aspect of complex mental processes; not as a simple function but as a compli-

[1] *Cf.* G. Dawes Hicks, "The Nature and Development of Attention" (*British Journal of Psychology*, vol. vi.).

cated and highly developed modification of an original and fundamental process of apprehending.

Baldwin states :[1] "We have not one attention, but many. Attention is a function of the content, not a faculty which takes up the contents ; and it is only as different contents attended to, overlap and repeat one another, that they have somewhat the same function of attention." Watt likewise says :[2] "According to our present knowledge there is no unitary cause which produces the effect known as the state or process of attention. It does not seem at all probable either, that when psychologists have done with finding out what factors influence attention for good or bad, there will be left any unitary process or anything at all which could be called attention. Attention is a popular name for a complex of states or processes of mind." The same conclusion is arrived at by Arnold[3] after a review of the experiments on the span of apprehension in the various sensory fields : "Attention in the visual field is something different from attention in the auditory field, and the same is true of attention in the tactile sphere. We cannot be said to possess any distinct and separate power of attention. In short, we have a number of attentions, and not a single power of attention."

Various theories have been propounded to explain attention, and while each insists on some one aspect of the attentive process which may even be essential, none succeeds in accounting for all the aspects. Most of the theories concern themselves with the phenomena of attention, rather than with attention itself. We shall consequently find it more profitable to commence our treatment by considering the changes effected in presentations as a result of attention, than by discussing the respective merits of the different theoretical accounts.

The most obvious result of attention is the increased clearness and distinctness which presentations attended to acquire. Consequent on this they arrest the flow of the mental stream and attain a certain fixity and stability. Their duration in consciousness is prolonged, and such prolongation facilitates

[1] *Mental Development in the Child and the Race*, p. 444.
[2] *The Economy and Training of Memory*, pp. 37–38.
[3] *Attention and Interest*, pp. 42–43.

the association and reproduction of allied ideas, and thus tends to determine the course of the mental life. The effect on presentations in consciousness which are not attended to is to cause these to be disregarded.

Various aspects of the attentive process can be distinguished. The clearness which characterises the presentations to which attention is given is the result of the *concentration* of attention; whether in addition to acquiring greater clearness the presentations actually increase in intensity, and whether we can consequently speak of the *intensity* of attention, is a problem which, although it has been the subject of several investigations, is still in dispute. The extent of the field of attention is determined by the *distribution* of attention: when visual stimuli are presented simultaneously, the number that can be apprehended in momentary exposure without counting is an index of the *range* of attention; the number of acoustical impressions presented successively, and apprehended likewise without counting, represents the *span* of attention. The *duration* of attention is the term employed to denote the period of time for which attention can be sustained; and when different activities are carried on concurrently and attention given to each, as when a teacher attends to the subject-matter of the lesson and to the behaviour of his pupils, we speak of the *division* of attention.

The varieties of attention have been variously classified, but as the basis of division we may select either the nature of the objects to which attention is directed, or the manner in which attention is originated and sustained.

According to the first classification, attention is sensuous when directed to objects of perception, intellectual when directed to ideas or beliefs. Meumann maintains that we must likewise recognise emotional and volitional attention, as attention can be directed to volitional acts and to feelings; further, that under sensuous attention we must distinguish sensory from motor attention, according as attention is directed to sense impressions or movements.

On the alternative basis attention may be divided into involuntary or non-volitional, and volitional. The term "involuntary" is ambiguous; and this ambiguity has given rise to much fruitless discussion as to whether the teacher should aim at training voluntary or involuntary attention. There is a primitive, instructive, or reflex form of involuntary or non-volitional attention which may be termed "enforced," and there is an apperceptive form which may be termed "spontaneous." The former does not require to be trained; in exciting this form of attention in children nothing is so effective as a brass band. It can consequently only be the latter form to which Herbart refers when he says,[1] "It is involuntary attention that the art of teaching must seek to induce." The relation between volitional and this spontaneous, non-voluntary form of attention is expressed by Stout in the statement[2] that the final aim of the teacher ought to be to convert voluntary into spontaneous, non-voluntary attention, by inducing direct instead of derivative interest in the subject-matter.

This latter division of attention does not represent fundamentally different kinds of attention distinct in origin, but rather differences in the stages at which the development of attention is viewed. When attention is considered in relation to mental development in general, the determinations of attention by instinct, by interest, or by purpose are seen not to be opposed one to the other but to correspond with different levels of mental attainment.[3]

The application to attention of experimental methods of investigation and of exact measurement has disclosed the complexity of the attentive process, revealed interesting individual differences in the various forms of attention, and enabled us to become acquainted with the characteristics which distinguish the child's attention from that of the adult.

Experimental investigation corroborates the view that attention is not a faculty; no single measure is applicable to the complex process of attention. Exact tests under laboratory conditions negative the conception of general ability in apprehension, even of general ability in visual apprehension. We can only speak therefore of measuring the various partial processes and their effects.

The range of visual attention has been investigated by means

[1] *Outlines of Educational Doctrine*, English trans., p. 62.
[2] *Groundwork of Psychology*, p. 53.
[3] *Cf.* G. Dawes Hicks, *loc. cit.*

of the tachistoscope;[1] a varying number of points or letters irregularly arranged is exposed momentarily, and the subject whose range is being determined is required to estimate the number seen. The adult usually apprehends five or six elements when they are so presented. When an after-image of the arrangement occurs, this range is considerably exceeded, as counting is then possible. The effect of practice upon the range of visual attention and of visual apprehension is decidedly small. What improvement there is seems to be due almost entirely to habituation to the experimental conditions and to the adoption of devices in grouping material.[2]

Tests on the span of auditory attention when the stimuli—beats of a metronome, for example—are necessarily presented successively, demonstrate that a greater number of elements than in visual attention, usually up to eight, can be apprehended without counting.

Considerable differences in the powers of attention exist amongst individuals. Some have a greater range or wider distribution, others a higher degree of concentration on a more limited number of presentations. An attempt has been made to formulate the relation between concentration and distribution reciprocally, the greater the concentration the less the distribution, and *vice versa*. In many cases this statement might be allowed to hold, but it negatives the idea of a development of attention and precludes the possibility of an individual increasing by training the number of objects to which attention can be given without at the same time decreasing the intensity. Pedagogically it would stultify the teacher's efforts to induce the pupil to attend to an increasing number of impressions with the same precision.

[1] The tachistoscope is an instrument for exposing to the subject of experiment a visual stimulus for a brief interval, usually less than a quarter of a second. By its use the possibility of eye movements during the exposure is excluded. There are various types of the instrument. Descriptions and illustrations of these will be found in *British Journal of Psychology*, vol. ii. pp. 244–6; Myers' *Text-Book of Experimental Psychology*, part ii. p. 106; Whipple's *Manual of Mental and Physical Tests*, part i. p. 265. A simple form of tachistoscope for demonstration purposes or class experiment can be secured by affixing a photographic shutter to a magic-lantern.

[2] G. M. Whipple, *Journal of Educational Psychology*, vol. i. pp. 249–252.

A narrow range or span does not always imply great concentration; it may be due to defective intensity, as with mentally deficient children who cannot apprehend more than two similar elements at the same time. With adults, however, the restricted range usually indicates great power of concentration with which is connected a high degree of objective fidelity. Individuals so endowed state only what they have definitely seen or heard and avoid all guessing and conjecture; by reason of the sharp fixation of impressions they are said to possess the "fixating" type of attention. An extended range may result from a roving tendency in attention which leads those endowed with this form to supplement what has actually been observed by conjecture: this type is designated the "fluctuating" type.

These types disclose themselves in reading tests, and, according to Münsterberg,[1] decide for which economic activity an individual is adapted. "Two working men, not only equally industrious and capable, but also equally attentive, may yet occupy two positions in which they are both complete failures because their attention does not fit the places, and both may become highly efficient as soon as they exchange positions. Their particular types of attention have now found the right places. The one may be disposed to a strong concentration by which everything is inhibited which lies on the mental periphery, the other may have the talent for distributing his attention over a large field, while he is unable to hold it for a long while on one point. If the one industrial activity demand the attentive observation of one little lever or one wheel at one point, while the other demands that half a dozen large machines be simultaneously supervised, all that is necessary is to find the man with the right type of attention for each place. It would be utterly arbitrary to claim that the expansive type of attention is economically more or less valuable than the concentrated type."

The effect of increased concentration of attention has been investigated, and it has been found that whereas the output of work is increased thereby, it displays in equal periods of time a greater range of variability; the more concentrated the attention is, the more subject

[1] *Psychology and Industrial Efficiency*, pp. 136–137.

is it to fluctuations. The pedagogical bearing of this result is obvious.

If the increased concentration is effected by an instruction to attend, it is found that some subjects tend to forget the instruction and are compelled to remind themselves of it repeatedly throughout the course of the test; this causes irregularities in their work curve, and by reason of the need for frequent admonitions to concentrate, their attention is said to be of the *dynamic* type. The effect of the instruction on other subjects is maintained throughout the whole course of the work and their work curve is even; they belong to the *static* type. If, however, the instruction is repeated frequently during the course of the work, the subjects belonging to the dynamic type are brought to work evenly, whereas with subjects of the static type the repetition of the injunction to attend acts as a distraction and introduces irregularities into the course of the work.

The effect of distraction has been investigated directly for its own sake, and it has also been employed as an indirect measure of concentration. With some individuals distraction diverts the attention easily; with others it has little or no effect. This susceptibility to distractive influences is not, however, a measure of concentration, but a specific characteristic, for some subjects who are easily affected by distractions possess at the same time a high degree of concentration. The habituation to distractions is also a variable characteristic, some subjects overcoming the effect of distraction quickly, others taking longer to habituate themselves to it. It frequently happens that in testing the effect of distraction a paradoxical result is obtained, namely, an increase in the work on which the subject is engaged. This occurs when the subject puts forth more energy than is necessary to compensate for the distracting influences, but it is probable that in such a case fatigue will be induced earlier than if no distraction existed.

The ability to divide attention amongst concurrent activities presents, when tested, two types: the attention in the one type oscillates from one form of work to the other form or forms; in the second type the main task secures the greatest attention and the subsidiary task a less amount. Maximal concentration on the main task is found to benefit also the subsidiary activity.

The question whether the various aspects of the attentive process are correlated one with the other has been the subject of investigation; if a high degree of correlation is found to exist, then the presence of one characteristic enables us without further investigation to infer the presence of the correlated characteristics. Individuals whose span of auditory attention is wide are found to possess also a wide range of visual apprehension. Persons whose attention is vivid and quick are usually of the fluctuating type, whereas those who attend slowly belong to the fixating type.[1]

The bodily attitudes and physiological accompaniments of the process of attention have been extensively investigated.[2] It is well known that when we desire to attend to a visual presentation we turn the head in the direction of the object, and that looking at the object involves the convergence and accommodation of the eyes. Even in intellectual, as distinguished from sensuous, attention there are movements of the body. If a person is told to think of something to his left, his body sways towards that side. Generally there is a tendency to movement in the direction of the object which for the moment is claiming the subject's attention. By suspending above the subject's head a blackened plate or sheet of glass, and attaching to his head a sharp-pointed instrument, such movements can be recorded.[3] Movements of the arm or hand can likewise be registered, and such movements are said to explain "muscle-reading" and "table-moving."[4]

The physiological symptoms of the attention process may be arranged into four groups: (1) the primary adaptative processes of the higher senses, such as those which secure the proper accommodation and convergence of the eyes in visual attention; (2) secondary adaptative motor activities which control the posture of the head, trunk, hands, etc.;

[1] H. C. M'Comas, "Some Types of Attention" (*Psychological Review Monographs*, vol. xiii.).

[2] *Cf.* W. B. Pillsbury, *Attention*, chap. ii.

[3] For tracings, see Stratton, G. M., *Experimental Psychology and Culture*, p. 204.

[4] *Ibid.*, p. 205.

(3) primary expressive processes, like changes in the rate of the pulse, in blood pressure, in respiration, in tension of the muscles; (4) secondary expressive processes; these are in part aimless, a play of feature or gesture which, from the biological standpoint, may have once had significance in the evolution of the race, but which disappear with age and training.

The first class of movements serves to adjust the sense organs to the stimulus exciting attention: these movements follow on attention and do not initiate it, and in many cases they cannot be brought about in any other way than by attending.

The second series has, according to Pillsbury, no influence upon the efficiency of attention. Meumann, however, maintains that they have positive educational value; they serve to attune the body to the impression which is being attentively apprehended, facilitate its reception, and inhibit inappropriate movements. All this favours the state of attention. Their educational importance must not, however, be overestimated. The correct attitude of the pupil does not guarantee the presence of deep concentration; but by causing him to adopt a proper attitude, the tendency to digression may possibly be combated and apprehension assisted. We cannot even infer, as some educationists do,[1] that the inward reality cannot exist without producing an outside corresponding to it: a more trustworthy index of the existence of attention would doubtless be the inhibition of unnecessary movements.

Although the third class of symptoms is quite beyond our control, they are probably adaptative; they remove a source of disturbance. With close visual attention the breathing is uniformly decreased in amplitude. In rate it is sometimes increased, sometimes decreased, and sometimes not changed at all. With auditory attention it is nearly always decreased in rate, but changed irregularly in amplitude. Deep breathing, with its accompanying movements, would interfere with looking; rapid breathing interferes more with listening.[2]

[1] Thring, *Theory and Practice of Education*, p. 177.

[2] M. L. Billings and J. F. Shepard, "The Change of Heart Rate with Attention" (*Psychological Review*, vol. xvii. p. 227).

Involuntary attention, it is interesting to note, displays the same changes in respiration, pulse beat, etc., as result from astonishment and fright.

The movements of the fourth class are neither useful nor symptomatic. The child exhibits a greater display of such processes than the adult. Every teacher knows with what energy the child in his work wrinkles his forehead, moves his lips, and rolls his tongue when writing. It is thus clearly seen that this play of motor processes is no index of the degree of attention, and that attention does not consist of these; otherwise the adult would exhibit them to a greater extent, or attention would be lost with their inhibition. They are merely the expression of an undeveloped attention. Meumann found that in memory experiments only the beginner or unpractised subject accompanied his attention with movements or muscular tension; the more practised our attention is, the more do these accompanying movements disappear, so far as they are not essential to the perception itself. All excess of motor tension is harmful for mental work; it is a useless expenditure of nervous energy.

When we proceed to compare the child's attention with that of the adult, we must recognise that on account of the great range of individual differences displayed in the various forms of attention in children and in adults the comparisons made are valid only for the average of classes and not for specific individuals.

The child's attention is evidently sensuous rather than intellectual; it is more easily, and with greater intensity, directed to concrete objects than to intellectual abstractions. Investigations requiring introspective accounts from the subjects of the experiment confirm this, for it is found that young children up to about seven years of age are quite unable to reflect on their mental processes, whereas their ability improves from this age onwards.

The child's attention is likewise passive or involuntary rather than voluntary, enforced rather than spontaneous, although the latter is displayed in a surprising degree in the child's play.

The adaptation of the child's attention to a new activity is much slower than is the case with the adult; this slower rate of reaction is, however, characteristic of all the child's psychical processes.

The child's attention is also dynamic rather than static; repeated injunctions are necessary to keep his attention concentrated, more especially when his efforts are being controlled by voluntary attention.

The restriction of the child's attention to a few objects is due to a cause quite different from similar limitation in the case of the adult; the latter is intentional, whereas the former results from the general weakness in intensity, the child being unable to observe a greater number of objects at once. The child's distribution of attention, when impressions are presented successively, appears in some cases to be wider than that of the adult; but with the child this is a defect arising from the fact that the child's attention is fickle and subject to quick change, easily passing from one object to another. The child's attention is also more easily diverted than is the attention of the adult, and the child is unable to withstand distraction to the same extent as the adult. The absorption of the child in his play and his indifference to all else when so engaged also result from the weakness of his attention, and are not proof of great concentration, for such absorption implies that all his mental energy is utilised in his play, and that there is no surplus at his disposal to which distractive influences might appeal.

The range of attention, as tested by the apprehension, in one single act, of simple objects like points, lines, circles, irregularly arranged, exhibits, according to Meumann,[1] the following development: six-year-old pupils apprehend 2 to 3 elements; twelve-year-old pupils, 3 to 4; fourteen-year-old, 5; and adults, according to their type of attention, 4 to 6. Freeman,[2] however, from experiments carried out at Leipzig, concludes that the difference is much less than might be expected. If we place the scope of attention of adults and older children (twelve to fourteen years of age) at about 5, that of the younger children (eight to ten years old) would be not less than 4; that is, up to and including four objects, the younger children can judge the number as correctly as adults. Freeman nevertheless admits that there is a marked difference between

[1] *Vorlesungen*, vol. i. p. 184.

[2] "Grouped Objects as Basis for Number Idea" (*The Elementary School Teacher*, vol. xii. p. 309).

children and adults in the ability to perceive and judge correctly grouped objects which extend considerably beyond the scope of attention. The subject evidently requires reinvestigation with a larger number of pupils than that employed by Freeman, and at the same time it would be interesting to determine the effect of training on the range of attention and the relation between the range and the general intelligence of the pupils.

Meumann gives the following figures to indicate the development of the span of auditory attention : for children of six to seven years of age, 4–5 sounds can be apprehended ; eleven to twelve years of age, 5–6 ; fourteen years old, 6–8. The average with adults, as already mentioned, is 8.

Whether the child's attention displays the typical differences of "fixating" and "fluctuating" is a question on which as yet agreement has not been reached.[1] According to Messmer, fixating attention is not to be found, at least up to eleven or twelve years of age. Meumann has, however, by means of the tachistoscope found cases of a distinct fixating attention in children of six or seven years of age, but on the whole the fluctuating or roving type preponderated.[2] Freeman [3] maintains that the results of his investigation do not admit of the subjects being classified into two such types.

The foregoing paragraphs indicate generally the differences between the attention of the child and that of the adult. The course of the development of attention is such that these differences are ever disappearing, and the child by degrees acquires the typical qualities of the attention of the adult. The exact determination by experimental means of this development in its various aspects would prove a fruitful field of investigation.

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[1] *Vorlesungen*, vol. i. p. 197. [2] *Ibid.*, p. 200.

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CHAPTER V

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (*Continued*)

SENSE-PERCEPTION

AS sense-perception is ordinarily regarded as the foundation of all the higher forms of knowledge, the task is laid upon Experimental Education of determining the conditions and content of the child's perception, and the typical differences between the perception of the school child and that of the adult, also of tracing the development which sense-perception undergoes during school life.

In the percept we can distinguish two aspects: the given sensory experiences, and the reinstated or revived experiences by means of which the former are interpreted. The revived experiences are of two kinds. Those of a sensory nature are so intimately associated with the given sensory content as hardly to be distinguished from them; they constitute what is termed the prepercept, and the coalescing of the given with the prepercept is termed assimilation or complication. The process of assimilation is so immediate that we tend to regard the whole perceptual experience as given.[1] It is only when the expectant prepercept is defeated and a different prepercept has to be found to synthesise with the given experience that we become aware of the double aspect of perception, as, for example, when a child taking a white cube to be sugar, and at the sight of it reviving experiences of sweetness, roughness, etc., finds on tasting that it is salt.

[1] *Cf.* Bergson, *Matter and Memory*, English trans., p. 124. "Every attentive perception truly involves a reflexion, in the etymological sense of the word, that is to say, the projection, outside ourselves, of an actively created image, identical with, or similar to, the object on which it comes to mould itself."

The percept may, however, also arouse in the mind ideas related in some way or other to the given percept. These revived ideas differ from preperceptions in having a completeness and independence which the latter do not possess; Meumann terms them "accessory" ideas. The interpretation of the given percept by such ideas, that is, by the existing mental content of the subject, is termed apperception. To illustrate the distinction between assimilation or complication and apperception, "we need only to observe first how the sight of a suit of polished armour instantly reinstates and steadily maintains all that we retain of former sensations of its hardness and smoothness and coldness, and then to observe how this same sight gradually calls up ideas, now of tournaments, now of crusades, and so through all the changing imagery of romance."[1]

In treating of sense-perception we must consider all the aspects, the sensory content, the assimilative and the apperceptive factors and their relation one to the other at the various stages of development. As apperception may occur at the ideational as well as the perceptual level, we may regard it as entitled to separate treatment.

The sensory content of perception comprises the sensations resulting from external stimuli like colours, sounds, etc., also the spatial and temporal relations. Although for convenience of treatment it is usual to consider such sensations in isolation, it must be remembered that they are not so met with in actual experience; a simple sensation, as Ward warns us, is a psychological myth. In Education consequently we should probably not speak of "sensory training" but of perceptual training; any improvement in sensory discrimination which results from training should be attributed to the assimilative or interpretative factors of perception, to judgment, even to general intelligence and culture, rather than to changes in the sense organs.[2] Whether such training is worth undertaking depends on the social

[1] Ward, *Encyclopædia Britannica*, "Psychology," p. 57.

[2] *Cf.* Bergson, *Matter and Memory*, p. 47. "The aim of this education [of the senses] is to harmonise my senses with each other, to restore between their data a continuity which has been broken by the discontinuity of the needs of the body, in short, to reconstruct, as nearly as may be, the whole of the material object."

value of the product, a fact which certain systems of education ignore.[1]

Colour Perception of Children.—In order to trace the development of the colour sense in his child, Preyer [2] employed what has come to be known as the "naming" method. This method may be applied in two forms. The colours—for example, green and red—may be presented, and the questions asked, "Where is red?" "Where is green?" Here the name is given and the colour required. Or the colours may be placed before the child with the question, "Which is that?" the name being required. Both methods were used by Preyer, with slightly different results; but as the latter was the more extensively applied, its results alone need be considered here. According to the number of times they were correctly named, up to the thirty-fourth month, the colours arranged themselves in the following order, expressed in precentages of the number of presentations: Yellow, 96·7 per cent.; brown, 90·8 per cent.; red, 86·7 per cent.; violet, 85·3 per cent.; black, 84·8 per cent.; rose, 72·4 per cent.; orange, 67·1 per cent.; grey, 51·5 per cent.; green, 45 per cent.; blue, 28·8 per cent. Of the four principal colours, yellow and red were found to be named correctly much sooner than green and blue. Preyer, moreover, maintains that the incapacity of the two-year-old child to name blue and green correctly cannot be attributed solely to a possible inability to associate firmly the names "blue" and "green"; for the names yellow and red have already been employed correctly many months before.[3]

This naming method, as has been frequently pointed out, does not give an unambiguous index of the development of the colour sense in the child; it indicates, rather, how associations between certain colour names and the corresponding colours develop, and might be termed an "association" method. Baldwin [4] contends that this method involves no fewer than four different conditions: (1) the child's distinguishing of different colours simultaneously displayed before him,

[1] Cf. *The Montessori Method*, p. 221. "Multiply the sensations and develop the capacity of appreciating fine differences in stimuli, and we *refine* the sensibility and multiply man's pleasures."

[2] *Senses and Will*, English trans., pp. 6–22.

[3] *Ibid.*, p. 21.

[4] *Mental Development in the Child and the Race*, p. 37.

that is, the complete development of the child's colour-sensation apparatus; (2) the child's ability to recognise or identify a colour after having seen it once; (3) an association between the child's colour-seeing and word-hearing and speaking memories; (4) equally ready facility in the pronunciation of the various colour names which the child recognises. The method, however, may be employed when we desire to investigate to what extent the power of naming colours is developed; but to determine the development of colour sense itself, later investigators have attempted to eliminate altogether the factor of names.

Myers [1] has suggested a form of association method without names, which he has designated the method of "grasp and reward." Two coloured bricks, one red, the other blue, were presented to the child. Each time the infant picked up one of them, say red, she was rewarded with a sip of honey, syrup, or sugar. When she picked up the other (blue) brick, no reward was given. Thus it was hoped to build up in the infant's mind a definite association between red and reward, so that she would always tend to select the red brick when it was offered simultaneously with any other (coloured or colourless) brick. A similar method is employed in testing animals for colour blindness. Myers [2] holds that this method constitutes a test for colour confusion, and thus differs from all other methods. In this respect it has the great advantage of being comparable with those commonly used for the detection of colour blindness in adults. Myers recommends this method, but as he subsequently abandoned it, no results are available.

Preyer, in addition to the naming method, employed that of matching colours. He took two counters of the same colour, and, giving one to the child, asked for one of the same colour to be chosen from a number variously coloured. Binet has also used this method, and preferred it to naming. It was likewise employed by Miss Tucker at Cambridge with school children, the Holmgren wools being substituted for counters. The children were at the infant-school stage, and their mistakes were the same as those made by primitive peoples. Blue is

[1] *British Journal of Psychology*, vol. ii. pp. 353–354.
[2] *Ibid.*, p. 355.

most often confused, generally with violets and later with greens; green naturally follows; then yellow; and with the younger children red, too, extends its range. Colour discrimination, as thus tested, shows increasing exactness with increasing age.[1]

Binet and Garbini applied the method of recognition, in which a colour is pointed out to the child, who is required to seek it amongst a number of others. Baldwin objects to this method on the ground that a child might possibly fail to recognise an isolated colour quality, when he could very well distinguish colour qualities side by side.

Baldwin introduced what he calls the "dynamogenic" method,[2] that is, the method of determining preference by the motor force which a given stimulus excites—for example, by the amount of reaching movement which the child makes to grasp a colour. This method is independent of the child's comprehension of language. A rod was placed horizontally before the child, parallel with the shoulders, and so equally distant from both hands that its distance from the child could be definitely regulated. On this rod the colours were placed successively, the object being to excite the child to reach for the colour. The number of tests was 217; of these 111 were with five colours and 106 with ordinary newspaper, chosen as a relatively neutral object. To determine the order of preference, the proportion of acceptances and rejections at the various distances was calculated, and the colours took the following order of attractiveness, viz. blue, red, white, green, brown. Yellow was, unfortunately, not included in the investigation.[3] McDougall[4] has suggested a modification of Baldwin's method. The objects presented in pairs to his child were balls about one inch in diameter, each consisting of a pill-box, containing a pea, and embedded in a loose sheath of knitted wool. The woollen thread was prolonged at one point to form a plaited cord about three inches in length. The balls were made of red, green, blue, yellow,

[1] *British Journal of Psychology*, vol. iv. p. 35.

[2] *Mental Development*, pp. 48–49.

[3] For criticism of Baldwin's method and results see McDougall, *British Journal of Psychology*, vol. ii. pp. 350–351.

[4] *Ibid.*, vol. ii. p. 338.

white, and grey wools. The colours were rich and the grey of a decidedly bright shade in order to ensure that any preference exhibited was not due to superior brightness. The two balls, about five inches apart and equally distant from the child's face, were dangled by their cords within easy reach. If he did not at once reach out and grasp one of the balls, they were jerked slightly and the rattling usually arrested his attention and led to a grasping movement. If he did not take one or both balls within half a minute, they were removed and a fresh attempt made after a short interval. This method has certain advantages over Baldwin's method, in which only one colour was presented at a time, and which, according to McDougall, can neither show that colour vision was present nor throw any light on the state or development of colour sense. McDougall maintains that his method is capable of affording evidence of the state of the colour sense from the sixth month onwards, and perhaps even during the fifth month. The experiments indicate that red, green, and blue are appreciated during the sixth month, since they are decidedly preferred to white and still more to grey of corresponding brightness; moreover, in the sixth month no one of these three colours is markedly preferred to the others, but there is a faint indication that during the fifth month blue is less appreciated than red.

Myers agrees with McDougall that at a very early age—probably long before the sixth month—infants are susceptible to relatively small differences of brightness; that at this age reds and yellows are distinctly preferred to other colours and to colourless objects of far greater brightness; and that novelty may be an important factor in determining the infant's choice of colour.

Valentine [1] tested the colour perception and preference of an infant at three months by measuring the times during which the child looked at either of two coloured wools held before him for two minutes at a time. Very decided preferences were discovered, the order of preference being as follows: yellow, white, pink, red, brown, black, blue, green, violet.

But Myers protests against conclusions as to the development of the colour sense being based on the colour preferences

[1] *Report of British Association*, 1913, pp. 689–690.

of infants. "I am convinced," he says, "that it is extremely dangerous to formulate any opinion on the actual colour experiences of an infant as the result of observing what coloured objects he prefers or rejects, when these objects are presented with other coloured or colourless objects." He illustrates the point thus: Supposing that an infant showed a preference for the taste of syrup when he had to choose between syrup and lemon juice, and supposing that he showed no preference when he had to choose between lemon juice and beer, who would venture to conclude that the sweet taste was already developed in the infant, but that the sour and bitter tastes were not yet differentiated from each other? Yet, he adds, conclusions on precisely these lines are drawn by those who have in a similar manner investigated the colour preferences of infants.[1]

The development of the colour sense in children must be approached directly and not through preferences in choice.

Colours differ from one another in brightness, yellow being brighter than red, green than blue. The grey which, for example in an engraving of a picture, corresponds with, and is employed to represent, a colour in the original picture may be regarded as an index of the brightness of that colour. The purity of colours may be affected by the admixture of other colours, yellow added to red resulting in orange, etc.; this change of quality is spoken of as a change in colour-tone. The purity of a colour may also be affected by an admixture of white, grey, or black—the colourless series of visual sensations, red with an admixtuie of white resulting in pink, with an admixture of black resulting in brown; this change is a change of tint or in saturation. The purer a colour is in the latter sense, the more highly saturated is it said to be.

Experimental psychology investigates these various aspects of colour perception, but the questions which, according to Meumann,[2] are of interest to experimental pedagogy include: (1) acuity and discrimination of colour tones; (2) acuity and discrimination of saturation of colours; (3) the æsthetic appreciation of colours; (4) the use of colours, as in art.

Sensitivity to colour or colour acuity has been investigated

[1] *British Journal of Psychology*, vol. ii. p. 359.
[2] *Vorlesungen*, vol. i. p. 236.

by Miss Tucker [1] at Cambridge by means of the tintometer.[2] The English children so tested were found to differ in no way from European adults, although all the averages increase enormously the younger the children are. But, although in matching colours blue is regularly confused with green, it is found that, tested by the tintometer, the ratio of the blue threshold—that is, the intensity requisite that the colour may be just perceived—to that of red or yellow remains constant throughout, so that the confusion of blue with other colours by children is not due to a defect in the perception of this colour. With increasing age there is a gradual decrease in the thresholds of discrimination of the various colours, but their relation to one another remains absolutely regular throughout. Miss Tucker also states that the quantitative results were not influenced by the pigmentation of the eyes—the thresholds for dark eyes being the same as those for light eyes—nor by the standard of intelligence of the pupils. This form of test also enables us to determine the extent of colour blindness. Miss Tucker found that with the Cambridge school children examined, colour blindness exists in the same proportion as amongst English adults, namely, 4 per cent., and this is practically confined to boys.[3]

The sensitivity to changes in saturation has been investigated by Jones [4] at the Institution of Leipzig Teachers' Association. School children of from five to fourteen years of age were tested, and, for purposes of comparison, four adults. Two methods were employed, the method of continuous variations and the method of minimal changes.[5]

According to the results of Jones's investigation, sensitivity to colour saturation improves considerably during school life: at fourteen, according to one method, it is twice, according

[1] A. Winifred Tucker, "Observations on the Colour Vision of School Children" (*British Journal of Psychology*, vol. iv. pp. 33–43).

[2] For description of instrument and procedure adopted, see Myers, *Introduction to Experimental Psychology*, pp. 33–34.

[3] For other methods of determining colour-blindness, see Whipple, part i. pp. 181–93.

[4] Ll. W. Jones, "Untersuchungen über die Reizschwelle für Farbensättigung bei Kindern" (*Veröffentlichungen des Instituts für exp. Pädagogik u. Psychologie*, Bd. ii.).

[5] For account of methods see Schulze, *Experimental Psychology and Pedagogy*, English trans., pp. 50–71.

to the other and more reliable method, three times, as delicate as at six or seven years of age. Girls, as in general development, are superior to boys during the early years of school life, but the boys gradually overtake them. At seven and again at eleven there are periods of arrest : the last three years of school life are years of development, especially the age of twelve. Boys display greater sensitivity to blue and green, girls to red and yellow. Of the adults tested, women appear to possess a finer sense of difference to colour saturation than men. Sensitivity to saturation of special colours is said to run in families, and may even be inherited.

It is popularly believed and frequently affirmed by psychologists that girls have a nicer appreciation of colours than boys, the latter being compensated by a better sense of form. Meumann affirms [1] that both with the naming and the matching methods the colour sense is found to be better developed with girls than with boys, and that in some districts the difference is considerable. He admits that this view has frequently been questioned, but maintains that the majority of investigations support this contention. In respect to appreciation of differences in saturation, according to Jones, the girls likewise display superiority. Miss Tucker, however, found that the average threshold, as determined by the tintometer for the colours red, yellow, and blue, is for any one age much the same for boys as for girls.[2] Any superiority which girls possess is probably to be attributed rather to a greater interest in colours than to a difference in native ability to perceive or discriminate them.

The influence of colour nomenclature on discrimination of colours has given rise to discussion and expression of differences of opinion. Baldwin in his discussion of the naming and matching methods of testing the colour sense refers to the conclusions of Lehmann, that the coloured wools are recognised when the colours are those whose names are known, and that shades which have no peculiar names, or whose names are unknown, are not recognised. This implies that colour discrimination is dependent on the ability to name colours. The very opposite has been maintained by

[1] *Vorlesungen*, vol. i. p. 231.
[2] *British Journal of Psychology*, vol. iv. p. 39.

Winch, who, from the results of tests on children from three to five years of age, affirms that discrimination and naming of colours are independent. "I have no doubt at all," he asserts,[1] "both from my own observations and from the work of others, that discrimination of colours is a much earlier thing than the correct naming of them." Miss Tucker, however, believes that the truth seems to lie between the two statements. "The name is probably at first attached only to well-saturated shades of the colour, and the exact application only learnt by degrees."[2]

That the capacity to match and to grade colours can be improved by training there is not the slightest doubt. Quite young children trained on the Montessori method develop surprising skill in this respect, but if we compare the social value of such training with the value of a training in exact nomenclature of colours, the latter might be considered to be the more desirable acquisition.

With the other aspects of the colour question enumerated by Meumann, namely, colour preference and application of colours in art, we shall deal when considering the æsthetic development of the child.

Sound Perception.—We know less of the development of the child's perception of sound than of his sense of colour. The child's perception of sound has been tested in connection with the investigation of the contents of children's minds on entering school, by determining the percentage of children who can sing a song from memory or repeat a tune sung; it has likewise been determined more exactly by psychological methods. The former method does not admit of definite conclusions, since its results are largely determined by accidental educative influences. Both methods disclose extraordinary individual differences; musically gifted children often learn to sing before they can speak (even as early as the end of the first year), whereas the child entering school is usually incapable of recognising differences in tone or tone intervals or of remembering simple harmonies.

Statistics of Annaberger[3] schools demonstrate that only

[1] *American Journal of Psychology*, July, 1910, p. 476.
[2] *British Journal of Psychology*, vol. iv. p. 36.
[3] Stanley Hall, *Aspects of Child Life and Education*, p. 45.

20 per cent. of new scholars can sing a song from memory, and that about 36 per cent. can sing a song or part of a song after it has been sung to them. This is important, for it shows that in music instruction we should not expect too much from children who have just entered school.

The tests for auditory acuity and discrimination may be divided into two classes: those which seek to discover for practical purposes defects in hearing, and those which investigate discrimination in pitch with a view to determining the possibility of music instruction in schools. As it is important to know which children in a class are colour blind, so it is even more important to discover those with defective hearing. Various methods have been employed to test the auditory acuity of children,[1] and as the conditions under which the tests were applied were not identical, the results are not quite in agreement. In a Chicago investigation with 6729 children, 1080, or 16 per cent., were defective in one or both ears (6·64 per cent. in both, and 9·55 in one ear). The results of other investigations give as hard of hearing or with defective hearing, New York, 13 per cent.; Riga, 22·2 per cent.; Stuttgart, 10 to 30 per cent.; Bordeaux, 17 per cent.; Paris, 22 to 25 per cent.; Munich, 25·8 per cent. Differences appear between the two ears, but Whipple [2] remarks that for practical purposes the determination of this difference is only significant when the inferiority of one ear is marked; in such cases pupils should be so seated in the class-room as to turn the "good" ear towards the teacher. Investigators are almost unanimous in maintaining that defective hearing has a positively injurious effect upon school-standing.

Gilbert [3] sought to determine the child's capacity for pitch discrimination, to discover whether at the various ages there were any, and, if so, how many, pupils who could not distinguish to a half-tone.[4]

Five boys and five girls of each age except eighteen and

[1] For methods see Whipple, *Manual of Mental and Physical Tests*, part i. pp. 200–213.
[2] *Manual*, part i. p. 210.
[3] J. A. Gilbert, "Experiments on the Musical Sensitiveness of School Children" (*Studies from the Yale Psychological Laboratory*, vol. i. (1892–1893), pp. 80–87).
[4] For discussion of methods see Whipple, *Manual of Mental and Physical Tests*, part i. pp. 213–223.

nineteen were tested; for these ages girls only were tested. As the object of the investigation was to compare children with one another, a single fundamental tone was used throughout, namely, the tone $\bar{a}=435$ of international pitch. The method was that of minimum gradation, ā being first sounded, then a note $\frac{1}{32}$ of a tone higher, and the child was required to answer "same" or "different"; ā was again sounded, then a tone $\frac{2}{32}$ higher, and so on, the second tone being raised $\frac{1}{32}$ each time, until the child had several times declared the tones to be different. Thereupon the second tone was started at the same pitch as the first, and in like manner successively lowered. The number of thirty-seconds of difference that were just perceived gave the result for a single test.

The complete results were:

Age . . .	6	7	8	9	10	11	12
Least perceptible difference in 32nds of a tone	12·3	9·1	6·8	4·8	6·2	4·8	4·1

Age . . .	13	14	15	16	18	19
Least perceptible difference in 32nds of a tone	3·7	3·5	5	4	2·6	2·4

Gilbert concludes that the pupils are fully capable of the task required of them in music instruction. The least sensitiveness occurs with children of six years old, with whom the average just perceptible difference is 12 thirty-seconds, or $\frac{3}{8}$ of a tone. Of the children examined there were only three whose averages exceeded half a tone. It is evident from these results that the least perceptible difference decreases with increasing age, that is, sensitiveness increases. This increase is at first rapid, but later almost negligible. At the ages ten and fifteen, however, exceptions occur, and to verify the data for those ages Gilbert repeated the test with increased numbers of pupils, but without having to alter his results. The loss of sensitiveness at these ages Gilbert attributes in the one case possibly to the second teething, which occurs at nine to twelve years of age, and which may have such an influence on mental life as to cause a loss of sensitiveness; and in the other, more definitely, to puberty, the average onset of which may be put at fourteen years and five months. It will be noticed that these sudden changes divide the development in pitch discrimination into three uniform stages—from six to nine, from ten to fourteen, and from fifteen to nineteen years of age.

Seashore [1] in a later investigation found that tone-discrimination developed early; about the eighth year pupils could recognise a difference of $\frac{2}{64}$ of a whole tone, an interval which only few adults could distinguish. He found no constant relationship between pitch discrimination and sex, and no correlation with general intelligence; he also declares that individual differences in pitch discrimination are not due principally to musical training.

Other investigators disagree with Seashore's conclusions. Burt,[2] for example, maintains that girls are much more acute than boys in respect to discriminating small differences in pitch, and he supports Spearman's contention that superior auditory acuteness is due to "general culture" more than to special practice.[3] While ability to discriminate small differences in pitch is doubtless a condition of success in musical education, the former may be present without leading to the latter, as musical ability includes, in addition to such appreciation of pitch differences, a good memory for pitch and melodies, a finely developed sense of rhythm, and an appreciation of melody, harmony, etc.

The other forms of perception, the olfactory and the gustatory, have not been so adequately investigated as the visual and the auditory; but the results would not be of equal educational value. The sense of touch, however, demands consideration by reason of the part it plays in the Montessori system; this method of education might indeed be designated "Education by touch."

Tactual Perception.—In what is popularly termed "touch" the psychologist distinguishes [4] sensibility to superficially painful, and to hot and cold stimuli; the appreciation of light touch over hairless regions; warmth and coolness; and the power

[1] C. E. Seashore, "Hearing-ability and Discriminative Sensibility for Pitch" (*Univ. of Iowa Studies in Psychology*, vol. ii. 1899).

[2] C. Burt, *Journal of Experimental Pedagogy*, vol. i. p. 108.

[3] C. Burt, *British Journal of Psychology*, vol. iii. p. 126.

[4] *Cf.* Myers, *Introduction to Experimental Psychology*, chap. i.

of precise cutaneous localisation; a system of deep sensibility in which only deep pressures and pains can be experienced, localised, and successively distinguished; also motor experiences from which we derive our knowledge of form and direction. The Montessori system has devised exercises to train certain of these senses; for example, the thermal sense, the discrimination of weights and of textures, of rough and smooth, and the perception of form. The materials and methods adopted were in many cases those in use in psychological laboratories, but whereas in psychology they are employed to *test* perception, in the Montessori system they are introduced to *train* perceptual discrimination: the practice effect which appears in the course of a series of psychological tests and is a disturbing factor which the psychologist seeks to eliminate, is what the Montessori system proposes to attain.

Of the development of the sense of pressure and of temperature we possess little or no knowledge, but the development of the perception of weight and of movement has been investigated psychologically. The importance for life and for education of the motor sensations is referred to by Meumann.[1] On their activity depend all delicacy in handling tools and instruments and all manual skill; they are also important for work with the pencil, the pen, and the brush—in writing and drawing, in modelling and in other forms of craftsmanship; the exactness of movements in gymnastics and sport depends on them, and, lastly, the estimation of differences in weights.

The factors governing the estimation of weights of objects have been investigated by many experimenters,[2] and tests of a nature similar to those employed in such investigations have been applied to children.[3] With boys from eight to fourteen years of age an addition of 20 grammes to weights of 250, 500, 1000, and 1500 grammes is under favourable conditions found to be recognisable.

Discriminative ability for sensations of movement can be better investigated by determining the increase of the angular movement of the arm which is just perceptible. Sensibility

[1] *Vorlesungen*, vol. i. p. 257.
[2] *Cf.* Myers, *Text-Book of Experimental Psychology*, part i. chap. xvi.
[3] K. L. Schaefer and P. Mahner, *Zeitschrift für Psychologie*, Bd. 38, 1905.

to movement as thus determined appears to reach early in childhood the same delicacy as that possessed by adults; the mean error with pupils of thirteen to fourteen years of age was found by Meumann to be about as great as that in his own case.[1]

Spatial Perception.—The child's apprehension of spatial relations is of greater significance for education than the sensory modes of perception, since it serves as foundation for his knowledge of forms and in part for his knowledge of number, as well as acting as the basis of his spatial conceptions.

For the theories of space perception the reader must be referred to works on psychology,[2] and of the early development of spatial perception all we need say is that at the outset the idea of distance of objects arises through the movement of grasping; a wider and better understanding of distance is developed when the child can measure distances by traversing them, as only those distances which we have actually traversed are properly estimated by us; of others which we have not experience we can hardly have an adequate idea.[3]

In considering space perception we must deal with the understanding of forms, figures, etc.; the proportion of lines, angles, planes; the understanding of perspective foreshortening; and the appreciation of the pictorial representation of space, which is of importance in all forms of instruction in which pictorial illustration is employed.

Meumann infers[4] from the trouble which young children experience with the apprehension of forms in reading and writing that the finer sense of form is only developed during school life and under the influences of education. This trouble may, however, result from the fact that usually the control and memory of the forms in reading and writing are purely visual; where, as in the Montessori system, the control and retention are tactual and motor, the child's ability to retain

[1] *Vorlesungen*, vol. i. p. 261.
[2] For example, Stout's *Manual of Psychology*, book iii. part ii. chap. iv.
[3] *Cf.* Meumann, *Vorlesungen*, vol. i. p. 268.
[4] *Vorlesungen*, vol. i. p. 269.

and reproduce such forms is exhibited in a more favourable light. Meumann is on surer ground in his deductions from the drawings of children, although here apprehension doubtless exists where reproduction is not possible and the development of the former precedes that of the latter. The finer understanding of forms depends on two very different psychological factors: (1) the adequacy with which spatial relations are recognised, and (2) the knowledge of the fundamental geometrical forms.

The spatial threshold of the child, that is, the distance apart which two points must be on the skin to be perceived as two, is smaller with the child than with the adult, by reason of the fact that the number of nerve endings on the same area of the skin is greater with the child. The recognition by the child of forms—circles, triangles, etc.—pressed on the skin is not much inferior to the adult's. The estimation of spatial intervals judged by the movements of the arm is with children more exact in the greater joints than in the finer, the reverse being the case with adults. In halving lines, with the exception of six- and seven-year-old children, Meumann found [1] that school pupils accomplish this as satisfactorily as adults do. In comparing the length of lines, young children are found to be quite proficient for short distances; in the case of children of six or seven years of age their judgment is not much behind that of the adult, and it is thus evident that this power of comparison is early developed.

Preparatory to his tests on mental association Ziehen investigated the mental contents of the children attending Professor Rein's Seminar School at Jena, and in doing so found that a metre was correctly indicated by most of the children. Ziehen, indeed, was surprised at the accuracy of the space ideas of the pupils, who ranged in age from eight to fourteen years; with only two of the forty-five tested was the spatial sense almost totally undeveloped.[2]

Meumann asserts [3] that the visual illusions are very early experienced by children—even by children as young as six. With regard to the over-estimation of the length of vertical

[1] *Vorlesungen*, vol. i. p. 278.
[2] Ziehen, *Die Ideenassoziation des Kindes*, p. 8.
[3] *Vorlesungen*, vol. i. p. 279.

lines relatively to horizontal—an illusion which it is important to recognise in drawing instruction—it seems that it is less with adults than with boys in junior classes, and Winch has demonstrated that it decreases with increasing age and school progress.[1]

The exact understanding of figures and forms appears first in the child when he has become acquainted with the fundamental geometrical forms, that is, with schematic figures which can be resolved into the circle, ellipse, triangle, square, etc. From the Annaberger statistics, already referred to, it appears that the circle and the sphere are to the child the best-known forms, then the square, and lastly the triangle, and that consequently what is geometrically simplest is not simplest psychologically. Herbart in his *ABC der Anschauung* took the triangle as his starting-point ; Pestalozzi was more correct with the square ; Froebel's first gift, the ball or sphere, has, however, most psychological justification.

The child's understanding of spatial forms represented pictorially appears early, but its development remains incomplete till well on in school life. Four stages can be distinguished.[2] The first is that in which the picture merely arouses in the mind of the child a memory image of the object and may lead the child to utter the name of the object. The second stage is that of the recognition of the represented objects—persons, situations, etc. Boys are superior to girls in this, and one investigator asserts that twelve-year-old girls are on the same plane as seven-year-old boys. The difference between the sexes in this respect even increases with age. At the third stage an analysis of the picture takes place, and its significance is understood : the picture becomes an object for contemplation, and not merely a stimulus for exciting free images in the mind. Last of all, the perspective of pictures is understood by the pupil.

Not only the æsthetic appreciation of pictures but their spatial interpretation by the child consequently stand in need of investigation by the teacher.

[1] *British Journal of Psychology*, vol. ii. pp. 220–225.

[2] J. van der Torren, "Über das Auffassungs- und Unterscheidungsvermögen für optische Bilder bei Kindern" (*Zeitschrift f. angew. Psychologie*, Bd. i.).

Perception of Time.—Four aspects of the perception of time fall to be considered [1]:—

(1) The estimation by the child of short intervals of time which can be directly compared: with this is connected his apprehension of rhythm and his ability to beat time or tap at a given rate.

(2) The estimation of longer intervals of time, when the attention is diverted from the passage of time and concerned with some activity which occupies the time; this is termed in psychology the estimation of "filled" times, or the indirect or mediate estimate of time, since the estimate is not based on the passage of time itself, but on characteristics derived from other forms of experience.

(3) The comprehension of all temporal relations, and of the standards and concepts of time based on these; for example, relations like simultaneity, succession, duration, and recurrence in time of corresponding impressions. On the temporal relations depend further our time concepts, like "present," "past," "future," and the more specialised forms like "to-day," "yesterday," "to-morrow," with which it is usual to presuppose the six-year-old child is well acquainted.

(4) The appreciation by the child of the division of periods of time, especially the knowledge of the divisions of the hour (minutes and seconds), the parts of the day, then the greater divisions of time, like weeks, months, and years. On the comprehension of such elementary divisions of time there also depend our ideas of definite periods in the present, past, and future, and these ideas develop only very slowly with the child.

For the refinements in the methods of testing the capacity to estimate brief intervals of time the reader is referred to works on experimental psychology giving an account of laboratory procedure.[2] Other non-laboratory methods include, for example, the exhibition of a picture for a definite time, say, one minute, and the recording by the pupils of the estimated time during which the picture is exposed. Our knowledge of the child's ideas of long periods of time is obtained by interrogating or cross-examining him, a somewhat unsatisfactory method, but the only one at present available.

[1] *Cf.* Meumann, *Vorlesungen*, vol. i. pp. 289–290.

[2] Myers, *Text Book of Experimental Psychology*, vol. i. chap. xxiii.

The child's tendency to imitate and repeat rhythmical movements discloses itself in the very early years of his life, but his ability to apprehend and to reproduce fine time relations develops only slowly and requires training. Meumann[1] investigated the child's ability to beat time by requiring him to accompany, by means of tapping, a series of sounds produced at certain rates or in various measures. The highest rate at which the seven-year-old child can perform this task is when the notes succeed one another at $\frac{4}{10}$ second interval; the power thus to accompany fails with many twelve-year-old children when the interval is greater than two seconds. With the shortest times the tapping is too slow, with the longer too quick, and it is observed that children frequently do not notice their mistakes. These children consequently cannot apprehend and reproduce musical measures involving intervals of less than ·4 seconds or greater than about 1·8 seconds, and the duration of notes or divisions of notes beyond these limits cannot be appreciated or reproduced by many children. Too much should not be expected of young children in this respect; but that the ability can be greatly improved by training, such systems as that of Emile Jaques-Dalcroze prove beyond doubt.

The results obtained by indirect measurement, by interrogating pupils as to the length of exposure of a picture, for example, results which can be readily verified, show that such estimation is very inexact. Filled times are over-estimated; for example, a one-minute exposure was believed by some pupils to have lasted two, three, and five minutes respectively. This tendency to over-estimate decreases with the lengthening of the time intervals, then comes an indifference interval, and thereafter with intervals of six to eight minutes an under-estimation.

The comprehension of long periods of time is very imperfect. Ziehen[2] found that with children of eight to fourteen years of age the arithmetical ratio between hours and minutes was familiar to practically all pupils; only three gave the relation false. The number of hours in a day was frequently given incorrectly. For many children of eight years of age he main-

[1] *Vorlesungen*, vol. i. pp. 296 *et seq.*
[2] *Die Ideenassoziation des Kindes*, vol. i. p 9.

tains that a day is not a measure of time, but is known only as the opposite of night. According to the answers given by the junior class (eight to ten years of age) the day has 19, 21, 23, 60 hours. In the intermediate class (ten to twelve years) only one scholar gave a wrong answer. The number of days in a year was unknown to almost all the pupils on their entrance to the junior class, that is, at eight years of age. In this class not a single right answer was given, and at the end of the school-year Ziehen determined that nine boys, including three of the intermediate class, had still no approximate idea of the number of days in the year. The answers of these pupils varied between 20 and 160 days. By questioning children of five and six years of age Meumann has become convinced that all complex conceptions of time are completely unintelligible to them. When we say to a child that an incident happened yesterday, the day before yesterday, weeks ago, or years ago, this is for him only an obscure reference to the past : so with references to the future. A child of six has likewise no idea of the seasons—at least as periods of time ; all he knows is that it is cold in winter and warm in summer.

The exact determination of the child's perception of time for the various ages is important pedagogically, as temporal relations are continually referred to in teaching, especially in the teaching of history ; and it would be well for the teacher to know to what extent the child appreciates these references. A boy, aged five, whose life-history the writer knew intimately, could not be got to date back anything beyond three weeks ; at seven and a half years of age he would go as far as six months, but not beyond it ; at eleven and a half he had a proper understanding of dates in history. Another boy of eight years of age would likewise not go beyond six months. Everything which happened before that seemed to be simply in the past. The perception of time intervals appears to be in this respect somewhat analogous to the perception of space. For near distances our space perception is tridimensional, and we can perceive depth. Beyond a certain distance everything appears in the same plane ; for example, all the stars seem equally distant. If we may regard time similarly, we may say that we can distinguish the relative position of recent events, but events in the distant past appear all in the same plane, this plane receding with increasing experience.[1]

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SCHULZE, R. (trans. by R. Pintner), *Experimental Psychology and Pedagogy*, chaps. ii. and iii.

WHIPPLE, G. M., *Manual of Mental and Physical Tests*, part i. chap. vi.

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[1] *Cf.* "There is a law, Professor Paul Janet says, by which the apparent length of an interval at a given epoch of a man's life is proportional to the total length of the life itself. A child of ten feels a year as $\frac{1}{10}$ of his whole life, a man of fifty as $\frac{1}{50}$, the whole life meanwhile apparently preserving a constant length" (James, *Principles of Psychology*, vol. i. p. 625).

CHAPTER VI

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (*Continued*)

APPERCEPTION

According to Stout,[1] "the main principle which psychology lends to the theory of education, as its starting-point, is the need that all communication of new knowledge should be a development of previous knowledge." Although this principle—the doctrine of apperception—is as old as Socrates, it has been left to Experimental Education to determine the forms according to which apperception operates for various ages, and also to institute investigations as to the actual content of children's minds.

The experimental investigation of apperception has two aspects, which we may term respectively the "formal" and the "material." The one seeks to determine the forms or categories according to which the child, at various stages of development, observes and describes objects presented to him, and which consequently distinguish the operation of the child's apperceptive process from that of the adult; the other seeks to determine the existing mental content, with the aid of which the child at various ages interprets the given material of perception.

Definite categories of observation appear to be typical of certain ages, and the exact determination of these is obtained by testing the observation and testimony of children.[2] To determine the accuracy and development of the child's testimony, pictures or simple objects are exhibited for a short time, say one minute, and immediately withdrawn. The pupil is instructed to observe the pictures or objects while they are

[1] *Analytic Psychology*, vol. ii. pp. 137–138.

[2] For tests, see Whipple, *Manual*, part ii. chap. viii.

exposed, and then he is required to describe what he remembers of the objects seen. His first spontaneous account is termed technically the "Report";[1] thereafter he is questioned by the experimenter, and this process is termed the "Cross-examination." After a given interval—an hour, a day, a week, etc. —the report and cross-examination may be repeated. From such investigations it is obvious that children, according to age and stage of mental development, view things according to quite different categories or points of view. Stern has distinguished three or four stages in the development of the child's apperceptive process. The first he calls the *Substance* stage; this term signifies that at the outset children observe only single disconnected objects or persons. The Substance stage is followed by the *Action* stage, when human actions and activities are observed. Thereupon follows the so-called *Relation* stage, in which the spatial, temporal, and causal relations of things are observed. Lastly comes the *Quality* stage, in which children analyse things into their qualities.

As illustrations of these various stages we may cite from Winch's investigation on Children's Perception[2] the first spontaneous reports of London children on the Breakfast picture previously employed for the same purpose by Stern. Typical of the enumerative or substance stage is that of E. M., which runs as follows:[3] "A little boy—a mother—a chair—a table—dripping—basin—a flower—a dolly." Of the action and relation stage the report of H. N. is representative:[4] "There is a little boy sitting on a chair eating cake, and there's a table there and a plate on the table. And the mother is there holding a dish, and there's the floor with lines on it, and there's a door where you go into the scullery; it was open. The table had legs with curls in them, what goes in and out like my mother's table. The little boy is just going to put the cake on his plate. The mother is standing up; the mother's got an apron on, and she has got her hair done up; she is just waiting for the little boy to finish his cake; she is going to cut a piece more. There is a gas-stove and a plant on it." The quality stage is evident in the report of W. S.:[5] "There is a little boy

[1] For "Bericht"—"Verhör," Whipple uses "Narrative" and "Interrogatory." [2] W. H. Winch, *Children's Perceptions*.
[3] *Ibid.*, p. 13. [4] *Ibid.*, p. 99. [5] Pages 114–115.

eating a piece of cake, and there is a lady with a big bowl in her hand. There is a flower-pot with some flowers in. There is a doorway behind the lady. There is a jug down by the table near the little boy. There were some lines on it. The door is open. The little boy is sitting on a chair. He has red stockings. His mother's got a red apron on. There is a big flower-pot. The cake that the little boy is eating has got currants in, and the mother is just lifting up the big bowl. There is a red flower with some green and black leaves. The little boy has a blue coat on. He's got black shoes on. And you can see the sky through the door. There is a lot of milk in the big bowl. And the little boy is eating a brown and yellow cake. You can see the sky through the door."

The ages given by Stern and others [1] for the first use of the respective categories are up to eight years for the substance stage, from eight to nine or ten for the action stage, and for the relation stage ten to thirteen. If, however, we analyse all the first spontaneous reports which are reproduced in full in Winch's work, we find that the first use of the categories by London children must be placed much earlier. The analysis in tabulated form appears thus :—

Initials.	Sex.	Age.	Enumerations.	Actions.	Relations.	Qualities.	Total.
R. H.	B	$3\frac{8}{12}$	9	..	1	..	10
E. M.	G	$3\frac{10}{12}$	6	..	..	..	6
Y. C.	B	$4\frac{5}{8}$	13	2	4	..	19
P. P.	G	$4\frac{9}{12}$	10	2	8	1	21
H. N.	B	$5\frac{5}{12}$	14	6	4	1	25
G. B.	B	$5\frac{7}{12}$	16	3	5	1	25
R. V.	B	$6\frac{9}{12}$	20	5	12	..	37
A. D.	G	$6\frac{11}{12}$	17	3	7	6	33
W. S.	G	$7\frac{1}{12}$	21	3	12	10	46
O. H.	G	$7\frac{2}{12}$	18	4	6	6	34
J. D.	G	$8\frac{3}{12}$	12	2	7	11	32
J. S.	B	$9\frac{4}{12}$	14	1	7	4	26
C. B.	B	$10\frac{1}{12}$	20	2	9	7	38
C. T.	G	$11\frac{9}{12}$	27	3	8	20	48
T. G.	B	$12\frac{5}{12}$	15	2	9	9	35
M. P.	G	$13\frac{2}{12}$	34	2	16	27	79

[1] *Cf.* Meumann, *Vorlesungen*, vol. i. p. 306 ; vol. ii. p. 404.

From this analysis we must infer that for London children the enumerative or substance stage does not extend beyond four and a half years of age ; the action and relation stage comprises the ages between four and a half and seven. About seven years of age the qualitative stage begins.

The fact that the use of certain categories is lacking in pupils at certain ages is obviously of great importance for some branches of instruction. Meumann consequently commissioned Miss Borst to determine how far this defect could be remedied by training. She instructed the pupils to observe according to certain definite categories—for example, colour, spatial arrangement, size of objects, etc. After this preparatory instruction the picture test was again applied, and a general improvement in systematic observation resulted,[1] brought about by the observance of a definite order in observation ; by instruction in the material aspects—for example, in the recognition and naming of colours, forms, etc. ; but mainly by greater conscientiousness on the part of the pupil. Greater improvement is, however, secured by appealing to the emotions and will of the child, awakening his interest in the test, arousing the desire to improve his report, and increasing his feeling of responsibility. Meumann is nevertheless convinced that this improvement is only temporary, and that if children are trained to employ higher categories than those appropriate to their stage of development, they use them only with difficulty, and drop them when the training ceases. If, then, at the infant stage of school life we prescribe observation lessons dealing mainly with the qualities of objects, our teaching is vain ; immediately the training ceases, the child relapses into the use of the category appropriate to his age. We might also infer that it is more important that the pictures used in teaching should correspond to the stage of the child's apperceptive development than that they should be artistically coloured.

Stern has demonstrated that the use of the categories according to which children consciously or unconsciously observe does not develop gradually, but that at a certain stage a category not previously employed appears quite suddenly, is forthwith spontaneously applied, and then shows no further development. Schröbler's investigations do not confirm this,

[1] Meumann, *Vorlesungen*, vol. i. p. 316.

but indicate a gradual development, influenced by the endowment of the individual and the effects of education. All these categories appear earlier in boys than in girls; but in the higher classes the sexes become level in this respect. Certain categories preponderate with girls, others with boys; for example, the personal with girls, and the objective with boys.

The progress due to age in the development of observation is very considerable throughout life. Whereas with seven-year-old children every third element of positive statement is false, with fourteen-year-old children only every fifth statement is false. Most errors arise with numbers (in answer to the question, How many ?), then with statements on colour, then actions of persons, then descriptions of objects. Spatial relations and statements on uncoloured properties of things are given almost correctly. This progress with age, like the child's general development, shows periods of advance, of arrest, and of retrogression. With boys the period from seven to ten years of age is a time of rapid development, and after that the development is slower. With girls there is at ten a certain arrest, and from ten to fourteen rapid development.

With reference to accuracy of testimony, Stern maintains that boys return a greater number of correct statements than girls; in positively false statements the sexes are about alike, but girls give the more indefinite replies. The superiority of boys becomes more evident when the more difficult forms of testimony are considered—statements on colour, for instance. The ratio of the degree of spontaneous report to cross-examination varies with the sexes according to age. Girls of the intermediate classes—that is, about eleven years of age—are inferior in spontaneous observation to boys, but in the junior and senior classes they excel the boys; although girls are superior in the amount of spontaneous observation, they are inferior in regard to the fidelity of their reproductions.[1] It further appears that the spontaneous observation of all pupils turns more to personal relations than to lifeless things, more to objects than to qualities and relations, more to spatial relations than to colours. What decides the selection in observation is not what strikes the senses, not the intensity

[1] For qualifications of Stern's conclusions in regard to sex difference see Whipple, *Manual of Mental and Physical Tests*, part ii. p. 32.

or liveliness of external stimuli, but the circle of interest of the child.

It may be added that the younger the children the more subjectively is their observation determined; and girls are more subjective in this respect than boys. The observation of children becomes more objective as their interest diminishes; concerning objects in which they are interested, a greater number of statements are made, but they are less trustworthy. Accuracy in reporting has been said to stand in a definite relationship with intelligence, the most highly endowed pupils making the best reports, but this has also been denied.[1]

We have thus far dealt with the formal side of the apperceptive process; it is, however, important educationally to know the actual mental content of the pupil at the different periods of development. This has in some cases been accomplished for children entering school, but not so extensively or systematically at the later stages of school life. For the vague opinions on the mental content of their pupils with which teachers are usually satisfied there must be substituted a knowledge which is capable of being expressed in exact quantitative terms. Inventories also require to be undertaken in different districts with pupils of differing social status, for in no field of Experimental Education is there greater danger of assuming that the same results hold under different conditions. This, too, is not a psychological, but, as Münsterberg has pointed out, a sociological and pedagogical problem.[2]

The systematic determination of the pupil's mental content would be valuable in many respects; it would disclose the knowledge and the ignorance of the pupil. The teacher would also learn the direction of the child's interest, the exactness of his perceptions and memory images, the accuracy of his recognition of previously experienced objects and processes, the extent of his vocabulary, his capacity for correctly naming objects, and the categories and concepts under which he arranges his perceived material. The teacher would thereby come to know the material upon which he has to work,

[1] *Cf.* Meumann, *Vorlesungen*, vol. i. p. 315, with Whipple, *Manual*, part ii. p. 34.

[2] *Psychology and the Teacher*, p. 230.

what he may and may not assume, where the typical defects in the child's experiences lie, and with what apperceptive material his instruction may be connected.

The results of the investigations in this direction are now easily accessible in Stanley Hall's essay on "The Contents of Children's Minds on Entering School," [1] which is probably the most valuable contribution of the Child-Study movement to the new Education. It may suffice to cite the following from one of the American investigations: 54 per cent. of the children entering school did not know a sheep; 61 per cent. had not seen potatoes growing; 35 per cent. did not know what clouds were; 48 per cent. were ignorant of what a river was; 35 per cent. of a circle; 62 per cent. did not recognise a spade; 50 per cent. could not tell the origin of butter.[2]

Stanley Hall concludes [3] that from such results it seems not too much to infer (1) that there is next to nothing of pedagogic value the knowledge of which it is safe to assume at the outset of school life. (2) The best preparation parents can give their children for good school training is to acquaint them with natural objects, especially with the sights and sounds of the country. (3) Every teacher on starting with a new class or in a new locality, in order to ensure that his efforts along some lines are not utterly lost, should undertake to explore carefully, section by section, children's minds, with all the tact and ingenuity he can command and acquire; and work of the same kind should be regarded as an essential part of his training. (4) The concepts which are most common in the children of a given locality are the earliest to be acquired, while the rarer ones come later. This order may generally be assumed in teaching as a natural one; for example, apples first (as appealing directly to the child without mediate process), and wheat last. The order, however, varies very greatly with every change of environment, so that the results of explorations of children's minds in one place cannot be assumed to be valid for those of another, save within very few concept spheres.

There is an extraordinary diversity between the mental

[1] *Aspects of Child Life and Education*, pp. 1–52.
[2] *Ibid.*, pp. 15–17. [3] *Ibid.*, pp. 23–24.

contents of town and of country children. This difference should be taken into account in teaching, and different primers ought to be provided. Stanley Hall notes [1] that the subject-matter of primers for town children is in great part still traditionally of country life; hence the danger of unwarranted presupposition is considerable.

It may be stated generally that the extent of the child's knowledge of objects is determined by the frequency of his use of these objects. This corresponds to the Froebelian principle, that what the child observes must find expression in action. Almost unknown to the child are those relations which presuppose an understanding of the causal connections of natural processes. From tests on the child's observation it is seen that what is known is what interests; anything which has no interest for the child may be seen a hundred or a thousand times without becoming a mental possession. Whatever plays a part in his protection or defence is especially well known to the child, and what excites pain appears to be more familiar than what excites pleasure.

From their diagnoses of the child's intelligence, Hartmann and Seyfert conclude that the content of the child's mind on entering school has an influence on later mental development. Children who at the outset appear at a disadvantage in regard to mental content, remain backward throughout the school course; [2] and Stanley Hall affirms [3] that a few days' residence in the country at the age of five or six has raised the level of many a city child's intelligence more than a term or two of school training without this could do.

Seyfert also remarks that children are prone to employ inadequate substitutes for the names of unknown objects. The child tends to substitute the part for the whole, the material for the object; he does not hesitate to coin new words with which to name unknown things or qualities; and he will substitute, spontaneously, the known for the unknown. Some of the misconceptions in the mind of the child, due to the too hasty assimilation of the new to the old, are surprising. The following were disclosed in Stanley

[1] Page 24.
[2] *Cf.* Stanley Hall, *Aspects of Child Life and Education*, p. 46.
[3] Page 25.

Hall's investigations.[1] Butterflies make butter; butter is also said to come from buttercups; grasshoppers give grass; kittens grow on the pussy-willow; all honey is from honeysuckles; and even a poplin dress is made of poplar-trees. The knowledge of this tendency on the part of the child is important pedagogically; and in it there is an advantage as well as a disadvantage. The advantage lies in the fact that when he has to introduce new conceptions and meanings of words it is easy for the teacher to connect them with what is already known; but there is the disadvantage that the new may be interpreted too much after the analogy of the old, and be inadequately analysed and comprehended. This leads to superficiality, to hasty and inadequate perception, and to the substitution of the easy for the more difficult. Hence the maxim—always connect the unknown with the known—may be dangerous. The principle of Apperception has, it would appear, the defects of its qualities.

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[1] Pages 24–27.

CHAPTER VII

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (*Continued*)

MEMORY

EVERY presentation experienced by a subject affects permanently in some way or other his mental life. It is not usually retained in all its entirety with the fulness and vividness of direct perception. What abides is comparable rather to the effect produced on the organism by our first attempt at performing some action in a game of skill; an image of the whole movement is seldom retained, all that is preserved is a tendency which facilitates the repetition of the action. Indeed, had psychology originally regarded the acquisition of a dexterity instead of the acquirement of knowledge, the development of the subject would not have been impeded by doctrines founded on mere hypostatisations. What is ordinarily retained, then, of a perceptual experience is a "disposition" which facilitates the recognition of a similar experience when it occurs—the same experience never recurs, the time factor alone constituting each experience a unique one. The term "disposition" adopted from the correlated physiological process is to be understood as connoting our ignorance of the factors and processes involved in retention rather than as explaining what takes place; the parallelism between bodily and mental processes is here purely hypothetical.

The early dispositions which are produced by the repeated presentations of an experience, at first only facilitate the apprehension of like experiences; later they make recognition possible, and as a last stage recall is possible. That recognition and the ability to recall are different stages of retention is evident from the fact that on their reappearance we can recognise many facts and faces of which we could not, if required, furnish an adequate description.

Such dispositions are not retained in consciousness unaltered. Just as in our perceptual experience the given is assimilated by the prepercept, so there exists a form of memorial assimilation modifying, in some cases erroneously, the retained factor by our already existent experiences.

In special cases the whole experience may be retained comparatively faithfully and be capable of being so reproduced; a scene once witnessed can on occasion be recalled with a fair degree of fidelity. The older psychology regarded only such cases, ignoring the more usual modifications which are preserved, and consequently ended in mental atomism. Thoeoretically, indeed, as is illustrated in the case referred to by Coleridge,[1] or from the experiences recorded by De Quincey [2] we must assume that every experience is capable of being retained, although only in abnormal cases can it be reproduced: practically, however, we cannot ignore obliviscence and the fact that much learning is necessary before reproduction or recall is possible. A very special case occurs when under emotional excitement we unite all the concomitant circumstances of an unpleasant experience so intimately that the one part cannot be reproduced without arousing the others, and consequently we seek to suppress the whole; such a whole is termed an emotional "complex," and figures largely in the doctrine of psycho-analysis and in the writings of Freud and his school.

The two forms of retention where only a disposition of the experience is preserved and where the whole experience can with a certain fidelity be reproduced correspond with the two forms of memory distinguished by Bergson,[3] and designated by him the "habit" memory and the "pure" memory. "There are," according to Bergson,[4] "two memories which are profoundly distinct: the one, fixed in the organism, is nothing else but the complete set of intelligently constructed

[1] *Biographia Literaria*, Everyman edition, pp. 58–60.

[2] *Confessions of an English Opium-Eater:* part iii., "The Pains of Opium" (Collected Writings, vol. iii. p. 441).

[3] *Matter and Memory.*

[4] English trans., p. 195.

mechanisms which ensure the appropriate reply to the various possible demands. This memory enables us to adapt ourselves to the present situation; through it the actions to which we are subject prolong themselves into reactions that are sometimes accomplished, sometimes merely nascent, but always more or less appropriate. Habit rather than memory, it acts our past experience but does not call up its image. The other is the true memory. Co-extensive with consciousness it retains and ranges alongside of each other all our states in the order in which they occur, leaving to each fact its place and consequently marking its date, truly moving in the past and not, like the first, in an ever-renewed present." His view he summarises in the sentence: "The past survives under two distinct forms: first, in motor mechanism, secondly in independent recollections." [1]

Of the former Bergson gives as illustration the learning of a lesson "by heart," and continues: [2] "The memory of the lesson, which is remembered in the sense of learnt by heart, has all the marks of a habit. Like a habit, it is acquired by the repetition of the same effort. Like a habit, it demands first a decomposition and then a recomposition of the whole action. Lastly, like every habitual bodily exercise, it is stored up in a mechanism which is set in motion as a whole by an initial impulse, in a closed system of automatic movements which succeed each other in the same order and, together, take the same length of time." The pure memory, he affirms, [3] "records, in the form of memory-images, all the events of our daily life as they occur in time; it neglects no detail; it leaves to each fact, to each gesture, its place and date. Regardless of utility or of practical application, it stores up the past by the mere necessity of its own nature." When in free association tests we require of the subjects accounts of the images reproduced on the mention of the stimulus words it is the pure memory, in Bergson's sense, that we are depending on, and the images which children recall on such occasions possess the space and time indices which, according to Bergson, characterise the pure memory. When we investigate the methods of learning or of memorising it is with the habit memory that we are dealing.

[1] *Ibid.*, p. 87. [2] *Ibid.*, pp. 89–90. [3] *Ibid.*, p. 92.

The two forms of memory are, for Bergson, fundamentally distinct; the habit memory or "the useful memory," as he calls it,[1] has an organic basis, and belongs to the sphere of matter: the pure memory enables us to abandon matter for spirit. Both, however, undoubtedly involve "retention"; the reinstatement of a past scene as well as the reproduction of intellectual work previously learnt imply that both have been retained. With the child, too, both memories are implicated in one another, and it is only late in his development that he comes to dissociate the process of learning from the incidents accompanying the learning and is able to recall the lesson without the latter adhering, that is, to dissociate the habit memory from the pure memory, and thus attain to imageless memorising.

In the past it was usual to base memory on imagery, just as thought was considered impossible without imagery, but according to Bergson's view the habit memory is imageless. Were memory dependent on imagery, there should be a positive correlation between amount of imagery and high standing in memory work, but experimental investigation fails to confirm this.[2] If Bergson's two forms of memory are independent, it may be necessary to reconsider the teaching processes and determine on which form of memory the latter are respectively dependent; the learning of tables, formulæ, etc., doubtless depends on the habit memory, and the recollection of a geographical feature once seen or of a historical incident once constructed in imagination belongs to the sphere of pure memory. It will also be further necessary to abandon the idea that the school subjects involving the habit memory can best be taught by evoking a special type of imagery.

Within the "habit" memory—to use Bergson's term—or the reproductive, as opposed to the recalling, memory we can distinguish:

(1) Temporary retention or immediate reproduction.

(2) Permanent or prolonged retention, or delayed reproduction.

By immediate memory is understood the direct or instantaneous reproduction of impressions which have not yet been

[1] *Matter and Memory*, p. 233.
[2] *British Journal of Psychology*, vol. vii. p. 484.

displaced in consciousness by other presentations, that is, there is no interval between impression and reproduction. If a sentence is read aloud to a pupil and he repeats or transcribes it immediately, then primary memory is at work; but if he is required to reproduce the sentence after an interval of an hour, or a day, prolonged retention or memory proper comes into operation. We are justified in regarding these two forms of memory as distinct, since they have entirely different courses of development, and individuals may be variously endowed with respect to them; persons good at memorising may have feeble powers of retention, and *vice versa*. Immediate retention appears to depend mainly upon concentration of attention, permanent retention upon the duration and repetition of impressions.[1]

We can also distinguish particular varieties of memory, termed special memories; for example, memories for objects, sounds, words of certain content, abstract terms, ideas, numbers, emotions, volitional acts, etc. These, again, we may regard as separate memories and not as one faculty operating in different forms, since they develop at different ages and are distinguishable as different traits in individuals, and since one may be destroyed or obliterated without affecting the others.[2]

These special memories are additional to the two divisions, immediate reproduction and prolonged retention, and may be considered both in respect to the manner of memorising and to the fidelity of their retentiveness. In the first place, then, we shall deal with the development of special memories, and thereafter proceed to consider the nature of immediate memory and of retention proper and the distinctions between them.

Investigations on the development of special memories were first undertaken by the Russian Netschajeff [3] on 687 St Petersburg scholars aged nine to eighteen; they were repeated by Lobsien [4] in Kiel on 426 scholars whose ages ranged from eight to fourteen. Netschajeff tested the pupils of six institutions of different types, but massed the results; Lobsien avoided

[1] *Cf.* Meumann, *The Psychology of Learning*, English trans., pp. 42–45.
[2] *Ibid.*, pp. 46–48.
[3] *Zeitschrift für Psychologie*, vol. xxiv.
[4] *Ibid.*, vol. xxvii.

this error by confining himself to the scholars of the elementary schools of Kiel.

The methods employed in testing the development of special memories are simple. Netschajeff first of all presented twelve different objects, such as are used in observation lessons—for example, handkerchief, pen-holder, book—which were shown to the children, each for two seconds, then they were covered and the pupils were required to write the names of the objects they remembered. This test determines the immediate memory for objects. Next, twelve sounds were produced with different instruments behind a screen—for example, clapping of hands, knocking, tearing silk cloth, stamping, whistling, etc.—and the children had to write from memory what they remembered of the sounds. Then, twelve numbers of two digits—for example, 27, 54, 76—were pronounced, and these, likewise, had to be transcribed. Thereafter groups of words, invariably trisyllabic, were presented. First, twelve trisyllabic words of preponderatingly visual content, that is, words denoting objects usually apprehended visually by a normal person—for example, pencil, calendar, scissors, bottle, etc.;[1] next, twelve words representing auditory presentations—for example, music, song; then twelve words denoting touch, temperature, and muscular experiences—for example, smooth, round, cold; then emotional terms, as care, joy, hope, sadness, were given; and lastly, twelve abstract conceptions like space, cause, quantity, quality. Lobsien reduced the number of words to nine, but did not restrict himself to trisyllabic terms. The objects were exposed for five seconds only, and the impressions were required to be written down in the order given. By confining himself to elementary school pupils he made his averages more reliable; his results are nevertheless in general agreement with those of Netschajeff.

The main results of these tests are as follows. It is evident that all types of special memory show periodic variations in their development, periods of rapid progress, of arrest, and of retrogression. The period between the ages of fourteen and fifteen is most unfavourable for all these memories, and, according to Lobsien's results, the greatest relative increase of immediate memory occurs between the tenth and twelfth years.

[1] The Russian equivalents were all trisyllabic.

Again, special memories develop at various rates with children, and differ with boys and girls. Young children from nine to fourteen years of age possess a surprisingly feeble memory for emotions, and this weakness lasts until the puberty stage. The development of the memory for abstract conceptions proceeds parallel with that for numbers, whereas the memories for objects and sounds are distinct from, and precede, those for words and numbers. The special memories may be arranged in the following order of development: with boys, the memory for objects is first developed, then words of visual content, words of auditory content, sounds, terms denoting tactual and motor experiences, numbers, abstract conceptions, and, lastly, emotional terms; with girls, the order is words of visual content, objects, sounds, numbers, abstract conceptions, words of auditory content, terms denoting tactual and motor experiences, and emotional terms.

In some respects the results of the various investigations are not quite in agreement. According to Netschajeff, it would appear that boys possess a stronger memory for objects directly perceptible, girls a stronger memory for numbers and words. According to Lobsien's results, girls are at all ages superior to boys in respect to all the special memories, with the exception of that for unintelligible terms. Meumann believes that boys are more disposed to think abstractly and girls to employ concrete imagery. The most striking difference between the memories of boys and girls appears between the ages of eleven and fourteen; during this period, the memory development of girls is, on the average, considerably superior to that of boys, but from fourteen onwards the boys approximate to, and then overtake, the girls.

With regard to accuracy in reproducing the order in which the presentations were given, Lobsien found that whereas girls are superior to boys in the memory for real things, boys are superior in all the other memories. In this connection the curve for girls shows a rapid rise at the age of thirteen to fourteen and a half.

Educationists should recognise the differences in development of the various forms of memory. It is noteworthy that the memory for numbers develops simultaneously with the memory for abstract conceptions, and both develop relatively late.[1] The difficulty which young children experience with arithmetic may be due to this late development of the memory for numbers ; and the feeble response of children to emotional effects, up to the puberty stage, should perhaps be taken into account in moral instruction and moral training.

Netschajeff in his investigation also found a connection between the memory development and the physical development of the child. He tested the lung capacity and the muscular power of 130 children, and proved that children superior in both physiological functions have also, on the average, better memories. Meumann [2] declares that we are justified in concluding that children of good physique are specially favoured for memory work.

The immediate memory of school children has been tested by Bolton in America, Binet and Henri in France, Schuyten in Holland, Winteler and Meumann in Switzerland and Germany, and by Jacobs, Winch, and Lewis in England. The methods were similar in all cases. Bolton read aloud to the children short lists of monosyllabic words, which they were required to transcribe immediately after hearing them ; in his tests numbers were also included. Binet used seven series of seven words each, and tested 380 school children aged eight to thirteen ; then sentences which had likewise to be written down were repeated. This method was followed generally by later experiments. Meumann introduced an improvement, investigating the maximum of immediate retention in a more systematic fashion by reading aloud to the children first three, then four, then five, and so on up to eight words, which had to be at once transcribed. This procedure is better adapted to the child ; for if as many as seven words are repeated to a child of eight, they may prove too many and lead to error. In Schuyten's tests at Antwerp, eight numbers of two digits were dictated. Jacobs [3] used nonsense syllables, letters, and single digit numbers. Winch [4] exposed to view sets of twelve consonants for twenty-five seconds, after which they were required

[1] *Cf.* The child's retentive power for number is greatest about the fifth or sixth year of his school life (*Journal of Educational Psychology*, vol. v. p. 420).

[2] *Vorlesungen*, vol. i. p. 429.

[3] *Mind*, xii., 1887, p. 75.

[4] *British Journal of Psychology*, vol. i. p. 128.

to be reproduced in writing. Lewis, for purposes of comparison, used both nonsense syllables and sense words.[1]

It was the introduction of "nonsense syllables" by Ebbinghaus [2] into the technique of memory experiment that provided the impetus to modern studies of memorising and retention. Such meaningless material, uniform in quality and capable of being manufactured to an unlimited extent and of being assembled in quantities of any desired length, afforded units which were comparable in difficulty, and thus removed the main objection to the conclusions derived from the usual memory material.

The results of the investigations on immediate reproduction are generally in agreement. The main conclusion is that the child's capacity for immediate retention, or his power of memorising, improves with age, but throughout the whole of school life it is much less than that of the adult. Further, this power develops only very slowly, and at thirteen or fourteen years of age—just when the elementary school child leaves school—it has not attained its maximum development. Comparative tests of children and adults, applied by Meumann, show that the development of the immediate memory is very slow up to thirteen years of age, from thirteen to sixteen there is a rapid advance, and at twenty-two or twenty-five years of age the educated person has attained the maximal power of memorising; after that, a slight retrogression sets in. Meumann found that the effect of practice was not so great with subjects from thirty to forty years of age as with students from twenty to twenty-five, and that at the age of forty he himself required for memorising a greater number of repetitions than the best students, although he had had more practice. The first noteworthy decrease of memory power has to be recorded after the age of fifty; the decrease with age comes about very slowly, and can to some extent be arrested by continuous training.

Lewis, setting out from the fact that children are at a decided disadvantage in comparison with adults in their power of

[1] *Report of Proceedings of L.C.C. Conference of Teachers*, 1910, p. 13 (King, London).

[2] *Memory*, English trans., chap. iii.; *cf.* Meumann, *The Psychology of Learning*, English trans., pp. 160–164.

memorising, believed that children might be compensated for their lower degree of intelligence by an increased endowment in respect of "brute" memory for unintelligible material. He accordingly prepared a series of memory material composed of fifteen monosyllabic sense words—for example, cut, new, ring, etc.—and a series of fifteen nonsense syllables. Each series was shown three times to the pupil, who was then required to reproduce as many items of the series as he could recollect. The results obtained demonstrate that, with pupils of different ages, namely, eight, ten, and twelve years, the marks obtained were very similar when learning sense words, but the average marks increased with the age of the pupils when learning nonsense material. There is, therefore, no mental compensation, and Lewis infers that the greatest importance should be attached to the clear and systematic apprehension of the form and meaning of the matter which has to be memorised. Much the greater part of the work of memorising, he continues, is effected by explaining carefully to the pupils the matter to be learnt and by cultivating habits of intelligent analysis and synthesis. Efficiency in memory work depends mostly upon the systematic apprehension and the rational comprehension of the significance of the matter. It is this aspect of memory which is capable of most development, and the teacher's efforts in this direction are bound to produce beneficial results. More time should be spent, especially in the lower classes, in the presentation of the matter, and less in mechanical repetition.[1]

The usual method of testing prolonged retention or deferred reproduction is to get the subject to memorise a series of nonsense syllables, and after a time to relearn them. Fewer repetitions are necessary to relearn the series, and the difference between this and the original number of repetitions gives a measure of retentiveness. The length of time allowed to elapse between the first and the second memorising must also be taken into account. As stated above, the school-child's capacity for memorising is considerably inferior to that of the adult ; with prolonged retention, however, the reverse is the case. Elementary school children retain what is learnt very much longer than the adult, or, in other words, obliviscence

[1] *Report of Proceedings of L.C.C. Conference of Teachers*, 1910, p. 15.

progresses more slowly with the school-child than with the adult.

Wessely [1] sought to determine by the following means how much of the memory material of the various school subjects remains and can be reckoned as a permanent possession. He required the pupils of a secondary school from ten to eleven up to fifteen to sixteen years of age to transcribe from memory a poem which they had learnt a year before, and thus obtained the amount retained. In a second test he required boys from nine to ten up to fifteen to sixteen years of age to learn eight Latin words. The effect of this learning was immediately tested, then again on the following day, then eight days after, and again after four weeks, by exhibiting the German equivalents and requiring the Latin words to be named.

The result of these investigations is that, according to the first test, the pupils' power of retention increased up to twelve or thirteen years of age; with the words it increased up to eleven or twelve, and from these ages retentiveness and accuracy of reproduction diminished. On one point there is a deviation in Wessely's result from those obtained by Meumann with elementary school children at Zurich. Wessely places the turning-point somewhat later than Meumann; but Meumann ascribes this to difference of training, and adds that the pupils tested by Wessely were not so well practised as the Zurich children, and that Wessely's material was not so well graded as his own. Springer,[2] testing pupils with numbers, concludes that retention is strongest in the eleventh or twelfth year of the life of the individual.

Since young children who become deaf before five years of age usually also lose their memory for sounds and their power of speech, retentiveness must be very feeble at this age. The curve for retentiveness, then, would rise from the early years up to some point within school life, probably about twelve years of age, when it would reach its maximum and then fall; whereas the curve for memorising only attains its maximum at about twenty-five years of age. The old adage, "Learn young, learn fair," is not justified as regards memorising, but,

[1] *Cf.* Meumann, *Vorlesungen*, vol. i. pp. 460–462.

[2] *Journal of Educational Psychology*, vol. v. p. 420.

in respect to retentiveness, the popular view that the child has a better memory than the adult holds to some extent. The pedagogical conclusion to be drawn from tests of retentiveness would be that formulæ, etc., which have to be continually employed and remembered throughout life, should be learnt at the most favourable age for retention.

With reference to the relation of Immediate to Prolonged Retention, Lewis, in the investigation already referred to, had both sense and nonsense material reproduced immediately after being memorised, then reproduced again on the following day after one additional repetition. The coefficients of correlation between the immediate and prolonged memory for the sense material were ·64, ·81, and ·76 respectively for the ages eight, ten, and twelve; and for the nonsense material the coefficients were ·78, ·75, and ·84 respectively. These results show that the pupils who memorised most on the first day were those who reproduced most on the second. The rapid learners are thus the rapid relearners. When, however, the rapid learner is called upon to reproduce freely without relearning he appears to be at a disadvantage as compared with the slow learner. The typically rapid learner, Meumann maintains,[1] is usually a rapid forgetter, and he instances a case of a rapid learner who was unable to reproduce a series of syllables two minutes after learning it. Some psychologists make allowance for this rapid forgetting by delaying reproduction for a time, up to two minutes after learning. In such circumstances the rapid learner would show poor immediate retention, and a high correlation between immediate reproduction and prolonged retention could then be affirmed. There are rapid learners who are able to retain well, and these clearly possess the most efficient type of memory.[2]

As regards the correlation of memory with general intelligence, there seems to be no unanimity of opinion. According to Bolton, memory development does not proceed parallel to development of intelligence, but is dependent on age. Meumann's investigations show that, generally, the more intelligent children are also endowed with the better memory.

[1] *The Psychology of Learning*, English trans., pp. 169–174.

[2] *Cf.* Pyle, *Journal of Educational Psychology*, vol. ii. pp. 311–321.

Ebbinghaus, however, using an auditory test, found that the scholars in the lower section of the classes were superior in memory to those more highly placed, thus giving an inverse correlation between memory and intelligence. Winch, on the other hand, employing a visual test, suggests that general intellectual proficiency is usually accompanied by good memory. Burt [1] used concrete words, abstract words, and nonsense syllables, and the pupils not only heard the words but also saw and spoke them. His conclusion is that immediate memory is correlated to a considerable, but not to a high, degree with intelligence. Meumann's claim that superiority of abstract memory to concrete memory is a strong mark of intelligence is not confirmed by Burt's results.

The contradictory nature of these conclusions indicates that this question demands further investigation whenever satisfactory methods for determining general intelligence have been devised. Since general intelligence is doubtless involved in the majority of memory tests—as Lewis's results go to prove—it may be that in attempting to estimate the degree of correlation we are merely working in a circle.

The substance or logical memory has not been so extensively investigated as the rote memory, although by reason of changed methods of teaching more and more is coming to be required of the former type of memory. The substance memory is tested by requiring the subjects to learn a passage and after a time to reproduce the passage, the ideas, not the exact words, being the basis of scoring. This method has been employed by Winch to test fatigue in evening schools, as a control test in a transfer of training investigation and in other ways,[2] but the substance or logical memory has not been much investigated on its own account. The most elaborate investigation is that of Henderson,[3] who tested over 200 subjects, ranging from pupils of ten years of age to adult students. If we distinguish, as in the case of rote memory, immediate reproduction from deferred reproduction,

[1] *British Journal of Psychology*, vol. iii. p. 143.

[2] *Ibid.*, vol. iii. pp. 386–405; *Journal of Educational Psychology*, vol. i. pp. 13–23, 83–100.

[3] Columbia University Thesis. See Whipple, *Manual*, part ii. pp. 205–221.

his results show that adults surpass children in the former but not in the latter. As also in the case of rote memory there is a positive correlation between learning capacity and retentive capacity, and the correlation between logical memory and general intelligence is in question. The subject of logical memory would doubtless repay further investigation.

Obliviscence or forgetting is a characteristic related to memory which is of considerable interest to teachers. It is usually regarded by them solely as a defect; but Ribot has termed it a condition of memory, and Adams has remarked that true learning is really judicious forgetting.[1]

Forgetting is usually regarded as a spontaneous process and explained by a vague reference to lapse of time, but this explanation would only be satisfactory were it always the unimportant facts that were forgotten. Forgetting is not, however, always judicious, as Adams would have it; the most essential facts and the most important engagements on occasion escape beyond the possibility of recall the memories of the best of us, and some other principle of explanation is demanded. The forgetting is in such cases, according to an interesting hypothesis of Freud, the outcome of a motive of displeasure.

Freud's view is expressed in the following passage:[2] "The principal conditions of the normal process of forgetting are unknown. . . . Our explanation deals only with those cases in which the forgetting arouses our astonishment, in so far as it infringes the rule that the unimportant is forgotten, while the important is guarded by memory. Analysis of these examples of forgetting which seem to demand a special explanation shows that the motive of forgetting is always an unwillingness to recall something which may evoke painful feelings." An instance from the present writer's own experience may illustrate the principle. Immediately following a family bereavement the writer was residing for a few days in the neighbourhood of Edinburgh, and to reach the

[1] *Herbartian Psychology*, p. 146.

[2] *Psychopathology of Everyday Life*, English trans., pp. 330–331. *Cf.* symposium by Pear, Wolf, Mitchell, and Loveday on "The Rôle of Repression in Forgetting" (*British Journal of Psychology*, vol. vii. pp. 139–165).

city had to take the suburban train at a small station called Craigleith. He had arrived and left that station on several occasions during his stay, but one day reaching Princes Street station in the city and desirous of booking to Craigleith he found on approaching the ticket office that he was absolutely unable to recall his destination. Knowing that the names of the various stations on the suburban lines appeared on boards above the entrances to the Departure platforms he proceeded to the one from which the trains to Craigleith usually started, and on reading down the list of names recognised Craigleith. Such an unusual case of forgetting evidently demanded consideration, and by Freud and his school would probably be accounted for after this fashion. During the period when the incident occurred the writer was anxious to repress his experience of recent bereavement; the deceased relative had died of a certain illness, and this ailment had been discussed some time previously with a medical friend named Craig. The repression of the bereavement suppressed the ideas of the disease and all connected with it, including the name Craig, which, it will be noticed, forms part of the name of the station Craigleith; as a consequence the latter could not be recalled, as it would have aroused unpleasant memories. In like manner Freud explains such exceptional forgettings.

Not all forgetting can be explained on these grounds; for an explanation of the ordinary evanescence from consciousness of matter learned in a merely mechanical fashion, by the "useful" memory of Bergson, we must at present rest content with the somewhat unsatisfactory reference to the lapse of time.

The rate of such forgetting was investigated by Ebbinghaus in connection with his work on memory.[1] He employed the learning of series of meaningless syllables, and sought to determine how the process of forgetting would proceed when left merely to the influence of time. The effect was determined by the relearning of the series after about one-third of an hour, after one hour, after nine hours, one day, two days, six days, or thirty-one days. The average saving was as follows :—

[1] *Memory*, English trans., chap. viii.

Hours	$\frac{1}{3}$	1	8·8	24	48	6×24	31×24
Saving in per cent. of original time	58·2	44·2	35·8	33·7	27·8	25·4	21·1

From these figures it is evident that almost one-half was forgotten in the first hour after learning; after nine hours two-thirds was forgotten. The same ratio between the remembered and the forgotten obtained after twenty-four hours, after six days about one-fourth only was retained, and after a month fully one-fifth of the effect of the first learning persisted.

The difference between the third and the fourth values, that is, between the results of the nine hours' interval and that of the twenty-four hours, was regarded by Ebbinghaus as unsatisfactory. He dismisses the conjecture that the influence of night and sleep could account for the fact that there is practically no forgetting in the interval elapsing between the ninth and the twenty-fourth hour, and it did not occur to him to suspect the presence of another influence counteracting obliviscence. Had he experimented with children, he might have found that the twenty-four hour reading gave a higher figure than the nine hour, and been thereby led to discover the presence of such another factor.

This other factor was disclosed in Ballard's investigation, doubtless due to the fact that he employed children as subjects of experiment, and is by him termed reminiscence. He explains it thus: [1] "As obliviscence is a gradual process of deterioration in the capacity to revive past experiences, so is reminiscence a gradual process of improvement in that capacity."

The fact of reminiscence is not new, and was even recorded by Quintilian; he remarks: [2] "It is astonishing, and we cannot well account for it, how much the interval of a night strengthens memory; whether during this time the labour of memory is in a quiescent state, fatigue having been a hindrance to it; or whether it is ripened or digested; or whether its strongest part lies in reminiscence. However this matter may stand, it is certain that the ideas which did not

[1] *Obliviscence and Reminiscence*, p. 17.

[2] *Institutes*, book xii. chap. ii.

readily present themselves flow in spontaneously the next day ; so that the same might be said to strengthen memory, which usually is a cause of introducing forgetfulness."

Ballard has demonstrated quantitatively the influence of reminiscence. How he was led to investigate the question may be recounted in his own words :[1] "My attention was drawn to Reminiscence in this way. The children in a certain slum school [in London] were alleged to have very bad memories : it was said that they could learn but little, and what little they learnt they could not retain. I tested this statement by setting the top class of boys, whose average age was twelve years and ten months, to memorise Cowper's "Loss of the *Royal George*." They were allowed thirteen minutes, and at the end of that time the books were collected and the boys were asked to write out as many lines as they could remember. After setting aside and leaving out of account the boys who were in any way familiar with the poem, nineteen remained as subjects of the experiment. Only one boy was able to write out the whole of the thirty-six lines, and the average number of lines for the class was 27·6. After two days' interval I again tested the boys. They were asked to write out all they remembered then. Neither teacher nor scholars expected this second test, and no opportunity was given for revision. Much to the teacher's surprise, eight of the boys wrote out the whole poem correctly, and the average number of lines correct was 30·6—an increase of more than 10 per cent. over the previous number. Out of the nineteen boys, none had deteriorated and sixteen had improved."

The investigation was extended to pupils of different ages with different intercalations of time between the primary and the secondary reproductions, and different types of material were employed. The result was that improvement in recall is found to vary with the material memorised, but the most favourable interval is almost invariably two days. The improvement likewise varies with the age of the subject ; in the case of young children of from five to seven the degree of improvement is much higher than with older children ; whereas in the case of adults there seems to be no improvement at all. Reminiscence is consequently characteristic of

[1] *Obliviscence and Reminiscence*, p. 2.

undeveloped intelligence; as Ballard states: "reminiscent activity, so far as it relates to recently acquired material, varies unevenly with the extent of the subject's general mental equipment." [1]

An analysis of the material reproduced in the second test revealed the fact that where reminiscence was demonstrated, it was not due merely to the addition of lines not occurring in the primary reproduction of the poem, but that substitution was taking place, some lines being omitted, others added. The omitted lines may be regarded as representing the influence of obliviscence, the additional recovered lines the influence of reminiscence. Thus the percentage of reminiscence may be considerably in excess of the amount of improvement, and reminiscence may still be operative when there is an actual decrease in the amount of material reproduced. From a modified form of Ballard's summarised results for ballad poetry this can be shown:—

Days' Interval.	Improvement.	Obliviscence.	Reminiscence.
1	11·9	8·6	20·5
2	14·4	8·8	23·2
3	9·2	10·7	19·9
4	4·8	15·7	20·5
5	·4	20·7	21·1
6	−6·4	25·1	18·7

The general conclusions regarding the influence of age on the various aspects of memory have been summarised by Ballard as follows: [2]—

"Up to the age of fifteen or sixteen there is a steady improvement in the rate at which poetry can be learnt, but after that period there does not seem to be much change. The improvement in this respect is very marked at the approach of puberty. If the degree of reminiscence is calculated relatively, by taking the ratio which the number of recovered lines bears to the number of lines initially learnt,

[1] *Obliviscence and Reminiscence*, p. 43. [2] *Ibid.*, p. 31.

then it may be said to hold true generally that reminiscence consistently diminishes with increasing age. When, however, reminiscence is calculated absolutely by taking the actual number of lines recovered without reference to the number originally remembered, we find that the power of reminiscence improves up to the age of fifteen or sixteen, and afterwards gradually declines."

"We are incidentally furnished," he continues, "with certain norms which may prove valuable in estimating the powers of memory of a child of given age. If we use ballad poetry, and insist upon verbal perfection, we find that as a rule a child at six, twelve, and fifteen can at a quarter of an hour's sitting learn 4, 14, and 20 lines respectively. After two or three days the 4 will improve to 6, the 14 to 17, and the 20 to 22 or 23."

The relation between reminiscence and general ability is somewhat obscure, but Ballard concludes,[1] "Generally speaking, among children of the same age the more intelligent learn faster, retain better, and recover more than the less intelligent. The latter, however, show a higher percentage of recovery or reminiscence."

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[1] *Obliviscence and Reminiscence*, p. 81.

CHAPTER VIII

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (*Continued*)

MENTAL ASSOCIATION AND IMAGINATION

IN the older psychology all mental development was believed to result from the synthesising of psychical units—sensations, ideas, etc.—by the process of, and according to the principles or laws of, association. Now we regard the process of development as depending rather on the dissociation of factors originally implicated in one another and on the assignment to each of a special function. Thus the child only gradually differentiates the perceptual from the imaginative spheres, and frees the memorising and thinking processes from imagery.

Association is not, then, the only, or chief, mental function, and the principles of association have under analysis failed to justify themselves. The laws of association—similarity, contrast, contiguity, cause and effect—were first reduced to two, namely, similarity and contiguity, and later to one—contiguity or the "law of totality."[1] The long maintained prominence of the two laws of association—similarity and contiguity—is accounted for by Bergson as a consequence of their practical utility. "The interest of a living being" he says,[2] "lies in discovering in the present situation that which resembles a former situation, and then in placing alongside of that present situation what preceded and followed the previous one, in order to profit by past experience. Of all the associations which can be imagined, those of resemblance and contiguity are therefore at first the only associa-

[1] H. Höffding, *Psychology*, English trans., p. 159.
[2] *Matter and Memory*, English trans., p. 322.

tions that have a vital utility." Similarity and contiguity are accordingly not causes, but categories, of association.

The existence in the mind of "spontaneously emerging" ideas also confutes the old associationist doctrine. That ideas may arise in the mind whose origin cannot be explained by connection with previously existent ideas is not now questioned; although their nature is obscure, the existence of such non-associative conditions of reproduction negatives the assumption that association is the universal principle of mental life.

The course of association may also be determined by the present content or constellation of consciousness rather than by similarity or contiguity, and this fact was likewise ignored by the older psychology.

Instead of discussing the *a priori* laws of mental life, modern psychology seeks to investigate the actual conditions under which the association and reproduction of presentations take place, and to classify the results which it obtains. The importance of this for psychology and education is indicated by Münsterberg[1] in the passage in which he states: "To understand the interplay of ideas in all these activities, such as memory and expectation, knowledge and reasoning, imagining and creating, it becomes necessary to know something of the raw material in the pupil's mind. The association of ideas is in itself, accordingly, neither thinking, nor imagining, nor remembering, nor expecting. But the association of ideas furnishes the supply for all these purposive activities, and particular kinds of associations must favour or oppose these various performances." For this reason the subject of Mental Association claims attention, because it is through the application of tests fashioned on the lines of the association tests that the problem of the psychology of thinking has been most successfully attacked. Here we shall confine our review to investigations with children and to results having educational significance.

A frequent objection to the association tests in Experimental Psychology is that the response to a given stimulus word may be accidental, varying with the occasion, and consequently of no value as an index of the mental content

[1] *Psychology and the Teacher*, p. 151.

and endowment of the subject ; but every association is now regarded as psychically determined, and because of this even psychopathology employs free association tests for the diagnosis of serious mental disorders.

Association tests may be divided into the two main classes, "free" and "constrained" associations.[1] In free association tests a word is presented to the subject, and he may reply with any term he pleases, for example, "horse—cart." In constrained association tests the subject's choice of response is restricted to a definite class of terms. He may be asked to give the superordinate, that is, the class to which a certain thing belongs, for example, "apple—fruit"; or he may be required to state the cause, say, of the rainbow. The latter type of association approximates more closely to actual conditions of thinking, and will probably be more extensively employed in the future.

Association tests may be applied to subjects individually, or may be dictated to groups or classes. The former method allows the reaction times and the introspection of the subjects to be ascertained, if desired.

The first important work on Mental Association in school children was undertaken by Ziehen at Rein's Seminar School in Jena about 1898.[2] He applied individually to forty-five boys, from eight to fourteen years of age, free association tests, his object being to prepare an inventory of the mental images of each pupil and to determine the rate of association and the nature of the imagery aroused by the given stimulus words. The choice of stimulus words was arbitrary, and the boys were required to respond as quickly as possible.

Ziehen concludes from his results that the rate of association is quicker with the adult than with the child, and that the speed of association increases markedly year by year. He found no appreciable difference in rate between subsumed and generalised or superordinate associations. Verbal associations, implying merely an alteration in the form of the given

[1] "Uncontrolled" and "controlled" are alternative terms used, for example, by Whipple, *Manual of Mental and Physical Tests*, part ii. chap. ix.

[2] *Sammlung von Abhandlungen aus dem Gebiete der pädagogischen Psychologie und Physiologie*, vol. i. part vi. and vol. ii. part iv.

word or the return of a given word of similar sound to the stimulus, are said to be considerably quicker than associations in which the response is the name of an object; and the average association time is longer, the more accurately the mental image is spatially and temporally defined. Verbal associations, however, seldom occurred with children, and they generally took the form of word completion, for example, "market"—"market-place." Verbal association appears to increase with age, and is most frequent with adults: rhyme associations also occur more frequently with adults, and similarly associations of words commonly connected, for example, "hand—foot."

The characteristic of "perseveration," by which, psychologically, is understood the repetition, usually inappropriately, of a term previously used in the investigation, was observed by Ziehen; but although remarking that it decreases with age, he did not attach to it as much significance as later writers.

Meumann applied free association tests with over 800 children of the elementary schools of Zurich.[1] The tests were naturally "mass" experiments, the class teacher reading aloud lists of words and the pupils writing the first other word that occurred to them. In these mass tests the times could not be determined, but in the upper classes the whole investigation went appreciably quicker than in the lower classes; and with fourteen-year-old children frequently only half the time taken by the eight-year-old children was required.

From his results Meumann concludes that wealth of imagery and originality of reproduction, without, however, any departure of the subject from the type proper to his stage of development, are characteristics of intelligence. The former is displayed in change of categories—object-reproductions alternating with qualities and processes; the latter is shown in the response of a term like "fuel," instead of the usual reply "black," to the stimulus word "coal."

Associations which arouse object-images preponderate with young children, verbal changes with older pupils. When about the thirteenth or fourteenth year concrete imagery fails, the pupils take to reproducing the logical opposite, for

[1] "Intelligenzprüfungen an Kindern der Volkschule," *Zeitschrift für die experimentelle Pädagogik*, vol. i. pp. 86 *et seq.*

example, "hot—cold." This form of reproduction, especially the use of correlatives, is usual with the less intelligent children and is the quickest form of association with adults. Unintelligent children reproduce words frequently named together, and depend much on what has been learnt at school for the material as well as the form of reproduction. With younger children visual reproductions preponderate, and auditory are in comparison remarkably rare; with older children the images derived from the various spheres of sensation are more evenly distributed.

Meumann distinguishes three forms of "perseveration," viz. :—

(1) When a previous stimulus or reaction word repeats itself where inappropriate;

(2) When a certain form of expression keeps recurring;

(3) When a certain type of relation, for example, oppositional or adjectival, determines the reproduction.

The following examples from an investigation by the present writer[1] may illustrate the foregoing :—

(1) Basket—handle; Sword—handle; Door—handle; Cup—handle.

(2) An extreme case—that of a boy of seven and a half years of age who, owing to his helplessness in the face of abstract terms, gave in a series of ten the following: Disgrace—I am in disgrace; Greed—I am greedy; Sadness—I am in sadness; Danger—I am in danger; Deceit—I am full of deceit. Liberty—I am full of liberty; Honesty—I am full of honesty; Honour—I am full of honour; Beautiful—I am beautiful; Bravery—I am in bravery.

(3) Adjectival form: Hat—Black hat; Lamp—Brass lamp; Cherry—Red cherry; Hill—Green hill; Castle—Big castle; Boot—Black boot; Snow—White snow; Butter—Yellow butter; Board—Brown bread board.

Oppositional form: In a series of ten, another subject gave Gladness—Sadness; Honour—Dishonour; Honesty—Dishonest; Disgrace—Graceful; Sadness—Happiness; Greedy—Ungreedy.

This last example indicates the power of the type of relation over the nature of the reproduction. Such "persevera-

[1] *British Journal of Psychology*, vol. iii. p. 368.

tion" Meumann regards as a definite characteristic of low intelligence.

To these the writer has added a fourth type, which to distinguish it from "perseveration" he calls "persistence."[1] This term implies the repeated suggestion of the same image by different stimulus words; it denotes perseveration of content in imagery as distinguished from perseveration of form. The different types of perseveration provide a more trustworthy index of intelligence than "persistence."

Winteler has tested individually for reproductions, both free and constrained, eight boys about ten years of age.[2] The times were measured with a Hipp's chronoscope, but the introspective data obtained were practically valueless.

In "free" reproduction two pronounced types emerged. One class reacted to substantives with an attributive adjective, to adjectives with a complementary substantive; this constitutes the perceptual or describing class. The other responded to a substantive with another substantive standing in logical relation, to an adjective with a contrary adjective, to a verb with a contrary or a synonymous verb; and this constitutes the comparing or relating type. No relation was apparent between the type and the degree of intelligence. In consequence of the limited number of Winteler's subjects a reinvestigation of this classification might be desirable.

Winteler arranged his constrained associations under the following heads, to find (1) a superordinate concept for a given concept, (2) a subordinate concept, (3) a co-ordinate concept, and to give (4) an example or species of a genus, (5) an opposite. He concluded from the reaction times that of the three tests, to find a superordinate, a co-ordinate, or a subordinate concept, the first entails the greatest, and the last the least logical effort. The shorter reaction times occur with the more intelligent subjects, yet the rate of reproduction possesses only secondary value for estimating the grade of intelligence.

The present writer reinvestigated at Cambridge in 1909-

[1] *British Journal of Psychology*, vol. iii. pp. 365 *et seq.* *Cf.* Meumann, *Vorlesungen*, vol. i. p. 498. "Persistence" should be considered in connection with Imagery rather than with Association, but it is more convenient to mention it here.

[2] "Experimentelle Beiträge zu einer Begabungslehre," *Zeitschrift für die experimentelle Pädagogik*, vol. ii.

1910 the subject of mental association with twenty-two boys from seven and a half to fourteen and a half years of age.[1] Both free and constrained associations were used, and special attention was paid to the following points: the relation of the speed of reaction to the age of the subject; the effect of practice on the rate of reaction; the order of difficulty as indicated by the speed of reaction of the various processes; the relation, if any, of the nature of the responses to the standard of intelligence; the various forms and the degree of perseveration; the nature of the child's imagery, its relation to age and intelligence; and the part played by imagery in constrained association.

The reaction times were measured with a stop-watch, the subject being thus unaware that he was being timed. The usual instruction given in such tests has been to answer as quickly as possible; since, however, the introspective account was considered the more valuable aspect of this investigation, the pupils were instructed to take their own time but to give the first word that occurred to them or to indicate whenever an image was aroused in the mind. Two quite different forms of attunement, according to Meumann, who used it with adults, result from this difference in the form of instruction. When rapidity of response is the controlling factor, the stimulus word is, he declares, comprehended after the most fleeting fashion; the reproductions are of little value—rhymes, word changes, opposites, etc.; the times are shortened; the statements regarding the processes intervening between the apprehension of the stimulus and the response are incomplete; and often the subject knows nothing of how he arrived at the reproduction. With the other form of attunement, however, these characteristics are reversed. Meumann maintains, therefore, that for tests with a problem to be solved the instruction "as quick as possible" is detrimental. This difference in attunement may have educational significance; the best results may not be obtained from pupils highly attuned to rapid answering.[2]

The results of the present writer's investigation indicated

[1] "Experiments on Mental Association in Children" (*British Journal of Psychology*, vol. iii. pp. 349–385).

[2] *Cf.* Dewey, *How We Think*, p. 38.

that, for different children, the speed of association bears no direct relation to age, and has little value as an indication of the intelligence of the subject. The number of subjects tested was not, however, sufficient to make the average results significant, and subsequent investigation with larger numbers suggests that Ziehen's hypothesis, although inadequately supported by him, is valid. The individual differences in the rates of reaction disclosed were considerable. For example, the investigation began with three boys of the same age and intelligence. By timing them with the stop-watch it was found that one of the boys invariably took three times as long as the other two to respond to the stimulus words. He was quite as intelligent as his companions, and the work presented no difficulty, yet his normal rate of reaction was considerably slower. The suggestion has been made that modern language teaching might one day be tested by presenting terms in the foreign language and noting the reaction times taken by the subject to respond with the English equivalents; but in view of the individual differences now disclosed by experiment this proposal is not likely to be adopted.[1] Reaction times have also been proposed as a means of discovering whether a pupil has been implicated in some misdemeanour. When a subject's normal rate of response has been determined, a belated reaction may be interpreted as indicating mental confusion. In the investigation just referred to, one pupil, whose normal rate of response, judged by the median, was 3·4 seconds, took 13·8 seconds to respond to the word "Beauty." On cross-examination, however, he admitted, not without blushing and stammering, that he had first thought of one of the girls in his class and had not wished to say so.

[1] *Cf.* Cattell (quoted by James, *Principles of Psychology*, vol. i. p. 559), who writes: "The rate at which a person reads a foreign language is proportional to his familiarity with the language. For example, when reading as fast as possible the writer's rate was—English 138, French 167, German 250, Italian 327, Latin 434, and Greek 484; the figures giving the thousandths of a second taken to read each word. Experiments made on others strikingly confirm these results. The subject does not know that he is reading the foreign language more slowly than his own; this explains why foreigners seem to talk so fast. This simple method of determining a person's familiarity with a language might be used in school examinations."

The most important fact revealed by a study of reaction times is that the rate is slower with the child than with the adult; in some cases, it has been asserted, the child takes almost ten times as long as the adult to respond to the same stimulus. From this we may infer that the rate of questioning in schools is probably too rapid and, as the writer has elsewhere suggested,[1] the determination of the *tempo* of questioning, for different ages and classes of children, would accordingly be a useful contribution to Experimental Education.[2]

The order of difficulty of the various processes, judged by the rate of reaction, seems to be as follows: whole—part (for example, chair—leg) being easiest; then part—whole (for example, leg—table); co-ordination, knife—fork; free concrete associations, dog— ; superordination, dog—animal; subordination, animal—horse; free abstract associations, honesty— ; and, most difficult of all, causal relations.

Meumann[3] has concluded, from his examination of the mental content of children entering school, that what excites pain appears to be better known than what excites pleasure; but, judged by the rates of reaction to the respective classes of terms, no principle has so far been established.

Analysis of the responses of pupils demonstrates that in finding the superordinate to a given concept the more intelligent children give the genus immediately above the given concept, for example, violet—flower; whereas the less intelligent give a genus more remote, say, violet—plant. This is doubtless due to the fact that with the former the system of knowledge is better articulated. This characteristic might, like "perseveration," be used to determine the general intelligence of pupils.

Experiments on mental association usually afford opportunities for detecting the presence of imagery and examining

[1] "Experimental Education" (*Journal of Education*, December, 1910).

[2] *Cf.* "We speak of him [the child] as 'impatient' simply because we are not patient enough to allow his actions to follow laws of time differing from our own" (*The Montessori Method*, p. 359). Also Dewey, *How We Think*, p. 38.

[3] *Vorlesungen*, vol. i. p. 359.

its nature and functions. In his investigation of mental association Ziehen sought to determine the imagery in the pupils' minds accompanying the association processes. He states, regarding the nature of the child's imagery, that he was prepared for a preponderance of individual images, but the extent to which this occurred astonished both himself and all to whom he communicated his results. He consequently concluded that the mental imagery of the child differs *toto coelo* from that of the adult.

By adopting the new form of attunement referred to above, and by leaving the subject free to indicate when an image was aroused in the mind, not requiring him to respond necessarily with a word, the present writer was able to determine somewhat fully the nature of the child's imagery accompanying association processes, both "free" and "constrained."

Sometimes it is asserted that young children cannot introspect; but when once it is explained to pupils of school age what is expected of them they usually experience no difficulty in giving introspective detail. For example, a boy of seven and a half years of age stated that when the word "cruelty" was given, he seemed to see two fellow-pupils who had "got a good scolding from the teacher" on the previous day; "they seemed to be in school with red faces," he said. In the case of silver—gold, he stated that he thought of the song—

> "I'll give you silver
> And I'll give you gold."

The variety of detail in the imagery of children is quite astonishing. A stimulus word may arouse not only visual imagery but auditory, tactual, etc.; and the majority of images have definite spatial and temporal localisation. So vivid, indeed, may be the imagery in some instances that whatever is in the field of perception against which the image is projected is obliterated. The child's imagery has in a high degree the characteristics of direct perception, and it is doubtless for this reason that the child readily confuses the two spheres, which for the adult are quite distinct. This has led Ziehen to affirm that, in respect to imagery, the mental association of the child differs entirely from that of the adult.

Meumann has, however, found amongst adults (chiefly students) a certain percentage with whom abstract terms were always accompanied by a surprisingly lively concrete content. He maintains that this concrete content has with the adult quite another significance than with the child; for whereas it often forms the only content of the words for the child, for the adult it serves only as a connecting link and reinforcement of the logical relations which constitute the essential content of the word.

We are, indeed, inclined to believe that the feature distinguishing the imagery of the child from that of the adult is the relevance or the irrelevance of the imagery. Bradley [1] gives the following instances of irrelevant imagery: "Should we be asked, Are roses red? Has coal-gas a foul smell? Is that white beast a horse? Is it true that he is dead?—we should answer, "Yes." But the redness present in consciousness may have been that of a lobster, the smell that of castor-oil, the imaged horse may have been a black horse, and death, perhaps, a withered flower." This might be so with adults, but in the present writer's investigation, when 110 tests were made with each of twenty-two boys, in no case could the imagery be described as irrelevant.

The more intelligent the child the fewer abstract reproductions does he return, and Meumann does not consider it a good augury that a child's imagery should approximate prematurely to the adult type. The greater the pupil's stock of imagery, and the longer he employs it, the better and sharper, he says,[2] will be his later concepts. From this, however, we cannot assume that there is a positive correlation between amount of imagery and intellectual ability, for children who are best endowed in the various forms of imagery do not necessarily stand higher in the class than those with only one form.[3] Betts,[4] from his study of mental imagery with college students, also concludes that there seems to be an entire absence of correlation between ability in imagery and ability in college studies.

[1] *Principles of Logic*, p. 9. Quoted by Stout, *Analytic Psychology*, vol. i. p. 50.

[2] *Vorlesungen*, vol. i. p. 500.

[3] *British Journal of Psychology*, vol. iii. p. 385.

[4] Betts, *The Distribution and Functions of Mental Imagery*, p. 48.

The first main classification of images is into concrete and verbal; and it may be said in this connection that the child's imagery is mainly concrete and the adult's mainly verbal; only about two per cent. of the imagery of pupils of school age is verbal.

The visual is undoubtedly the preferred type in respect to concrete imagery, the auditory coming next, but the auditory images are only about 20 per cent. of the visual.[1] Olfactory, gustatory, tactual, and other forms of imagery are disclosed by the child's introspection, but these are infrequent.

It is not infrequently maintained that, as we have general ideas, we must consequently have some form of imagery corresponding thereto, usually termed "generic" imagery. That we have power to construct images answering to various requirements is certain, and it seems as if a pupil of limited experience may have compensation in the form of special ability for constructing imagery, but we do not seem to be capable of constructing images answering to general ideas. Galton, in his *Inquiries into the Human Faculty*, gives, in illustration of these "generalised mental images," a case where a speaker says:[2] "The boat was a four-oared racing boat; it was passing quickly to the left just in front of me, and the men were bending forward to take a fresh stroke." "Now at this point," he says, "the listener ought to have a picture well before his eyes. It ought to have the distinctness of a real four-oar going to the left, at the moment when many of its details still remain unheeded, such as the dresses of the men and their individual features. It would be the generic image of a four-oar formed by the combination into a single picture of the great many sight memories of those boats." Nothing resembling a "composite" image corresponding to a general idea is to be found in children's thinking nor, we believe, in adults' thinking. In some cases the images are very vague, but unless mere vague-

[1] *British Journal of Psychology*, vol. iii. p. 376. *Cf.* S. S. Colvin and E. J. Myers, "The Development of Imagination in School Children" (*Psychological Review*, Monograph Supplement, vol. xi. p. 123): "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."

[2] Everyman Edition, p. 77.

ness is held to constitute generality, it may almost be said that with school children no generic imagery exists.

An interesting phenomenon emerged in the present writer's investigation of the imagery of children, and was termed self-projection.[1] R. L. Stevenson describes it in the following passage referring to the imagery in children's thinking.

" Rummaging in the dusty pigeon-holes of memory," he writes,[2] " I came once upon a graphic version of the famous Psalm, 'The Lord is my Shepherd,' and from the places employed in its illustration, which are all in the immediate neighbourhood of a house then occupied by my father, I am able to date it before the seventh year of my age, although it was probably earlier in fact. The 'pastures green' were represented by a certain suburban stubble field, where I had once walked with my nurse, under an autumnal sunset, on the banks of the Water of Leith ; the place is long ago built up ; no pastures new, no stubble fields ; only a maze of little streets and smoking chimneys and shrill children. Here in the fleecy person of a sheep, I seemed to myself to follow something unseen, unrealised, and yet benignant ; and close by the sheep in which I was incarnated—as if for greater security—rustled the skirts of my nurse. 'Death's dark vale' was a certain archway in the Warriston Cemetery ; a formidable yet beloved spot, for children love to be afraid—in measure as they love all experience of vitality. Here I beheld myself some paces (*seeing myself, I mean, from behind*) utterly alone in that uncanny passage ; on the one side of me a rude, knobby shepherd's staff, such as cheers the heart of a cockney tourist, on the other a rod like a billiard cue, appeared to accompany my progress ; the staff sturdily upright, the billiard cue inclined confidentially, like one whispering, towards my ear."

This reflexive attitude—the seeing oneself from behind, as Stevenson describes it—is surprisingly common in the imagery of school children. With some pupils it occurs in almost every image, and it appeared in a pupil as young as seven years of age.

On this feature Freud remarks : [3] " This circumstance must

[1] *British Journal of Psychology*, vol. iii. p. 379.
[2] *Essays of Travel : Random Memories.*
[3] *Psychopathology of Everyday Life*, p. 64.

excite our wonder, for adults do not see their own persons in their recollections of later experiences. It is, moreover, against our experiences to assume that the child's attention during his experiences is centred on himself rather than exclusively on outside impressions. Various sources force us to assume that the so-called earliest childhood recollections are not true memory traces but later elaborations of the same." Meumann instances such self-projection as the counterpart for later childhood of the young child's tendency to falsify by imagination his perceptual and remembered experiences.[1]

A study of children's imagery will help to chasten the teacher's opinion as to the importance of the school in education. Life, we are often told, is the best school, and wisdom keeps school outdoors; and while one may be reluctant to enter an apology for idlers, it cannot but be admitted that the investigation of children's imagery, to which reference has already been made, proved that practically all the imagery with which children ordinarily do their thinking has been acquired elsewhere than at school. In fact, the real season of education seems to be during the holidays. All the school does is to organise and systematise those outdoor experiences.

Although it is now generally accepted that thinking is possible without imagery, imagery may play a part in the appreciation and interpretation of certain forms of literature. The conclusions so far arrived at on this point are as follows:[2] (1) In literature where the meaning is contained in the imagery, or where the imagery plays a large part in the thought of the matter in hand, strong imagery is often of great value and may be used in the interpretation of the matter. Sometimes, however, it may actually hinder the understanding of the literature, and its rejection by the pupil may be absolutely necessary if he is to grasp the meaning. (2) In literature where the imagery is not essential, but merely enriches or develops the thought, strong imagery is often a positive hindrance to interpretation. In dealing with such literature the teacher should therefore not exert himself to develop the imagery of the piece by explanation or emphasis, until after the interpretation has

[1] *Vorlesungen*, vol. i. p. 518.

[2] E. A. Peers, "Imagery in Imaginative Literature" (*Journal of Experimental Pedagogy*, vol. ii. pp. 174–187, 261–280).

been completed by his pupils. (3) There is no reason to suppose that, other things being equal, a piece of literature containing many pictures is necessarily easier or harder for a boy to grasp than a passage entirely devoid of pictures.

The course of imagery forms the basis of the child's imaginative activity. By dissociating the images from the given material of perception and forming from them new combinations, the child acquires the first mental possession which, along with recollection, is his very own. His imaginative activity animates his play, personifies all the objects and processes, and transfigures all actions and individuals in his environment; but it likewise enters into his recollections and affects his testimony, occasioning what are termed "children's lies."

When we seek to define imagination and explain its function in education we find that we are on debatable ground. One of the chief requirements of education, according to many writers, is to cultivate the pupil's imagination, the usual means suggested being the recitation of fairy tales. Such writers condemn the Montessori system, for example, because of its alleged failure in this respect; but Dr Montessori defends her method on the ground that the proofs of imagination in the child to which these writers point are not proofs of imagination but evidences of unsatisfied desire, and she explains that the poor child uses a walking-stick as a horse because he has not a pony to ride. The function of the imagination is to act as a substitute for, and to masquerade as, the real, according to the Montessori view,[1] and it cannot accordingly be our wish to develop in the child the illusive imagination founded on credulity.

Before we can judge of the educational aspect of the question, we must first decide what the true nature of imagination is. Dr Montessori regards it as a substitute for real experiences, just as Freud regards dreams as the disguised fulfilment of repressed wishes. Imagination, however, appears to be a special type of mental activity, just as play is a special type of physical activity and not a substitute for work; in fact in the metaphor, "the play of imagination," there may be a clue to the function of imagination.

[1] "The Imagination in Childhood" (*Times Educational Supplement*, November 2, 1915).

McDougall in his consideration of play [1] instances the case of young dogs playfully fighting together. "One seizes the the other by the throat and pins him to the ground, and so forth; but all this is done in such a way as not to hurt his opponent; the teeth are never driven home, and no blood is drawn. That they do no hurt to one another is by no means due to lack of muscular power or of sharp teeth; nor is there any lack of energy in the movements in general; in merely chasing one another the utmost exertions are made. This peculiar modification of the combative movements seems to be an essential character of the playful fighting of many young animals, and boys are no exception to the rule." It cannot be explained on the ground that the young dog has learned self-restraint: we must suppose, since the movements he makes are in other respects like those of real combat, that the instinct of which they are the expression is a peculiarly modified form of the combative instinct.

The mental attitude of the young dog in play must be quite different from that in real fighting, so is the little girl's likely to be different in playing with her doll than when playing with a baby. The doll in this case is not a substitute for the baby, and the kind of life the young girl attributes to the doll must be conceived by her as different from the kind of life of which she believes the baby to be possessed, just as the puppy's act of biting in play is different from that of biting in actual combat.

If imagination is a special line of mental activity, then Dr Montessori's view is wrong, but it does not follow that those who propose to cultivate the child's imagination by means of fairy tales are right.

The imaginative activity of the young child plays a similar rôle to æsthetic enjoyment in the adult,[2] and the view that imaginative activity is a substitute for real activity is paralleled in æsthetics by the view that æsthetic enjoyment is conscious self-deception, and that a work of art gives us the illusion of reality.[3] A work of art is, however, a form of reality, an "equivalent" of reality,

[1] *Social Psychology*, pp. 110–115.

[2] Meumann, *Vorlesungen*, vol. i. pp. 519–520.

[3] Meumann, *Einführung in die Ästhetik der Gegenwart*, pp. 78–79.

to use Meumann's term, and not a mere illusion of reality, just as imaginative activity is not a mere substitute for real activity.

By imaginative activity we may accordingly understand that play of our reproduced presentations which, on the one hand, does not directly subserve the recall and recognition of objects, and, on the other hand, does not possess the character of logical thinking; it has freed itself from its connection with original perceptual experiences and become a spontaneous and independent activity. Its characteristics are that the imaginative content interests us for its own sake and acquires a certain independence; the images likewise tend to become dissociated from the order in which they were originally acquired and to form new combinations. It differs from thinking in that in imagination images constitute the content; in thinking, meanings are primary, the imagery, when not irrelevant, serving merely to reinforce and sustain logical connections. Ideas of relation are not, however, always absent in imaginative activity, otherwise it would be absurd to advocate "the scientific use of the imagination." In such a use of the imagination images form the content, ideas of relation the form, and the product is an imaginative, not a conceptual, construction.

Various forms of imaginative activity can be distinguished. Imagination may be passive and unsystematic, or, to employ the term used in connection with association, "uncontrolled." We speak in this sense of giving "free rein to our imagination"; our activity has no definite aim. What happens is that one image suggests a second, and this a third, and one cannot foretell what the end will be. Hobbes cites an example of divergent association which illustrates well this wayward nature of imagination.

"For in a discourse of our present civil war, what could seem more impertinent than to ask, as one did, what is the value of a Roman penny. Yet the coherence to me," he says, "was manifest enough. For the thought of the war introduced the thought of the delivering up of the king to his enemies; the thought of that thought brought in the thought of the delivering up of Christ; and that again the thought of the thirty pence, which was the price of that treason, and thence easily followed that malicious question, and all this in a moment of time, for thought is quick."[1]

Here we see the inconsequent nature of uncontrolled imagination, and the same waywardness is evident in all reverie and day-dreaming. Those who oppose the cultivation of the imagination by means of fairy tales[2] do so on the ground that they only stimulate the child's tendency to employ this form of uncontrolled imagination and foster lack of concentration. What is required to accord with the child's general mental development is the curbing of this form of imagination and the utilisation of the imaginative activity to subserve definite purposes. Hence we are led to the active, systematic, or controlled form of imagination.

In controlled imagination the activity is regulated by definite aims and directed to ends which hold the attention and determine the selection of images. It is such imaginative activity that the artist employs in framing a composition, the novelist in constructing his plot, or the inventor in creating a new device. It is this type of imagination that education should cultivate, and, as is evident, it demands that the pupil should have a definite aim or end to realise.

The uncontrolled and controlled types of imagination are distinguished by Dewey as the imaginary and the imaginative, and he states:[3] "The imaginative is not necessarily the imaginary; that is, the unreal. The proper function of imagination is vision of realities that cannot be exhibited under existing conditions of sense-perception. Clear insight into the remote, the absent, the obscure is its aim."

In addition to the uncontrolled and controlled forms of imagination we can distinguish further the concrete or perceptual and the abstract types of imagination. Imagination may also be lively, working with clear and distinct images,

[1] Hobbes's terminology is wrong in referring to the process involved as thought.

[2] The writer objects to the grounds on which the teaching of fairy tales is defended, not to the teaching itself. For fairy tales are part of the literary heritage of the race, and as such ought to be known, and the early years of school life may be the best time for teaching them, for then the conflict between the imaginative sequences in the tales and the causal order of the natural world will not be so acute as later on.

[3] *How We Think*, p. 224.

or hazy and dull, working with indistinct imagery; merely reproductive or constructive; and the constructive imagination may be highly productive or poor and unfruitful. These oppositions are not necessarily exclusive, and the distinctions, being partly conditioned by the process in which they appear, and expressing themselves at different stages in the individual's development, are only relative. Imagination can also, according to the sphere in which it works, be characterised as practical, ethical, æsthetical, or religious.

The child's imaginative activity has the following characteristics, which are the more pronounced the younger the pupils are. It is more uncontrolled and roving than controlled and systematic, more concrete than abstract, more subjective, uncritical, and fantastic than controlled by critical judgment. For this last reason it appears to be lively and productive; this productivity is not, however, due to wealth of imagery and power of original combination, but, like many of the child's other seeming advantages, it is really a defect, arising out of the undeveloped state of his inhibitive powers, his inability to criticise, and estimate the value of, his own imaginative constructions, and his failure to subordinate these to observation and recollection. The imaginative activity of the child is further mainly reproductive and imitative; his personification of the objective world, and the incidents which he represents with wooden blocks and figures, are reproductions of actions of adults and situations which he has observed.

The child's disposition to endow all objects of his environment with imaginary qualities is likewise maintained to be a special characteristic of the child's imaginative activity. Children personify their playthings, prefer to live in an imaginary world, and so vivacious are their animistic tendencies that they project imaginary attributes into houses and landscapes, even into things beyond their experience, heaven and hell and the social and religious circle of ideas. Analysis of such imaginative content has shown that it is very deficient in respect to the variety and fulness of the images employed, and that it works with mere analogies derived from a very limited stock of experiences. These analogies are applied in the most liberal fashion, subject to no check by critical judgment, to fill out the gaps in observation, recollection, or in actual experience. This is very evident in the religious experience of children: they construct with the greatest *naïveté* religious conceptions out of their own circle of ideas. After death, for example, people are said to be drawn up with ropes or to climb a high hill to get into heaven.[1]

Although his imagination is not active in the sense of being creative, the child has nevertheless a strong impulse to employ his imagination. It appears in this respect to be an expression of that general compelling force which leads the child to be active, and which is evident from the manner in which he employs his leisure time in play.

The child's imagination is not, in Meumann's opinion,[2] merely imaginative; even in his play the personifying tendency of imagination creates new situations and assumes new forms. Imitation serves but as the stimulus to induce originality. Herein lies the educational significance of imagination. It forms the sphere in which the child's self-activity, the joy of discovery and the capacity for invention, can first be aroused and exercised, and thus serves as a field for awakening in the child ideas of self-dependence.

Any training of the imagination should thus afford opportunities to the child for self-activity. A frequent complaint against present-day instruction is its passive character, and the cultivation of the imagination by the recitation of fairy tales is an example of this, whereas the child's imagination leads directly to activity. As R. L. Stevenson says:[3] "We grown people can tell ourselves a story, give and take strokes till the bucklers ring, ride far and fast, marry, fall, and die; all the while sitting quietly by the fire or lying prone in bed. This is exactly what a child cannot do, or does not do, at least when he can find anything else. He works all with lay figures, and stage properties. When his story comes to the fighting, he must rise, get something by way of a sword and have a set-to with a piece of furniture, until he is out of breath. When he comes to ride with the king's pardon, he must bestride a chair, which he will so hurry and belabour and on which he will so furiously demean himself, that the messenger will arrive, if not bloody with spurring, at least

[1] *Cf.* Stanley Hall, *Aspects of Child Life and Education*, p. 34.
[2] *Vorlesungen*, vol. i. pp. 529–530.
[3] *Child's Play.*

fiery red with haste. If his romance involves an accident upon a cliff, he must clamber in person about the chest of drawers and fall bodily upon the carpet, before his imagination is satisfied."

"And then the child, mind you, acts his parts. He does not merely repeat them to himself; he leaps, he runs, and sets the blood agog over all his body. And so his play breathes him; and he no sooner assumes a passion than he gives it vent."

The fact that the child naturally expresses in action his imaginative conceptions, and that his imaginative world has not the intimate and secret character of that of the adult, removes an objection frequently urged against allowing children to exercise their imagination.

The danger of imagination lies nevertheless in the facility with which the child can employ it; it tends to become a substitute for, and to subordinate to itself, perception, recollection, and judgment. There results the natural confusion of the imaginary with the actual, and the consequent so-called "children's lies." These should be treated as practical difficulties, not as ethical misdemeanours, and the child should be brought to see that the distinction between the true and the false is a serious affair in practical life.

Education should consequently seek to secure that imagination is based on adequate analysis of objects of perception, and that it is subordinated, through training in attention and judgment, to perception and recall, both in observation and in testimony.

There are various methods of investigating imagination experimentally. In addition to the reproduction method, described above, investigations of testimony may be used, and, with young children, interpretation of schematic and of incomplete drawings, gradually increasing in difficulty. All forms of combination or completion tests will be found serviceable where the pupil is required to fill in words elided from a text; to form sentences embodying given words; or to complete stories, parts only of which have been related. When further investigations have been carried out by these means more definite conclusions on the development of the child's imagination will be possible.

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CHAPTER IX

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (*Continued*)

THINKING, REASONING, AND SPEECH

THINKING

THINKING or thought must be distinguished both from perception and from imagination. In perception we accept the given as real or actual: there is in perception this element of judgment. The judgment is implicit and unquestioned. If we doubted whether the experience was real we could not apply the term perceptual to it. It is not in the sense that it might equally well be judged as unreal that we judge the perceptual experience to be ıeal. There is in perception no problem, no alternative. Thinking as distinguished from perception admits of alternatives; if there was no possibility of error, of selecting a wrong alternative, there would be no need to think. It is this greater freedom of choice of means to attain a certain end that raises man's behaviour above that of the animals which is mainly determined by impulse and instinct, and leads to the definition of man as "the thinking animal."

Thinking, as we have stated, is not bound to the actual like perception. It admits a choice amongst alternative causes, a freedom of selection of means. Its freedom is not, however, like the freedom of uncontrolled imagination, a freedom of caprice. It is a controlled activity, determined by some end which it has selected or some problem which has been set it. The freedom of thought is thus not an unlimited freedom; it is a freedom within a system, a choice amongst a predetermined set of alternatives.[1]

Agreeing with controlled imagination in having an end or aim, thinking differs from this form of imaginative activity in two respects: Whereas images form the content of imagination, meanings form the content of thinking, imagery if present being usually irrelevant. Thinking likewise differs from imagination in regard to the end or aim to which the activity is directed. Its end must ultimately be consistent with the real or the actual, whereas the end of imaginative activity need not be so. Thinking is thus not bound so directly to actuality as perception, and again has not the unlimited choice of ends permitted to imagination. It is effective because it possesses a freedom denied to perception and is controlled by an end which is not selected capriciously or arbitrarily and which consequently turns it into channels which will lead to a profitable issue.

The child's thinking, we have already suggested, is accompanied by a greater preponderance of, and is more dependent on, concrete imagery than the adult's. As a consequence of this the child is more likely to lose sight of the end of his activity and to follow the course of his imagery, whereas the looser connection between the imagery and the thinking, or the irrelevancy of the imagery when present, removes the like temptation from the adult. The adult's thinking will be more effective than that of the child, as it is thus not so likely to be led astray. It is in the difference of emphasis on the respective factors—the imagery and the end or purpose—that the difference in the thinking of the child and of the adult doubtless lies.

It is only within recent years that the psychology of thinking has been made the subject of investigation even with adults, and for our knowledge of the thinking of the child of school-age we are still almost exclusively indebted to researches undertaken for other purposes than the direct investigation of thinking, mainly to tests on controlled association and on general intelligence.

The tests which have been productive in results from which

[1] *Cf.* Dewey, *How We Think*, p. 12: "The problem fixes the end of thought, and the end controls the process of thinking."

inferences can be drawn as to the development of the child's thinking include the controlled association test, which requires a pupil to name the class to which a certain thing belongs, because the arrangement of concepts according to their degree of generality is one of the fundamental logical activities of the child. With younger children to whom the ordinary instruction would be unintelligible, examples of what is expected may be given and further examples are then required. Association tests which demand co-ordinates to the terms given, opposites or causes, have likewise value in this respect, as also those in which analogies have to be completed, thus "Paris : France : : London : —— ?" The evidence derived from the application of such tests indicates that the rate of thinking increases with age, and that the more developed the child is intellectually the better articulated is his system of knowledge and the more exact are his replies. Thus in naming the class to which an object belongs the older or more highly endowed pupils state a proximate genus, whereas the others reply with some indefinite class term, for example, "thing." The ability to state satisfactorily the cause of an event, although correlating highly with general intelligence, is found to be little developed even in gifted children before the age of ten or eleven.

A test of intelligence which is of value for the psychology of thinking is that which requires the definitions of terms. In the Binet scale, a child of the mental age of six in defining concrete terms like fork, table, etc., is expected to mention the use of the objects. At the mental age of nine definitions superior to use are required.[1] A more exact analysis of definitions given in the application of the Binet scale to Scottish children has disclosed six types: [2] (1) the purely functional definition, for example, "a chair is for sitting on," the predominating type of definition given by children under six years; (2) in addition to a statement of function, a distinct recognition of the objective nature of things is implied, their

[1] *Cf.*, however, W. Boyd, "Definitions in Early Childhood" (*Child-Study*, vol. vii. pp. 66–70).

[2] Agnes L. Rogers and J. L. McIntyre, "The Measurement of Intelligence in Children by the Binet-Simon Scale" (*British Journal of Psychology*, vol. vii. pp. 288–292).

"meaning," however, still remaining subjective in character, for example, "a table is where you put dishes on when you go to take your dinner"; (3) pure description, a purely objective attitude towards things being adopted, for example, "a chair is just a board with a back and four legs"; (4) also descriptive but displaying marked advance in complexity, for example, a school is defined as "a big place with classes in it"; (5) classification is achieved but no specification is added, thus, a school is defined as "a building," a chair as "a bit of wood"; (6) definition proper, for example, a fork is "an instrument which has a handle with three prongs or four for taking your meat with, along with a knife." Only at age eleven was this kind of response relatively frequent in the case of the Scottish children tested.

Pohlmann obtained children's definitions of words belonging to ten different groups, namely :—

1. Concrete objects, for example, calendar, picture, sun.
2. Perceptual qualities excluding touch : white, loud, sweet.
3. Touch qualities : blunt, round, smooth, cold.
4. Tools and instruments : hammer, thermometer.
5. Materials : iron, silk, wood.
6. Natural science concepts : bird, fish, fruit.
7. Relationships : mother, aunt, cousin.
8. Social and ethical concepts : family, state, justice.
9. Religious concepts : prayer, sin, God, heaven, resurrection.
10. Compound concepts : writing-table, electric-bell.

To these, Meumann suggests,[1] should be added :

11. Activities and events : walking, spending.
12. Æsthetic concepts : beautiful, ugly, comic.

Classifying the answers according to their value, Pohlmann divided the development of the ability to define into the following stages : (1) mere statement of an example ; (2) use or purpose or characteristic activity ; (3) analytic description ; (4) superordinate class, together with a specific character-

[1] *Vorlesungen*, vol. ii. p. 431.

istic or a logical relation; (5) proximate higher class with specific difference and statement of logical relations of the characteristics; (6) genetic definitions.

Reasoning

Among the experimental tests of higher mental processes which Burt [1] applied in the diagnosis of general intelligence, he employed syllogisms, some valid, others fallacious, and required the children to indicate those which they regarded as valid and those which they believed to be invalid. As an example we may instance:

> One of the children in the class must get the prize. I am one of the children in the class. Therefore, I must get the prize.

Such tests are regarded by Burt as having significance in determining degree of general intelligence, but their application on a more extended scale is necessary before they can be of much assistance in elucidating the development of the child's logical power of inference.

Winch [2] has likewise devised reasoning tests which he regards as suitable for children between eight and fourteen years of age, and can be answered by them collectively. Six equal sets have been arranged, and it has been found that the improvement due to practice is negligible. Arithmetical problems were excluded mainly because ability in solving these is too much influenced by school training. As examples of the tests we may quote:—

1. Harry is heavier than John, and John is heavier than William. Is Harry heavier than William, or lighter than William, or the same weight, or can't you tell? You must give the reasons for your answer.

2. Some of the boys who go to West Street School wear blue caps. If you were to meet a boy in the street who goes

[1] C. Burt, "Experimental Tests of Higher Mental Processes and their Relation to General Intelligence" (*Journal of Experimental Pedagogy*, vol. i. pp. 93–112).

[2] W. H. Winch, "Some New Reasoning Tests suitable for the Mental Examination of School Children" (*British Journal of Psychology*, vol. vii. pp. 190–225).

to that school, would you expect that he would have a blue cap, or would you expect that he would not have a blue cap, or can't you tell ? You must say why you think so.

3. A toy-shop is on the left-hand side of a baker's shop, and a butcher's shop is on the left-hand side of the toy-shop. Is the butcher's shop on the left-hand side of the baker's shop, or on the right hand of the baker's shop, or can't you tell ? You must give reasons for your answers.

4. James had half as many marbles as Tom, and Jack had half as many as Tom. Did James have more marbles than Jack, or less than Jack, or the same number as Jack, or can't you tell ? You must say why.

5. Less than half the boys in a class had all their sums right, and less than half had no mistakes in dictation. Do you think there were any boys in the class who had all their sums right and also no mistakes in dictation, or do you not, or can't you tell ? You must say why you think so.

The tests of Winch contain too large a number of four-termed syllogisms, or three-termed syllogisms with copulas differing from the orthodox type, that is, of the form :

$$\begin{aligned} &B > C \\ &A > B. \\ \therefore\ &A > C. \end{aligned}$$

These are difficult to reduce to the ordinary syllogistic moods, and while the conclusion is evident enough in most cases, the reasons for the conclusion are not easy to formulate, as each such syllogism depends for its validity on a special axiom. To test the reasoning ability of children the number of such arguments should be restricted, the conclusion alone, not the reasons for it, required, and new tests of a more truly inductive nature should be added.

To the subject of the reasoning abilities of children Bonser[1] has devoted a special investigation. The tests were designed to determine (1) mathematical judgment, (2) controlled association, (3) selective judgment, and (4) that complex of analytic and synthetic thinking used in the intellectual interpretation of literature.

[1] F. G. Bonser, *The Reasoning Ability of Children of the Fourth, Fifth, and Sixth School Grades.*

The tests on mathematical judgment comprised two-step problems of the usual arithmetical text-book order, for example, "A pint of water weighs a pound. What will a gallon weigh?" "What number added to 16 gives a number 4 less than 27?" The controlled association tests included the completion of sentences; for example, "A—— is one who plays a musical instrument"; the deletion of the wrong word in sentences like "Days are longer shorter in summer than in winter"; and giving opposites to such terms as day, tall, east, etc. In the selective judgment test the subject was required to select the correct reason in cases like the following: Why oak wood is better than pine for making furniture?

> Oak wood is harder than pine.
> Oak trees have acorns, pine trees do not.
> Oak wood takes a finer polish than pine.
> Oak trees are easier to climb than pine trees.

Selection of good definitions, for example, of island:

> A piece of land out in the water.
> A small body of land.
> A body of land entirely surrounded by water.
> Cuba is an island.
> A portion of land rising above the surrounding level.

The test on literary interpretation required paraphrases of two given poetical stanzas.

The number of children tested by Bonser was 757, 385 boys and 372 girls, belonging to grades IV., V., VI. of certain public schools in New Jersey. The results indicate that in mathematical judgment progress is shown from grade to grade, boys increasing from 14·50 in Grade IVA. to 28 in VIA., girls from 11·36 in IVA. to 25·92 in VIA. By the controlled association tests similar progress from grade to grade is revealed, the gain being, however, less than in the mathematical tests, and the boys being generally superior in the one test, the girls in the other. Very marked progress from grade to grade is evident in the results of the selective judgment tests; in the lower grades the boys are the better, in the higher grades the girls. In the paraphrasing of poetical stanzas the girls are, however, superior to the boys in every grade, and the sex difference is greater above twelve years than below that age. Both boys and girls show decided improvement from grade to grade.

In general, it may be said that whereas the boys are superior to the girls in mathematical judgment, the girls are superior in literary interpretation. Bonser concludes that in the progressive development shown in median ability through the grades tested, and in the high group correlations among these tests, it is evident that they are valid measures of several phases of that complex capacity we call reasoning ability.[1]

Further analysis of the thought and reasoning processes will be required, and tests suitable for the exact estimation of the various aspects will have to be devised, before we possess anything like a satisfactory account of this aspect of the child's intellectual development.

Speech Development

Although thought is prior to, and possible without, language, its progress is largely dependent on the existence of general terms, and its highest flights are only possible by embodying its abstractions in words. The progressive use of higher forms of language thus becomes an index of the stage of development of the individual's thought. The mastery of language, both in respect to extent and exactness of use, is also in large measure dependent on general intelligence, and has been employed as a measure of the latter.

The development of the child's speech has been extensively investigated, the methods employed being almost exclusively restricted to the statistical and the observational, as the most interesting stage of the child's speech development lies in the earliest years of childhood when the child cannot be subjected to experiment; the reproduction methods already described might nevertheless be employed in the solution of many of the problems of the child's speech development.

The extent of the child's vocabulary at various periods of early childhood and its analysis according to the various parts

[1] F. G. Bonser, *The Reasoning Ability of Children of the Fourth, Fifth, and Sixth School Grades*, p. 90.

of speech employed may be gathered from the following tabulated summary of some recent studies:[1]—

Name of Investigator.	Bateman.	Boyd.	Bateman.	Drever.	Drummond.	Drever.	Bateman.	Boyd.	Drever.	Drever.
Age of child in months	12	21–24	28	28	31	34	36	36	43	54
Percentage of—										
Nouns	50	49·4	50·62	49·8	50·3	54·3	54·7	43·7	54·5	59·1
Verbs	20	20·8	23·46	23·2	20·8	21·3	22·2	20·9	19·6	16·9
Adjectives	20	13·5	11·60	12·8	10·6	12·8	10·16	16·2	12·4	11·9
Pronouns	..	2·9	7·65	3·2	3·3	3·3	2·84	2·9	3·4	1·9
Adverbs	..	7	2·96	4·9	8·5		7·05	9·8	4·7	3·2
Prepositions	..	·2	1·24	2·3	2·5		1·76	2·8	1·9	1·6
Conjunctions	..	·1	0	·6	·27	6·2	·27	2·1	1	·9
Interjections	10	·2	2·47	..	..		1·63	·5	..	..
Unclassified	..	·1	..	2	·96		..	1·8	1·2	1
Total number of words in vocabulary	10	658	405	345	726	694	738	965	824	1712

The influences determining the range of the vocabulary are the child's general mental development, his interests, and the nature of his environment. The extent of this last factor may be inferred from the results of an early investigation carried out in three typical schools in Glasgow with the view of ascertaining the actual vocabulary of an average child at five years of age. This brought out the fact that the *English* vocabulary of a slum child of five did not extend beyond some two or

[1] W. G. Bateman, "A Child's Progress in Speech, with Detailed Vocabularies" (*Journal of Educational Psychology*, vol. v. pp. 307–320); "Two Children's Progress in Speech" (*Journal of Educational Psychology*, vol. vi. pp. 475–493). The reader is referred to these articles for fuller references on the subject.

W. Boyd, "The Beginnings of Syntactical Speech" (*Child-Study*, vol. vi. pp. 21–24, 47–51); J. Drever, "A Study of Children's Vocabularies" (*Journal of Experimental Pedagogy*, vol. iii. pp. 34–43, 96–103, 182–188); Margaret Drummond, "Notes on Speech Development" (*Child-Study*, vol. ix. pp. 83–86, 95–99).

three dozen words; on the other hand, it was found that an average child of five from a middle-class home had command of, or understood, not less than a thousand English words, while bright children carried the number up to one thousand five hundred or even two thousand.[1]

Against the usual practice in the collection of children's vocabularies of recording in isolated fashion the words used by the child Boyd has protested, maintaining that this procedure does not afford us much insight into the child mind, nor does it enlighten us much in regard to the course of development of the child's linguistic powers. "In such collections," he says,[2] "rare words and common stand on a level of undistinguished equality, and all the significant distinctions of sentence structure and idiom have totally disappeared. We might as well seek for real insight into the genius of a people in the dictionaries of its language as hope to get any intimate view of the first workings of mind in the alphabetically arranged list of a child's words." Boyd himself accordingly adopted the method, previously employed by C. and W. Stern,[3] of recording the sentences used by the child; 1236 sentences were reported at the end of the second year, and 1200 in the last fortnight of the third year. The average number of words in the sentences at the former age was 3·3 as compared with 6·5 words at three years of age. For the brevity at the earlier age there are, he states,[4] several causes: "the rarity of connecting words and of qualifying phrases, the absence of co-ordinate and subordinate clauses, the frequency of elliptical constructions." A more extended application of this method would enable us to trace the stages in the evolution of the child's use of grammatical forms and be of value in throwing light on the teaching of composition.

For pedagogical purposes such studies of the child's early speech development as those mentioned have not the same significance as studies of the child's speech development during school life would have, but unfortunately the later

[1] J. C. Smith, *Report of the Committee of Council on Education in Scotland*, 1905–1906, p. 287.
[2] *Child-Study*, vol. vi. p. 22.
[3] *Die Kindersprache.*
[4] *Child-Study*, vol. vi. p. 22.

school period has not been very fully investigated, because as a rule it is only the earlier stage that has interest for the psychologist. Some children even before entrance to school have developed a command of sentence structure and formation, but this in some cases may not be attained till six or seven years of age. The correct use of the various forms of subordinate clauses and the appreciation of style usually fall within the school life, and the latter may even continue to develop in later life ; a nicer appreciation of the effects of style appears to accompany the beginnings of adolescence. Improvement in the style of the pupil's own composition is largely dependent on the extent of, and the command which he has over, his vocabulary, and in this respect can be influenced by the teacher's methods.

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CHAPTER X

THE ÆSTHETIC AND ETHICAL DEVELOPMENT OF THE CHILD

EMOTIONAL AND ÆSTHETIC DEVELOPMENT

THE emotional and volitional aspects of the child's mental development have, in comparison with the intellectual, until recently been largely neglected by both analytical and experimental psychology, and the experimental methods have not to any considerable extent been applied to children. This neglect has been attributed by McDougall [1] to the reliance of psychology on the method of introspection. "The psychologists, endeavouring to define their science and to mark it off from other sciences, were led to accept a too narrow view of its scope and methods and applications. They were content for the most part to define it as a science of consciousness, and to regard introspection as its only method; for the introspective analysis and description of conscious states was a part of the proper work of psychology that had not been undertaken by any other of the sciences. The insistence upon introspection as the one method of the science tended to prolong the predominance of this narrow and paralysing view of the scope of the science; for the life of emotion and the play of motives is the part of our mental life which offers the least advantageous field for introspective observation and description. The cognitive or intellectual processes, on the other hand, present a rich and varied content of consciousness which lends itself well to introspective discrimination, analysis, and description; in comparison with it the emotional and conative consciousness has but little

[1] *Social Psychology*, pp. 6–7.

variety of content, and that little is extremely obscure and elusive of introspection."

The methods by which the life of feeling is investigated are various, the chief being the "impression" or "stimulus" method and the "expression" method. In addition to these may be mentioned the "statistical" method and the method of interrogation.

The "stimulus" methods attempt to determine in what manner, and to what extent, feelings are dependent upon the quantity, quality, or combinations of sensory stimuli: stimuli of like quality, but of different intensities, are allowed to act upon the individual, and the effect of the resultant feeling is noted, or investigations are made of the emotional reactions to sensations of different quality, or the æsthetic effects of certain combinations of stimuli are estimated, for example, of lines divided in various proportions, or of lines of different form, serrated or sinuous, or of colours.

The "expression" methods study the bodily changes, the so-called expression movements which arouse, accompany, or result from, certain affective conditions or from æsthetic experiences.[1] The expression movements fall into two classes: (1) the real expression movements including the facial expressions, the movements of mimicry, and the changes in bodily posture, the pantomimical movements; (2) the so-called expression movements, or rather physiological changes, including variations in the character and rate of the pulse beat, in respiration, in volume of the limbs, in energy and rate of movement, in the secretion of the glands, and in the size of the pupils of the eyes.

The "statistical" methods collect, usually according to a *questionnaire* which gives direction to the collection, cases of the expressions of the child's feelings, for example, of the expressions of sympathy, of cruelty, etc., and from the frequency of such cases attempt to draw conclusions as to the feelings which are dominant in the various years of life and as to the first appearance of the various emotions. The method of interrogation encourages the child for the

[1] For a full account of these methods with excellent illustrations see Schulze's *Experimental Psychology and Pedagogy*, trans. by R. Pintner, chap. iv.

same purposes to express himself in regard to his affective life.

An indirect means of investigating the emotional and volitional development of the child is to be found in the child's "judgments of worth" or judgments of value, æsthetic and ethical, as distinguished from his logical judgments. In so far as children can appreciate and pass such judgments—for instance, beautiful and ugly, good and bad—it is evident that their æsthetic and ethical senses are awakened; and their testimonies as to such values are of great importance as indications of general development and, in particular, of the development of feeling and will.

So far we know but little of the child's affective moods, emotions, and sentiments. From various observations all that we have learned is that the younger the child the more volatile and vacillating is his emotional life. Emotional states are also easily suggested to children; as with feeble-minded persons, both old and young, various moods can be readily induced or inhibited in children.

Of the special forms of feeling, the æsthetic have been investigated most. Letters, figures, various forms of writing, etc., have been presented to children, who have been required to judge which examples they preferred. Meumann[1] has also tested children from seven to fourteen years of age with the usual æsthetic tests, requiring the pupils to arrange a series of colours in order of preference, and also to judge of their combinations in pairs; the pupils were likewise required to give judgment on divisions of lines, and on triangles and quadrilaterals with sides variously proportioned. These tests showed that, generally, the colour and dimension judgments were very definite, whereas with the younger pupils the divisions of lines were often a matter of indifference. The favoured colours were blue, red, and yellow; adults, however, seldom preferred yellow. The colour combinations were generally given after the same fashion as with adults, those lying nearest the contrast colours being the most pleasing. The difference in the æsthetic sense of the sexes was generally confirmed; girls showed more appreciation for colours, boys for form.

[1] *Vorlesungen*, vol. i. p. 591.

A mass method, not without objection perhaps, but one which has the merit of simplicity and has produced interesting results, has been employed by Winch[1]: he sought to determine which of the simple colours were preferred by school children; whether the preferred colours changed as the children advanced in age and intellectual proficiency; and what was the effect on colour preference of sex, social status, and colour work done in school. The following words were written on the blackboard: White, Black, Red, Green, Blue, Yellow; and the children were required to write on a slip of paper the name of the colour which they liked best or considered the prettiest, thereafter the next colour they would choose, and so on.

Taking first the results from girls' schools alone, we find that blue in all cases takes the first place, black invariably the last. Red usually comes second, but in a school of very high type it fell to third place and with adult women to fourth place. Yellow generally takes third place at the outset of school life, but drops to fifth place with advancing age, at a rate apparently dependent on the mental proficiency and social status of the pupils. Green usually takes the penultimate place to begin with, but rises steadily as the pupils advance in culture; in a school of high social status it was a pronounced feature in all standards, but it rose very little, if at all, in a school situated in a poor neighbourhood. With adult women green easily takes second place. Winch accordingly suggests that a preference for green may probably be a characteristic of fairly high mentality. White, in the case of girls, usually oscillates between the third and fourth positions.

With boys, as with girls, blue is normally the first choice, but red competes more keenly for the place of honour, and in some cases even takes first position. Black is always at the bottom, and white next to it—which is a lower position than with girls. Yellow begins with the second or third place and consistently falls to the fourth, whereas green, after rising throughout with advancing age and mental proficiency, attains premier place with male adults.

From his investigation Winch concludes that colour pre-

[1] *British Journal of Psychology*, vol. iii. pp. 42–65.

ferences show regular changes in definite directions as children advance in age and mental proficiency; that there are some differences of a constant nature between male and female preferences; that there is evidence of the development of preference depending on social status; that there is no evidence of colour preference being influenced by colour work in schools; and that colour preference appears to be a function of general mental proficiency rather than of age. It is also suggested that the preferences indicated should be taken into account when constructing school appliances for the various classes.

Bullough [1] has sought to determine whether differences of æsthetic effect can be explained by differences in the perception of single colours, and the application of his method to school children might be profitable. His investigation enables him to classify his subjects into four perceptive types:—

1. A group which represents the *objective* aspect, describing colours as thin, poor, hard, warm, soft, etc., these terms having reference to the nature of the colours themselves and not to the effects produced on the subjects.

2. A group which represents features producing certain effects on the subject, such as stimulating, soothing, energetic—an aspect which might be termed the *physiological*.

3. The third group represents the suggestive power of colour or its *associative* aspect; for example, a colour might suggest a sunset, a railway signal, or a medicine, and be liked or disliked accordingly.

4. The fourth type represents the very subtle and divergent features of "temperament" or "character"—the *character* aspect. By the "character" or "temperament" of a colour is meant the appearance in a colour, or the expression by a colour, of what in a human being would be called his character, mood, or temperament. Extreme examples occurred when an orange colour was described by a subject of this type as "trying to be what it isn't"; and a blue-purple was described by another such subject as "a person with a past." Judgments on pictures, it has been maintained,[2]

[1] *British Journal of Psychology*, vol. ii. pp. 406–63.

[2] C. W. Valentine, *Experimental Psychology of Beauty*, chap. vii.

disclose similar "types" to those which, as just described, exist in the case of colours.

The school child's æsthetic appreciation of pictures has been extensively investigated. The pedagogical significance of these investigations lies in the fact that they warn us of the danger of assuming that the school pupils' interpretation is the same as that of the adults, or that the pictures which please the adult can also be regarded as suitable for the child.

At Meumann's suggestion, Albien at Königsberg submitted to a number of boys, aged seven to eighteen, two pictures for their æsthetic judgment, one representing an emotional scene, the other a mere realistic incident. The pupils were required to state in writing which they considered the more beautiful, and why. It was discovered that the number preferring the emotional picture increased with advancing age; at the same time Albien found that the judgments of the pupils were rarely passed on the formal elements of the artistic representation, but almost always on the content, just as with adults æsthetically untrained an extraordinary wealth of æsthetic predicates was displayed in the pupils' judgments, but these were applied to the subjects of the pictures and were not employed to describe their artistic merits.

Forty-seven Würzburg school pupils representing the best and the least intelligent of each class were investigated by Friedrich Schmidt.[1] Two pictures were shown, and the pupils were required to express themselves freely on each picture. Only one very intelligent boy of the highest class mentioned anything about the artist and his work: "It must have been an artist who did it," he said of one of the pictures. With the exception of some empathetic [2] judgments passed

[1] *Zeitschrift für die experimentelle Pädagogik*, vol. vii. (1908).

[2] "Empathy is a term which has come to be employed in psychology and æsthetics to designate the general tendency to project oneself into situations in which one is interested, and to experience such sensations as would result from one's active participation in such situations. For instance, when we observe or even imagine a feat of strength, our bodies become set and our muscles become tense; when we see a slender column which supports a heavy capitol, we experience an empathetic feeling of the heavy stress which is borne by the column" (Meumann, *The Psychology of Learning*, English trans., p. 205, note).

by the older and more intelligent pupils, not a single real æsthetic judgment was given.

The development of the æsthetic judgment has been more exactly investigated by F. Müller.[1] He found that the younger the child the more were pictures regarded from the non-æsthetic standpoint. With young children it was the object represented that was judged, no attention being paid to the idea of the artist, to the technique, to the kind of treatment or the means employed, colours, drawing, composition, etc. Only gradually do references to these appear. Of the media the colours are the most easily understood and valued; more difficult are the spatial elements, and still more so the unity of the work of art and the relation of the various parts to this. Relatively late are the first evidences of the adoption of the standpoint of the artist, his ideas, his skill; these appear only in details, as in mention of a colour, or a light-effect. Very gradually arises the judgment from this point of view of the picture as a whole.

Dehning[2] has sought to determine the influence on the child's susceptibility to æsthetic effects of training in the viewing and judging of pictures. The general results were that only after ten years of age could the child be successfully influenced in this way. At thirteen years of age the first evidences of the spontaneous appreciation of a work of art as a whole manifest themselves, and from sixteen years of age onwards such appreciation can be generally secured through instruction. From ten years of age onwards artistically valueless pictures are quite satisfactorily discriminated from valuable pictures, and from thirteen years of age great accuracy is displayed in such discrimination. When artistic understanding of pictures is once developed, it is retained from ten years of age onwards; under ten years of age the effect of colour at most possesses validity, in other respects children judge pictures purely by their content. The pedagogical consequences can readily be inferred from such results.

By inquiring of children as to the feelings aroused by decorative objects, such as a cupboard, chair, etc., Meumann has

[1] *Aesthetisches und ausseraesthetisches Urteilen des Kindes.* *Cf.* Meumann, *Vorlesungen*, vol. i. pp. 597–598.

[2] *Erziehbarkeit d. aesthetischen Urteils.*

determined that real æsthetic judgment cannot, for a considerable time, be expected of children. He frequently found that children of the first school year ignored the æsthetic form or the decorative aspects and regarded objects according to their utility or conspicuous features. Whereas in the young child of school age æsthetic appreciation of works of art and of decoration is not developed, the elementary æsthetic relations—colours, tone combinations, simple melodies, strongly defined contours and forms of objects—are the objects of his æsthetic apprehension.

Dierks has also demonstrated that his pupils paid practically no heed to placards and wall texts until their attention was directed to them; and we may from this conclude that children cannot be expected to develop æsthetic appreciation without training. The same fact is indicated by the results of an experiment by Professor O'Shea in the schools of Dakota. The pupils were required to draw decorative objects, and it was found that the youngest children omitted all decorative detail and drew only the utensil as such; of the eight-year-old children, about 50 per cent. endeavoured to include the ornamental, and of the sixteen-year-old pupils about 87 per cent. reproduced the ornamental.

From the experiments of Schulze,[1] who photographed the facial expressions and the gestures of children in the presence of pictures, nothing unfortunately can be inferred as to the æsthetic judgment of the child. These experiments only indicate that children allow themselves to be influenced by the content of the picture, not that their feelings are aroused by the artistic elements of the representation; for children, a picture is not an æsthetic experience but a mere object.

The preferences which children of various ages show for melody and rhythm have been investigated by Lichtenberger. The results indicate that the difference in the emotional effects of melodies and rhythms is not so marked with children from six to eight years of age as with nine-year-old children; at nine a definite discrimination for both factors of the emotional effect of music appears, and continuous rhythm seems to have more emotional value than melody. It is

[1] *Cf.* Schulze's *Experimental Psychology and Pedagogy*, English trans., chap. iv.

also interesting to note from these investigations that with children the memory for rhythms has been proved to be stronger than the memory for tones.

The child's æsthetic appreciation of musical intervals has been investigated by Valentine with the following results.[1] Among the children in the primary schools no appreciable preference for concords before discords is discernible before the average age of nine, at which age a considerable advance takes place. A group of children of the age of twelve or thirteen gives an order of preference for the twelve intervals within the octave, which is remarkably like that given by adults. Preparatory school girls show an aversion to discords (except to the minor eleventh) even at the ages of seven and eight, and about the age of nine they give, on the average, an order of preferences for the twelve intervals very similar to that given by adults. Thus, by the age of nine, they reach a stage of development only attained by the primary school children at the age of twelve or thirteen.

It has been suggested [2] that in their attitude to tones or combinations of tones individuals can likewise be classified into types somewhat analogous to those affirmed by Bullough to exist in the case of colours.

An interesting research might result from instituting a comparison of the child's judgments on, and appreciation of, songs with his judgments on pictures as described above.

Volitional and Ethical Development

The ethical endowment of the child must be sought in instincts and impulses which are common to man and to the animals. The affective aspects of the psychic process which is the concomitant of instinctive action constitute, according to McDougall's view,[3] the primary emotions,[4] and out of the

[1] C. W. Valentine, "The Æsthetic Appreciation of Musical Intervals among School Children" (*British Journal of Psychology*, vol. vi. pp. 190–216).

[2] *British Journal of Psychology*, vol. vii. pp. 71–74.

[3] *Social Psychology*.

[4] In regard to what emotions are to be considered as "primary" Shand disagrees with McDougall. See the former's *The Foundations of Character*, p. 27; for relation of instinct to emotion, see p. 188.

latter by their fusion or blending in various ways the complex emotions are constituted. In addition to the instincts which play a part in the genesis of the emotions and to others with which there is no emotional correlate, there are general non-specific innate tendencies which are of importance for the social and ethical life of man. These include suggestion, imitation, and a primitive sympathy, together with the tendency to play, habit, and temperament. Temperament which, according to McDougall,[1] "is the source of many of the most striking mental differences between individuals and peoples," is the resultant of many relatively independent factors, such as the differences exerted on the nervous system by the functioning of the bodily organs, native differences of excitability, of rapidity of response and transmission of nervous impulse, and differences in respect to fatiguability and rapidity of recuperation. We cannot consequently distinguish, as did the older psychology, any clearly defined classes of temperament.[2]

The sum of all the innate dispositions with their specific impulses or tendencies constitutes the disposition of the individual, and differences of disposition are due to native differences in the strengths of the impulses or to differences induced by use or disuse in the course of individual development. The factors constituting temperament are in the main natively given, and although they are alterable by disease and the influence of physical environment, they are but little capable of voluntary effort.[3] Character, however, "is the sum of acquired tendencies built up on the native basis of disposition and temperament; it includes our sentiments in the widest sense of the term, and is the product of the interaction of disposition and temperament with the social environment under the guidance of intelligence. Thus a man's temperament and disposition are in the main born with him, and are but little alterable by any effort he may

[1] *Social Psychology*, p. 116.

[2] *Cf.* Shand, book i. chap. xiii.

[3] By temperament, Shand explains (p. 129) "we mean that part of the innate constitution of the mind which is different in different men, so far as this refers to their feelings and perhaps also to their wills; but that part of their constitution which is the same in all of them we do not call their temperament."

make, whereas character is made largely by our own efforts."[1]

When we proceed to consider the ethical development of the child and of the adult, we find that the transition from the lowest stage of behaviour to the highest stage of moral conduct is conditioned by three factors, the development of self-consciousness, of the sentiments, and of character.

Considering first the affective aspect of moral conduct, we find that the chief requirement of moral progress is the organisation of emotions or emotional dispositions into sentiments. "In the absence of sentiments our emotional life would be a mere chaos, without order, consistency, or continuity of any kind; and all our social relations and conduct, being based on the emotions and their impulses, would be correspondingly chaotic, unpredictable, and unstable. It is only through the systematic organisation of the emotional dispositions in sentiments that the volitional control of the immediate promptings of the emotions is rendered possible. Again, our judgments of value and of merit are rooted in our sentiments; and our moral principles have the same source, for they are formed by our judgments of moral value."[2]

The development in the individual of the sentiments themselves follows the order, the concrete particular, the concrete general, and the abstract, the illustrations which McDougall furnishes being the love for a child, the love for children in general, and the love for justice or virtue. The actual development of sympathy during the course of the child's life, as determined by the number of cases expressing this sentiment in the various years, is indicated by Boeck in the following table:—[3]

Year of age .	1	2	3	4	5	6	7	8	9	10	11	12
Number of cases .	3	66	95	94	93	60	41	28	37	25	19	10

[1] McDougall, *Social Psychology*, p. 120.

[2] McDougall, p. 159. *Cf.* Shand, *The Foundations of Character*, p. 62: "In the growth of character, the sentiments tend with increasing success to control the emotions and impulses; in the decline of character, the emotions and impulses tend with increasing power to achieve their freedom."

[3] Reproduced in Meumann, *Vorlesungen*, vol. i. p. 610.

The objects of sympathy were found to be :

I. Human beings, 358.
  A. Actual, 285 (Mother 74, Father 23, Sister 86, Others 102).
  B. In tales and pictures, 73.

II. Animals, 207.
  A. Actual, 179.
  B. In tales, pictures, etc., 28.

III. Inanimate objects, dolls, plants, 65.

The first expressions of sympathy attach to the family circle ; from three years of age onwards they extend beyond this. Fuller knowledge of the actual development of this and of the other sentiments would be welcomed by educationists.

The second of the three main lines along which ethical development proceeds is the self-conscious. The instincts or impulses which constitute the original motive power to all the higher activities are at first "blind," but as the child's general intellectual development proceeds, he becomes clearly conscious of the end of his actions, it becomes for him an object of desire. This results in greater continuity of effort : his behaviour is no longer vacillating, for when the power of representation of an object has been attained, the attention is not so readily distracted by irrelevant sensory impressions as it would otherwise have been. The second effect on his conduct of the child's intellectual development is to lengthen the train of activity through which the end is attained. The interpolating of subsidiary aims between the impulse to action and the end to be attained proceeds to such an extent that the life of the plain man has been characterised as all means and no end.

Light might be thrown on the development of this, the intellectual, aspect of the child's moral development by considering the replies given by pupils to the tests suggested as means of measuring reasoning ability or of diagnosing general intelligence which require them to give illustrations of proverbs [1] or interpretations of fables.[2]

[1] W. H. A. Dockerill and A. J. Fennings, " A New Test of Reasoning " (*Journal of Experimental Pedagogy*, vol. ii. pp. 356–361).

[2] L. M. Terman and H. G. Childs, *Journal of Educational Psychology*, vol. iii. pp. 133–143.

For the higher forms of moral conduct, in addition to the organisation of emotional tendencies into sentiments and the development of self-consciousness enabling the individual to represent more fully and clearly the end of his actions and also to attain his end by more prolonged and indirect means, there is also required an increased volitional control and regulation of the instinctive impulses. For some possess the highest ideals and the noblest sentiments but fail to realise their ideals; they are sentimentalists. What they lack is tenacity of purpose; their sentiments must be consolidated and confirmed by habitual action in accordance with their promptings. "Habitual action on the motives supplied by the systematised sentiments is, then, an essential factor in character, over and above the possession of the sentiments."[1] The need for resoluteness of will is emphasised in the maxim *Pecca fortiter*; but for the highest form of conduct the strong will requires to be directed by enlightened sympathy.

The organisation of emotions into sentiments, the development of self-consciousness, and the increase of volitional control and habituation to actions of the right type are the prerequisite conditions of moral progress. These factors contribute in varying degree to moral development in which we can, according to McDougall, distinguish four levels:—[2]

(1) The stage of instinctive behaviour modified only by the influence of the pains and pleasures that are incidentally experienced in the course of instinctive activities.

(2) The stage in which the operation of the instinctive impulses is modified by the influence of rewards and punishments administered more or less systematically by the social environment.

(3) The stage in which conduct is controlled in the main by the anticipation of social praise and blame.

(4) The highest stage in which conduct is regulated by an ideal of conduct that enables a man to act in the way that seems to him right regardless of the praise or blame of his immediate social environment.

The first stage is that implied in the proverb "The burnt

[1] McDougall, *Social Psychology*, p. 260.

[2] *Ibid.*, p. 181. *Cf.* Shand, *The Foundations of Character*, pp. 172-173.

child dreads the fire." Here pain inhibits the child's impulse to touch the fire, to which the instinct of curiosity prompts. Such inhibition is the first step towards moral conduct, and is the innate basis of self-control. "To hesitate is to be lost" while proved by experimental analysis to be true of developed conduct, must, for the earliest stage, be revised and rewritten "To hesitate is to be saved." The whole aim of early moral training is to introduce between the prompting of impulse and the action that ensues a period for reflection. "Fear of punishment," McDougall maintains,[1] "can secure this control of the immediate impulse by a more remote motive at an earlier age than it can otherwise be effected, fear being the great inhibitor of action." The Montessori method of education through its game of silence trains this power of inhibition by quite other means than the employment of fear, and experiments to determine the most effective, and at the same time the most humane, means of attaining this end would be a serviceable contribution to Education. The control of conduct by public approval and disapproval is doubtless the highest stage which we can expect to secure in school work—it is expressed in the term "good form" or *esprit de corps*,—the final stage of conduct being possible only to those who have experience of various moral standards, and who have developed strong self-reliance.

To the Child-Study movement we owe most of our knowledge, general as it is, of the actual course of the ethical development of the child. The contribution of Experimental Education is as yet small; but although the methods employed may seem indirect, they are opening up a field where there is at least some hope of a harvest.

Children's interests, aspirations, and ideals have been investigated by Child-Study methods, and the results are not without value.[2] The pupils are required to answer, giving reasons for their answers, such questions as, "What would you like to be when you are grown up?" "Who is your ideal person?" "What is your favourite subject of study?" "Who is your favourite author?" "What is

[1] McDougall, *Social Psychology*, p. 187.

[2] For summary, see King, *Psychology of Child Development*, chaps. xi.–xiii., and for criticism of methods chap. xiv.

your favourite game, activity, or amusement ? " The investigations have been carried out in England, America, Germany, Austria, and Switzerland, and the results are valuable, not only as affording material for judging of the development of the whole spiritual nature of the child, but because they provide us with standards whereby we may compare the various educational systems and estimate the power of the school in furnishing the pupils with ideals. The treatment of the results takes two forms : one statistical—an enumeration of the persons, authors, games, etc., preferred, the other psychological and pedagogical—the analysis of the reasons given and the relation of these to the general development of the child on the one hand, and to the subjects and methods of school instruction on the other.

Confining our attention to investigations of the children's choice of ideal characters, we find that the younger pupils select a person in their immediate environment—a relative or a member of their circle of acquaintances—whereas with increasing age there is a wider range of choice, historical characters, public men, etc., being selected. Explorers and inventors are better known than artists, but these are not always given the precedence of politicians and local celebrities. The younger children likewise express preference for making money, etc., while with older pupils intellectual and æsthetic values preponderate. School libraries, it is maintained, help to extend the range of, and to elevate, the pupils' ideals. The elementary schools are, in comparison with higher grade schools, inferior in furnishing ideals, and the German schools are in this respect behind the English and American. In the reasons given for preferences a development can also be traced ; the younger children apply to the preferred personalities indefinite predicates like good, etc., whereas special characteristics like brave, wise, benevolent, appear in the accounts of older scholars. The choices of girls are more limited to characters in the immediate environment than is the case with boys, and biblical characters are more favoured by girls. Secular history furnishes the greatest proportion of ideal characters, and far behind it come biblical history, poetry, and literature.

A parallelism between the course of development of the individual's ideals and those of the race has been suggested, but although there are undoubtedly points of correspondence between the two, such a parallelism cannot be substantiated, stages which are successive with the race being contemporaneous in the individual's development.

In like manner the friendships of the child have been investigated. The question put to 2336 pupils in primary schools in Massachusetts was: What kind of companion would you like to have, and why? The pupils usually indicate preference for companions of their own sex, only 20 boys favouring girls and 28 girls favouring boys. The reasons given indicate a development from emotional characteristics like friendliness, brightness, to mental and moral qualities like veracity, fidelity, unselfishness.

In directing attention to such factors in the moral life as inhibition, suggestion, etc., lies the most valuable contribution of Experimental Psychology to the subject of the ethical development of the child. The most important, and at the same time the most harmful, of the various forms of inhibition are the specific emotional and volitional forms, which have for long remained unrecognised by educators. Meumann illustrates one type from the experience of a thirteen-year-old boy whom he knew.[1] On his entrance to a new school his previous teacher, who had an antipathy to him, was tactless enough to introduce him to the new teacher with a drastic and false report. From that moment the boy, who so far had been above the average, did no good; not only did his intellectual efforts diminish from day to day, but his attention and conduct also deteriorated, and he became emotionally depressed. At the end of the school year he failed to obtain a remove, and the boy would have been ruined had not his parents, who had faith in their child, withdrawn him. He was sent to another school, and there met a teacher who showed confidence in him; from that moment the boy changed completely, gained excellent certificates, and left as one of the best pupils. His case is typical, in that a single definite volitional inhibition entered into the life of the child, extended to the entire inner nature, undermined his self-confidence, depressed his emotional life, and diminished all his efforts, intellectual as well as moral. If

[1] Vol. i. p. 636.

such a child is not saved through change of environment, or the opportune introduction of a sympathetic teacher, or if he has not the power to rise above the effects of the inhibition, his career may be ruined. Seizures by such inhibitions in the volitional life of the child occur extraordinarily often, and are in a sense parallel to the physiological inhibitions which arise through the premature exertion of the physical powers.

Two forms of such inner inhibitions can be distinguished. One arises in a special sphere and has a certain retro-active tendency, but it does not go beyond this sphere; the other begins either from a single incident, in a certain subject, or from a definite class of work, has an extensive tendency, and eventually affects the whole mental life of the child.

The former type is frequently exemplified in laboratory work. A pupil may be required to memorise a series of twelve nonsense syllables and may get the impression that the task is beyond his powers; the result is that the number of repetitions required for learning increases immensely, and sometimes no learning at all is effected. If the same pupil, on first learning, found the task easy of accomplishment and received the impression that his powers were adequate to the task, the number of repetitions required for learning the series would decrease rapidly and the learning of nonsense syllables would progressively improve. The effectiveness of such volitional inhibitions is most easily observed in tests on immediate retention, when the method of gradual increases in the length of the series is employed; seven words may readily be retained by the subject without a mistake, whereas, when the series consists of eight words, only two or three are reproduced. The explanation is that the presentation of the series of eight words suddenly arouses the feeling that the series is too long, the attention is inhibited at a definite place in the series, and the subject forgets all, or almost all, that has been previously impressed on the mind. The inhibition thus works backwards and disturbs the impressions made under normal conditions.

The prolonged self-extending form of inhibition, although fundamentally the same phenomenon, acts in a somewhat different manner. It occurs, as a rule, in the efforts of a child in a special subject. The pupil may, through wrong treatment on the part of the parent or teacher, or the action of his fellow-pupils, suddenly become remiss and his efforts, mainly in a particular subject alone fall off; the relations between the pupil and the teacher undergo a change, they become estranged, the pupil loses confidence in himself, and his work in all subjects suffers. The child can succumb completely to such volitional inhibitions, and his whole life may thus be grievously affected.

All natures are not equally susceptible to these inhibitions, and when they appear they affect individuals differently. One type suffers only temporarily and overcomes them unaided; some are affected for a time, while others may be injured permanently. Sensitive natures are especially susceptible to volitional inhibitions, as are also children with a tendency to emotional depression, or those whose self-confidence is weak, whose suggestibility is great, whose endowment is irregularly distributed over the school subjects. A similar susceptibility characterises those who are very ambitious, and individuals who are physically retarded or delicate.

In such cases experiment can render the greatest service by demonstrating the presence of volitional inhibitions. By experiment it is possible to determine quantitatively—for example, through memory tests—the simple intellectual efforts of an individual in whom the existence of inner inhibitions is suspected. These can be compared with his efforts in school work. It may be objected that the inhibition might extend to the experimental work, but when such tests are conducted in a laboratory an entirely new environment is provided and the work required of the pupil in the psychological experiment allows of his elementary powers being observed in a manner impossible with complicated school subjects. Such tests can also be employed as a means of overcoming the inner inhibitions. We can increase the child's self-confidence by adapting the tests to his powers and thus enable him to overcome the effects of his inhibition.

A form of inhibition which has acquired interest for Education, although it is primarily of pathological importance, is that known as "psychical repression."[1] The child may find

[1] *Cf.* Ernest Jones, "Psycho-Analysis and Education" (*Journal of Educational Psychology*, vol. i. pp. 497–520).

himself giving way to ancestral tendencies or inherited impulses having their origin in the psycho-sexual instinct which conflict with the ethical and cultural environment in which he moves. The constant recurrence in memory of such experiences may so perplex him as to affect his physical health and moral life, or the painful complex may be permanently inhibited or "repressed" and be thus rendered incapable of recall.

To such "repressions" are attributable much of infantile hysteria and the psycho-neuroses of later life. These "repressions" occur at an extraordinarily early age, and may either be organic or impulsive or be intentional and volitional. They affect adversely the physical condition of the child and lead to ethical demoralisation, and there is little hope of the child being cured unless he meets with an adult who understands his condition and who can secure his confidence. The diagnosis of such "repressions" is a task for psycho-analysis; the means originally employed was hypnosis, but later the method of free associations has been adopted. When once detected, such "repressions" may be removed by getting the child to make a complete avowal of his original experience, and by thus facing the facts liberate himself from the consequences of the "repression."

The original experiences may, however, not be repressed, but be sublimated [1] by the re-direction of the energy of the components of the sexual instinct into other and higher channels, and the choice of vocation can thus, it is maintained, be frequently traced to such unrealised and buried tendencies. This process of sublimation is a phenonenon of early childhood, and is usually brought about unconsciously, but in the future it will probably be incumbent on Education to direct and co-ordinate consciously this process.[2]

The "repressions" may, instead of being sublimated, manifest themselves in "reaction-formations," such as a strong "sense of sin," an over-sensitiveness to suffering, or in other forms which may have disastrous social consequences.

[1] Sublimation is defined by Freud as "the capacity to exchange an original sexual aim for another one which is no longer sexual, though it is psychically related."

[2] *Cf.* Ernest Jones, "Psycho-Analysis and Education; The Value of the Sublimating Processes for Education and Re-education" (*Journal of Educational Psychology*, vol. iii. pp. 241–256).

Other painful experiences than those indicated, for example, dissension between parents, may have the same injurious effects on the child's bodily and mental well-being as consciousness of guilt.

In close connection with volitional inhibition stands the phenomenon of the child's suggestibility. Only through experiment and pathological observation have we been led to recognise to what an extraordinary degree the will of the young child even up to the end of his twelfth year is susceptible to suggestion.

Various tests have been employed to determine the suggestibility of individuals.[1] Leading questions can be put in tests on testimony, and the susceptibility of the children to the influence of the experimenter thereby determined. Many of the illusions investigated by psychology can likewise be used to determine suggestibility. The results of such tests indicate that suggestibility decreases slowly with age; the power of withstanding suggestive influence is at seven years of age half that at fifteen. Girls are more suggestible than boys, and the course of susceptibility to suggestion is, with the two sexes, an irregular one. The correlation between the results of some of the tests[2] would seem to indicate that suggestion is not to be regarded as a faculty, but that there are various forms of suggestion just as there are different forms of attention or of memory.

The common characteristics and actions of persons are more readily accepted by suggestion than those occurring less frequently, but the size of objects suggested has no influence in their acceptability; the position and colour of objects which do not exist in the test picture are even stated with definiteness by some children. The degree of suggestibility also varies, according to intelligence and temperament, the less intelligent children, and also those of sanguine nature, being highly suggestible.

To strengthen the child's power to withstand unfavourable suggestions is one of the main requirements of education, and the best means of attaining this is to increase the child's

[1] See, for example, Whipple, *Manual*, part ii. chap. x.

[2] Scott, "Personal Differences in Suggestibility" (*Psychological Review*, 1910).

self-confidence. It is important that every teacher should recognise what a powerful instrument for influencing his pupil he possesses in suggestion, and how this can be applied in a good as well as an evil way.[1]

For questioning in instruction it is significant to note that a question has always a subsidiary suggestive effect. Some persons may have their views influenced as readily by questions as by direct argument, and this suggestive force in the interrogatory form of a statement must necessarily be much greater in the case of children.

As an illustration of direct experimental research on volition we may cite the investigation carried out at Louvain in 1910–11 by Boyd Barrett.[2] His subjects learned to associate nonsense names with tastes of certain liquids, and having decided on their order of preference were required to choose which liquid they would drink when two of the names were presented to them on a stimulus card. The times required for the choice and the subjects' introspections were recorded. From the introspections the factors influencing choice were determined, and the following conclusions drawn. Immense profit to the will and character is to be secured "by clearly fixing and defining the various scales of values which we utilise in our various spheres of occupation, and by knowing them so well that almost automatically we may apply them in daily life. By this means we economise motivation, and store up volitional energy. We choose swiftly and easily, in a word, automatically, and thus leave no place for hesitation."[3] Hesitation "is a malady or disease of the will. It renders impossible serious motivation, it runs counter to volitional economy, wastes the force of the mind, fatigues and discourages. It leads to habits of irresponsible, haphazard choosing, and even neglect of duty. Indeed the only times the subjects disobeyed the instruction were after hesitations."[4] The great means of avoiding it are said to be the acquisition of the habit of serious, decisive choosing and the avoidance of repining over past decisions. From the results of his

[1] *Cf.* Keatinge, *Suggestion in Teaching*, and Adams, *Exposition and Illustration*, chap. v.

[2] E. Boyd Barrett, *Motive-Force and Motivation-Tracks*.

[3] *Ibid.*, pp. 176–177.

[4] *Ibid.*, p. 177.

research Boyd Barrett suggests that virtue might be defined as a habit of choosing unhesitatingly the highest on a scale of values clearly and definitely known.

An attempt has been made to determine experimentally the ethical significance of "Perseveration," one form of which has already been encountered in Mental Association. From numerous tests and a consideration of an interrogatory comprising such questions as "Do you often notice a tune, line of poetry, phrase, problem, etc., coming back to your mind again and again without your intending it?" "When something is to be done or imminent, for example, a task, an examination, etc., does it often come to your mind during the days preceding it?" Lankes[1] has concluded that perseveration is a native quality of the nervous system, innately different with different individuals but modifiable by the individual's own effort and will. Perseveration is doubtless one of the factors constituting what has been above called temperament.

The beginnings of a comprehensive experimental science of character are to be found in Webb's investigation entitled "Character and Intelligence."[2] From the results of this investigation he claims to have demonstrated that in addition to the common factor of "general intelligence" there exists in the individual a second factor exerting a widely-ramifying influence on the side of character. He adds:[3] "Its generality has been demonstrated. It markedly dominates all the correlations yielded by the estimates of moral qualities, the deeper social virtues, perseverance, persistence; also, on the negative side, qualities relating to instability of the emotions and the lighter side of sociability. Its nature is best conceived, in the light of our present evidence, to be in some close relation to "persistence of motives," that is, to depend upon the consistency of action resulting from deliberate volition, that is, from will." Further research along the lines proposed by Webb will doubtless resolve the present perplexity in regard to that aspect of personality which we term character.

[1] W. Lankes, "Perseveration" (*British Journal of Psychology*, vol. vii. pp. 387–419).

[2] *British Journal of Psychology*, Monograph Supplements, vol. i. No. 3.

[3] *Ibid.*, p. 76.

Of the three factors in ethical development, the self-conscious, the emotional, and the volitional, each has been regarded by one school of educationists or another as the chief means of improving the moral behaviour of the pupil. Plato, accepting the Socratic dictum that virtue is knowledge, maintained in the *Protagoras* that virtue could be taught, and the Herbartians have insisted that in the content of instruction, in humanistic studies, is to be found the best means of creating interest and thus leading to virtue. Pestalozzi emphasised the emotional factor, maintaining that feelings constitute the bases of morality; "in moral as well as in intellectual education," he says,[1] "I have urged the supreme character of the motive of sympathy as the one that should early, and indeed principally, be employed in the management of children." Aristotle emphasises the volitional aspect, maintaining that goodness of character is the outcome of habit;[2] and Meumann, whose results led him to regard the doctrine of formal training as valid in the intellectual sphere, insists strongly on the need for the formal training of the will.[3] This, he maintains, develops qualities which are more valuable to the child and more directly serviceable to him in later life than any mere acquaintance with ethical stories and humanistic studies. It is just this formal side of volitional development, he adds, that is most accessible to systematic observation and experiment, the ethical endowment of the child not being capable of experimental analysis, and his general volitional development, influenced as it is by contact with adult life, not being amenable to experimental control.

While not decrying the importance of the careful selection of the content of instruction, Meumann objects that this is only an indirect means of influencing the will, whereas formal training applies directly and necessarily to the will itself. The whole of the school work of the pupil, he suggests, can serve as means for training the qualities of the will, and for their experimental investigation all that is required is to set the pupil a task the results of which can be statistically estimated, and improvement in which is possible and is dependent on the will.

[1] *Letters to Greaves.*

[2] *Ethics*, book ii. [3] *Vorlesungen*, vol. ii. p. 631, also pp. 653 *et seq.*

Whether the formal training of the will recommended by Meumann will achieve all that he claims for it or not, it will still be necessary for a complete training of character to improve the child's ethical insight and likewise to influence his emotional life, through suggestion, example, admonition, praise and blame; in fact, to use every effort to secure a ready and resolute response of the will to enlightened motives.

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CHAPTER XI

INDIVIDUAL DIFFERENCES

IN the early stages of the development of Experimental Psychology, when the main object of the study was to establish certain general laws, the individual variations which were disclosed in investigations were regarded by experimenters as disturbing factors which they would fain ignore if they could. Such individual differences have nevertheless come to be studied for their own sake, and this consideration now constitutes a special department of psychology.

The "differential psychology," as Stern denominates it,[1] adopts the categories and methods of procedure of general psychology, but it extends these and reforms them according to its own requirements. It investigates the formal aspects of variations, for example, the range of variation, the question of concomitant variation, the correlation of variations, and the substitution and compensation of differences. It also seeks to determine which variations are dependent on inner causes (inheritance, etc.) and which on environment and training.

In Education an alternation similar to that experienced by psychology can be traced. The individual differences of pupils were for long ignored; now the demand is to individualise instruction, but opinion is not yet unanimous as to whether in Education the individual differences should be reinforced or suppressed. It will, however, be generally agreed that before the problem can be solved we must determine the extent of such differences and their cause—that is, whether they are due to natural endowment or training, and this is the task which Experimental Education has set itself.

[1] *Cf.* W. Stern, *Differentielle Psychologie.*

Teachers who profess to study the individuality of their pupils must now do so scientifically. To escape the labour of studying psychology, which, it was assumed, could only provide general laws, some teachers have been in the habit of maintaining that they studied the individual pupils; the new differential psychology, with its scientific treatment of individual differences, has, however, made untenable this lazy fallacy and demonstrated that a sentimental interest in individual pupils is not a substitute for a scientific study of their differences. "The problem of typical differences," as Meumann states,[1] "is of paramount interest for pedagogical practice; it alone can furnish us with a definite basis for the characterization and treatment of pupils."

The study of individual differences is also the necessary prerequisite of an applied psychology, and it is to applied psychology that mankind looks for the solution of many of its social problems and for improvement in its economic conditions. In adumbration of its future importance we may cite the effect of the application of scientific management to labour conditions and its consequences for education.

Scientific management is the latest advance in industrialism, and it is claimed that its effects on production will be relatively as great as that of the introduction of machinery. It seeks to discover the best means and the best men for undertaking the various industrial processes. In pursuance of this latter purpose it selects its workers on the basis of, and as the results of tests on, psychical qualities and discards those who are not endowed with the specific mental qualities demanded for the work required.[2] Scientific management thus works negatively; it does nothing to enable the human misfits to discover for what specific vocation they are best adapted. This positive task will ultimately devolve upon the teacher. It is already in a manner undertaken by the educationist under the title of "vocational guidance"; but before it can meet the demands of scientific management this vocational guidance will require to become scientific, and consequently psychological.

It will be in the future the work of the teacher with the aid of the consulting psychologist to test the various mental

[1] *Psychology of Learning*, English trans., p. 168.

[2] *Cf.* Münsterberg, *Psychology and Industrial Efficiency*, p. 54.

powers of the individual pupil and to suggest to him, as a result of such tests, the type of occupation which he can profitably follow. To guide a pupil in his choice of a vocation was, according to Bacon, one of the chief duties required of the teacher. When it is scientifically performed it will not only prevent an economic loss both to the community and to the individual, but it should be an advantage socially and morally, for then each individual will be doing the work for which he is best suited, thereby attaining, according to Plato, his own greatest happiness and the greatest happiness of the community. Thus will Education assist in the realisation of the ideal state sketched by Plato in the *Republic*, the pattern of which is laid up in heaven.

Practically every psychological investigation has revealed individual differences.[1] But these were in almost all cases but incidentally enumerated, their origin and their significance being ignored. Even yet the subject of individual differences is almost exclusively concerned with discussions of theoretical import and with methodological issues.

The causes of differences in individuals, according to Thorndike,[2] comprise, on the one hand, the influences of remote and of immediate ancestry, of sex, of maturity, and, on the other, the environmental influences, both physical and social, including the effects of training and education. When, however, we seek to discover the extent to which each of these factors contributes in the production of individual differences the inadequacy of scientific data becomes at once apparent.

The influence of remote ancestry, that is, of race, has been indirectly determined by the psychological tests which anthropologists have applied to peoples of different cultural status. The results have shown that in respect to the elementary mental functions, sensory acuity and discrimination, etc., the differences between primitive peoples and peoples of higher culture are negligible, that it is in respect to the higher intellectual qualities which are the result of education that the differences are most pronounced. "The differences in original nature within the same race are, except in extreme cases, many times

[1] The bibliography in Stern's *Differentielle Psychologie* gives references to over 1500 investigations.

[2] *Educational Psychology*, vol. iii. part ii.

as great as the differences between races as wholes." [1] The bearing of these results on the political treatment of races is obvious.

The effect of immediate ancestry is one for works on Heredity. If we accept the modern view of heredity, then the individual's endowment is conditioned by the physical or mental constitution not of his parents but only of their germs, and this renders almost impossible the transmission of acquired characteristics, especially those of a higher order. If the Mendelian theory of heredity is accepted and the dominant characteristics of human nature traced and means for their ready diagnosis discovered, an exact estimate of the individual's endowment and of the contribution of his immediate ancestors may be possible, but at present we are still far from this much desired end.

The obviousness of the physical sex difference has caused its significance for mental work to be much overrated. Thus Thorndike remarks: [2] "The individual differences within one sex so enormously outweigh the differences between the sexes in . . . intellectual and semi-intellectual traits that for practical purposes the sex difference may be disregarded." From a comparison of sex differences displayed in investigations where the pupils were drawn from co-educational establishments with those where the sexes were educated in separate institutions, Meumann suggests [3] that the differences are largely due to the influence of environment and training rather than to sex as such. Burt and Moore from an extensive survey of the theories of sex differences and of the experimental data available have formulated their main conclusion as follows: [4] "With few exceptions, innate sex-differences of mental constitution are astonishingly small—far smaller than common belief and common practice would lead us to expect. Neither on the simplest level, nor the more complex levels, nor on the highest levels of all, neither on the intellectual side, nor on the practical side, nor on the emotional side, have we found sex-differences so large as those found in few physical character-

[1] Thorndike, *Educational Psychology*, vol. iii. p. 224.

[2] *Educational Psychology*, vol. iii. p. 184.

[3] *Vorlesungen*, vol. ii. pp. 757–761.

[4] C. Burt and R. C. Moore, "The Mental Differences between the Sexes" (*Journal of Experimental Pedagogy*, vol. i. pp. 273–284, 355–388).

istics. So far as the innate differences exhibit any general tendency in their relative size, they tend to diminish rather than to increase as we pass upwards from simple processes of sensation and movement to complex processes of reasoning. They appear, too, to be throughout quantitative rather than qualitative—differences in the degree to which capacities common to both sexes are developed in the one sex or in the other, not differences due to the presence of capacities of a certain kind in one sex and their absence in the other." [1] As regards the mental characteristics which concern the teacher, this conclusion agrees with that of Thorndike quoted above.

The difference between the sexes lies not in the average capacity of achievement but in the range of variability. The male sex exhibits a greater variability than the female except in the two years nearest the age of puberty for girls. Thus there are more geniuses amongst men than amongst women; there are likewise more idiots. The neglect of this difference in range of variability has given rise to many of the popular misconceptions in regard to the differences between the sexes.

By the influence of maturity Thorndike understands [2] the difference amongst individuals of the same age in the extent to which the original impetus to mental development has run its course. The study of this factor is complicated by the lack of any measure of maturity, but its influence is implied in the recognition of the inadequacy of chronological age as a measure of maturity and in the introduction into educational literature of such terms as "physiological age" and "mental age."

The influence of environment in producing individual differences, and the amount of this influence compared with that of original nature, sex, and maturity, are far from being satisfactorily determined. "A sound science of the influence of the environment," as Thorndike states,[3] "has hardly been begun." With greater knowledge we are much less dogmatic than Locke when he wrote that "of all the men we meet with nine parts of ten are what they are, good or evil, useful

[1] C. Burt and R. C. Moore, "The Mental Differences between the Sexes" (*Journal of Experimental Pedagogy*, vol. i. p. 384).

[2] *Educational Psychology*, vol. iii. p. 270.

[3] *Ibid.*, vol. iii. p. 284.

or not, by their education. 'Tis that which makes the great difference in mankind." [1]

To distinguish innate differences from the effects of educative influences various methods are employed.[2] The first is the effect of practice on performance. The greater the amount of practice required to secure a certain effect the less the initial endowment, other things being equal. Innate capacity is frequently judged not merely by the relation of practice to performance but also by the absolute performance of the individual. Great superiority over the average in intellectual effort indicates higher endowment. The spontaneous appearance of definite activities is usually attributed to innate tendencies ; a child who begins at an early age spontaneously to interest himself in music is naturally regarded as possessing a strong innate musical disposition.

When varying amounts of practice have already influenced the initial capacities, the cause of the differences in individuals can be inferred from the effects of equalising practice.[3] Further practice of equal amounts will reduce differences when these are not due to innate causes ; if, however, the inequalities increase with further practice, they cannot have been caused by irregularities in previous practice, and must be due to innate conditions.

The general conclusions which Thorndike states include : [4] (1) The variations are, in general, greater in acquired than in original traits. (2) They are, in general, greater in traits peculiar to man than in traits characteristic of all mammals. From a review of the investigations in which the amounts of practice was controlled and equalised, Thorndike concludes that equalising practice seems to increase differences.[5]

Opinion is divided on the question whether individual differences can be reduced to certain constantly recurring types, as Meumann [6] and Stern [7] maintain, or whether, as Thorndike insists,[8] the variations are continuous, and the

[1] *Some Thoughts Concerning Education*, § 1.
[2] *Cf.* Meumann, *Vorlesungen*, vol. ii. pp. 306–314.
[3] *Cf.* Thorndike, *Educational Psychology*, vol. iii. p. 305.
[4] *Ibid.*, p. 317. [5] *Ibid.*, vol. ii. p. 305.
[6] *Vorlesungen*, vol. ii. p. 77.
[7] *Differentielle Psychologie*, chap. xii.
[8] *Educational Psychology*, vol. iii. p. 317.

individual differences not so pronounced as to admit of such a classification.

As an illustration of what is to be understood by types, we may instance the "Fitting Sizes" scheme by which the Post Office Stores Department supplies uniform to British postmen and which implies the existence of physical types. In all about three-quarters of a million articles per annum are supplied to about 110,000 individuals. "Briefly the basis of the scheme is this: that among a number of men of one height will be found a certain number also alike in respect to all other measurements. These form one group, and the majority of the rest of the uniform-wearing staff are found by experience to fall into other similar groups. The number of fitting sizes is so large, and the gradations so fine, that under the scheme men can be at least as well fitted as if the clothing were made to their individual measurements. This is not surprising when it is stated that the fitting sizes scheme provides for no less than 1800 different sizes of postmen's coats. The number of men who cannot be provided for under the fitting sizes scheme is extremely small, and comprises only the excessively stout, the excessively long, and so on." [1]

Types have been affirmed to exist in the case of almost every mental activity investigated. Those who support the doctrine of types assume that individual differences are either quantitative, giving rise to differences in degree or amount of mental power, or qualitative, giving rise to "types" of difference and of endowment.

On the basis of the individual differences in attention it has been maintained that types of attention exist. Meumann has distinguished between individuals with typically concentrative or intensive attention and others with typically distributive attention. Scientific investigators usually belong to the former; business men, military geniuses, etc., to the latter. Men like Napoleon and Cæsar are said to have possessed the power of distributive attention in a high degree, the latter being able, it is said, to dictate four letters while writing a fifth. Freeman, however,[2] maintains that the

[1] G. Morgan, *The Post Office Stores Department, Its History, Development, and Functions*, p. 9.

[2] *Pädagogisch-psychologische Arbeiten*, vol. i. p. 138.

results in his investigation do not support this sharp division into two types.

Messmer has proposed another classification of types, the objective and the subjective, or the fixating and the fluctuating types. The representatives of the former have a limited field of observation, in which, however, the impressions are clearly apprehended; the latter attend less to the objective stimuli than to the ideas used to interpret them. But Freeman likewise denies the validity of such a classification, stating that the characteristics are variously combined, and that in his investigation the subject with the greatest range of attention was the subject whose judgments were most correct.[1]

Opinions in regard to the existence of types of attention are consequently far from being unanimous.

In reaction tests when a stimulus is given and a given movement has to be executed, individual differences have been exposed, and types have been based on them.[2] One type of subject, termed the "motor" type, attends to the movement to be executed rather than to the stimulus; the other, the "sensory" type, directs the attention to the expected stimulus, and in this case the reaction is slower. The question has been raised whether these exhaust the typical modes of reacting, or whether there may be others. Flournoy has maintained that there are four reaction types, distinguishing, in addition to the "motor" and "sensory," the "central" and the "indifferent." The central has the shortest reaction time, the subject's attention being concentrated on the reaction as a whole—from stimulus to movement; with the indifferent type the direction of attention has no definite effect on the rate of reaction. Stern has distinguished between a "subjective" and an "objective" type. The former takes up an active attitude to everything that he encounters. His own action forms the central point of things, and his environment is only of significance in so far as it participates in this. The latter type allows outer stimuli to affect him passively; he regards them theoretically. His attention is sensorially directed and his attitude is contemplative. For the subjective type the stimulus is merely the occasion of the response, for the objective

[1] *Pädagogisch-psychologische Arbeiten*, vol. i. p. 136.
[2] Stern, *Differentielle Psychologie*, p. 214.

type it is the cause of the reaction.[1] It has been disputed whether such differences are fundamental and due to endowment, or merely the result of training. Meumann supports the view that they are fundamental, and maintains that the doctrine of types is valid here. He suggests the following classification : One type, he says, reacts from the outset much more quickly than the other, displays strong motor tension, and directs the attention solely on the organ to be moved—this is the impulsive type. The second type is the intellectual or reflective type—those who await the stimulus calmly, try to apprehend it clearly, and take longer to react.

Differences in attunement may also be disclosed in association tests. Those subjects who reply quickly, but give little introspective detail, form one type ; the other type take longer but give a fuller account of how they arrive at the response.[2]

In estimating the length of time which a certain movement takes, some individuals depend on their consciousness of the time taken, while others depend on the extent of space passed over ; on these grounds psychologists distinguish a temporal from a spatial type of apprehension. If, again, an arm-movement is carried out with the eyes open, and then repeated with the eyes closed, it is found that one subject relies on the space passed over, another on the time taken, and a third on the impression of the first and last positions of the arm. Stern accordingly maintains that a " material " type of apprehension, depending on the sensational content, and a " formal " type, depending on the spatial and temporal relations, can be distinguished, and that these types stand in close relation to the concrete and the abstract imagery types.

Binet found that descriptions of an object or picture by different individuals presented certain characteristic differences : on the basis of such differences he arranged his subjects into four classes or types—the descriptive, who merely enumerate what they see ; the observational, who describe movements and relations of figures in the picture they are describing ; the emotional, who attribute emotions to individuals in a scene ; and the erudite, who relate all they know about an object. In this classification the obser-

[1] Stern, *Differentielle Psychologie*, p. 215.
[2] *Cf. British Journal of Psychology*, vol. iii. pp. 358–359.

vational stages, already mentioned in connection with the psychology of testimony,[1] appear to be reproduced, the purely descriptive type in Binet's classification corresponding with the substance stage of Stern, and the observational type with the action stage. Stern would reduce Binet's four types to two general types, the "objective" and the "subjective." Binet's types cannot, indeed, be regarded as elementary; they are, according to Meumann, determined partly by interest, which is conditioned by practice and habit, and partly by individual differences in the properties of attention. Interest may be directed to the actual object, to its theoretical aspect, or to its emotional value—æsthetic, ethical, or practical; the first-mentioned trend of attention probably corresponds to the analytic, the other two to the synthetic types of attention. Binet's types may consequently be brought under these categories, and Stern's categories of observation may be added as a standard for the development of apprehension.

The imagery types, on account of their pedagogical significance, have received more attention than any other aspect of the endowment problem. Imagery types arise from the fact that individuals differ from one another in the sensuous content of their images. There are two forms of imagery used in thinking—concrete object imagery, used mainly when we recall experiences which have previously occurred, or when we allow our imagination to run free; and verbal imagery, constituting the silent speaking which usually accompanies thinking in the narrower sense, that is, judging, reflecting, etc. Each of these two forms of imagery may be variously constituted with different individuals; hence the imagery types.

The first type is the visual, deriving its material from visual perception; the second, the auditory, dependent on hearing; the third, the motor (kinæsthetic or tactual), constituted out of experiences of movement or touch. The last alone is not yet adequately determined. We may regard these as pure types, since an individual's imagery may possibly consist exclusively of visual, auditory, or motor elements. Gustatory and olfactory types may also exist, but are not

[1] See Chapter VI., above.

common. Various combinations of these are possible, and give rise to mixed types.

In attempting to determine the predominance of a type in any individual the nature of the reproduced object or process must be considered, because imagery tends to adapt itself in a certain degree to the nature of the object recalled; thus in recalling a procession visual imagery may be dominant with an individual who recalls a melody by auditory imagery. The predominance of one form of imagery—for instance, visual—may be the result merely of habit and not of an innate disposition to visualise. When the dominance of one type of imagery arises from congenital tendency, the other forms of imagery may exist only feebly, and an artificial change of imagery type, though difficult, is possible; or the other forms may be entirely absent, constituting a psychical defect for which, so far as our present knowledge extends, there is no compensation.

The two main forms of imagery—the concrete and the verbal—are in the same individual usually quite differently constituted. The difference in the material of the images corresponds to a difference of function. As words are acquired by an acoustic-motor process, in verbal imagery, auditory and motor elements preponderate over other sense elements. Consequently one or, at most, two forms of sensory elements are usually employed in the construction of verbal imagery, whereas concrete imagery is composed of sensory elements derived from other spheres. Thus, most individuals are visualisers when they do not think in words; when thinking in words they belong to the acoustic-motor type.

Within the concrete visual type there exist qualitative differences, some individuals imaging colours best, others forms. These differences may be intensified by training; but there are individuals strongly endowed in one such aspect, even when this is not due to training. In the concrete auditory, the tactual-motor, the olfactory, and the gustatory forms of imagery, differences and extremes are found similar to those existing in the visual sphere.

Of more importance pedagogically, and more exactly investigated psychologically, are the typical differences displayed in thinking in words. The following pure verbal imagery types can be distinguished : the auditory, who thinks in words heard, consequently in the imaged sounds of spoken words ; the visual, in the visual forms of printed or written words ; the motor type, in experiences of previous vocal movements, including incipient movements of the larynx, tongue, or lips. In addition to these pure types it has been maintained that there are indifferent or mixed types, in which there is no predominance of any one mode of sense elements. Whether all the possible types actually exist can only be determined by experiment : it is doubtful whether auditory-visual imagery without the presence of motor factors, or whether a visual motor type, exists.

There are three sets of methods for determining imagery types, namely, memory methods, association or reproduction methods, and the Kraepelin methods.

Of the memory methods, the simplest is to obtain the subject's introspection as to the process of retention. Various forms of distraction—for example, the beat of a metronome—can also be introduced in the memorising tests and the effects noted. The method of prompting or of aids may likewise be employed, as, for example, requiring the subject to learn rhythmically, which assists the auditory and motor type ; or grouping the material spatially, which assists the visualiser. Netschajeff's and Lobsien's tests [1] may also be applied for this purpose.

The reproduction methods or association tests have already been discussed,[2] and the necessary variations require but brief enumeration. The stimulus word may be either spoken or presented visually. Sounds, colours, etc., may be substituted for words as stimuli. The visualiser will, it may be concluded, generally respond more quickly to stimuli presented visually, or to visual terms, the audile to auditory stimuli and terms.

According to the Kraepelin methods a number of individuals are required to write out in a given time as many words as possible from a certain sensory sphere. As our vocabulary of words derived from the different sensory spheres varies, a direct comparison of the number of, say, the visual and the olfactory terms is not possible ; but the number of terms reproduced by an individual from one sphere may be compared

[1] See Chapter VII. [2] Chapter VIII.

with the number reproduced by another individual from the same sphere.

The secondary devices suitable for determining imagery types include the kinds of error made by different individuals in speaking, reading, and writing. The visually-endowed individual confuses words which appear alike but sound differently; the audile makes the opposite mistake. In learning nonsense syllables the visualiser attends to the consonants more than to the vowels, because the varying lengths of the former are more attractive to the eye; the vowels, on the other hand, receive more attention from the audile. The visualiser has a better local memory than the audile, recalling easily the position in a book where a passage occurs; in retaining a passage, however, the visualiser makes more omissions than the audile. A special device employed to determine the visual type is to require the subject to spell long words backwards. As the visualiser has all the letters before him he has much less difficulty in accomplishing this than the audile, who is dependent for the reproduction on the natural order of the letters of the word and can reverse this only with difficulty.

An experimental study of ideational types of American upper elementary and high-school pupils on the basis of ten different methods, including most of those just mentioned, has led the investigator to the conclusion that there is no reliable method for determining the imagery of children.[1] The tendencies found in one test are contradicted by those revealed in another.

We pass now to the important questions, how such imagery types are distributed in children, and wherein lies the educational significance of the doctrine. Unfortunately, final answers cannot be given without a systematic investigation of the imagery of large numbers of children of the different ages, and this has not yet been undertaken.

A fundamental question for the pedagogical significance of the imagery types is whether we have in them innate tendencies which from the outset dispose some individuals to employ visual imagery, some to think in vocal sounds, and others to apply the motor and tactual elements; or whether

[1] W. P. Wharton, *Experimental Study of Ideational Types.*

these differences are the result of education and training, that is, whether it is possible to change the type or not.

Experimental psychologists find that the type of imagery used can be altered by laboratory practice, and Baldwin considers that the method of learning may determine the type used.[1] "The part played by the visual and motor memories, in my own case," he says, "is seen in the fact that when I wish to speak in any language but English, the German words come first into my mind; but when I sit down to write in a foreign language, French words invariably present themselves. This means that my German is speech-motor and auditory, having been learned conversationally in Germany, while the French which was acquired in school by reading and exercise-writing is visual and hand-motor." Dispositions of a certain type may, however, be so weak that they are incapable of improvement: a change to this form is then impossible, and we recognise in it a defect in imagery type.

Children generally favour concrete imagery, while adults mainly use verbal imagery. Until fourteen years of age and over, children work more with concrete than with verbal imagery, although under the influence of school instruction they more and more come to think in words.[2] Whether the types are differently constituted in the different years of age is still undetermined. Children, like adults, when using concrete imagery, mostly visualise; in respect to verbal imagery they mostly belong to the acoustic-motor type. With females visual imagery remains throughout life more in evidence than acoustic-motor. The types, concrete and verbal, are very seldom pure types, other elements accompanying the predominating form according to the object imaged. All types appear to be alterable in the sense that weak aspects can be improved by training. Present-day instruction, in Meumann's estimation, tends to develop auditory and vocal imagery and to suppress concrete visual imagery.

How far pure types occur, and to what extent psychical defects exist among children, is important pedagogically, lest a task be enforced which, by reason of such defects, is incapable

[1] *Mental Development in the Child and the Race*, pp. 412–413.

[2] For analysis of children's imagery and relative proportions of various forms, see *British Journal of Psychology*, vol. iii. p. 376.

of performance. In the investigations which have so far been made with children, no case of an absolutely pure type has yet been discovered, and it is an advantage pedagogically that amongst children the mixed type predominates. A pure type Meumann regards in general as a defect.

The general didactic significance of the imagery types lies in the fact that each pupil is disposed to apprehend the material of instruction according to his preferred form of imagery, either mainly visually, acoustically, or in motor fashion; if a school task corresponds to his imagery type he is at an advantage, whereas when there is no such correspondence he has to attain his end indirectly. The teacher should consequently be acquainted with the imagery types of his pupils in order that he may know what to require of them. It has been suggested that pupils should be arranged in sections or classes according to their imagery types. This demand ignores the psychological fact that by far the greater number of pupils are of the mixed type, and that, by training, the undeveloped elements of imagery in each child can be improved.

In addition to imagery types, it has been maintained that memory types also exist. As these have been disclosed by the methods adopted in learning "by rote," they may be termed "learning types." There can be distinguished the slow and the quick type of learner—the former seems to be the rapid forgetter also;[1] then the purely mechanical learner who adopts no devices but learns by mechanical reiteration, and the mnemotechnical learner who cannot manage without the formation of helpful associations. Moreover, there are the analytic and synthetic types, the former directing the attention mainly to the whole, of which the particular elements are regarded as members, the latter connecting the particulars synthetically one to another.

Types of workers have been distinguished and denoted by the terms morning workers and evening workers.[2] With the former, the maximum of the day's work is attained during the morning; with the latter, in the evening. The intensity of sleep is differently regulated in the two cases. The morning worker begins right away to sleep soundly, and towards

[1] *Cf.* Chapter VII., above.
[2] Stern, *Differentielle Psychologie*, p. 191.

morning his sleep becomes lighter; with the evening worker the reverse is the case.

The existence of æsthetic types has been affirmed,[1] and four types of temperament—sanguine, choleric, etc.—are accepted by popular psychology. Temperament is, however, now regarded as a resultant of many relatively independent factors, and McDougall maintains[2] that it is impossible to distinguish any clearly defined classes of temperament.

From the foregoing it is evident that the doctrine of mental types has been very widely accepted. It is, however, equally evident that in almost every case where the existence of types has been affirmed, it has later been denied. Even those who, like Stern, uphold the doctrine of types and maintain that the exact logical and methodological formulation of the concept of "type" is one of the most urgent problems of the science of individual differences,[3] nevertheless define the concept with such reservations as to excite suspicion as to its validity. In his definition[4] Stern allows that the group of individuals who have in common the specific disposition constituting the type is not sharply delineated from other groups of individuals, and he distinguishes a type from a class,[5] in the former the limits being fluid, in the latter sharply defined.

Thorndike rejects the doctrine of different mental types, maintaining that there is only one type, that the variations in the capacities and achievements of individuals cluster round one central tendency or type, and that such variations are usually, perhaps always, continuous.[6] The case for this single type theory is, he asserts,[7] stronger in combinations of original traits than in traits produced by training. The objections which he urges to the doctrine of types are:[8] (1) that the single type theory arose from exact measurements, while its opposite came from speculative prepossessions, and that in proportion as exact measurements have been applied, evidence expected to favour the multiple theory has turned

[1] See Chapter IX., above.
[2] *Social Psychology*, p. 117.
[3] *Differentielle Psychologie*, p. 162.
[4] *Ibid.*, p. 168.
[5] *Ibid.*, p. 173.
[6] *Educational Psychology*, vol. iii. p. 317.
[7] *Ibid.*, p. 384.
[8] *Ibid.*, pp. 379–380.

out in favour of the single type theory; (2) the rarity of the inverse correlation between desirable traits upon which so many of the supposed multiple types are based; (3) the fact that the single traits involved are so often distributed each approximately symmetrically around one mode; (4) the fact that investigators who are strongly in favour of the multiple type theory and accustomed to interpret facts in harmony with it, yet find so few actual cases of it.

Thorndike's conclusion is, however, that "it is not necessary to try to decide between these two theories, or to determine just what compromise is the true one. It is better to accept frankly our ignorance of just how individuals do differ in combinations of traits until they have been measured in respect to all the traits involved." [1]

A question which arises in regard to the relation between mental traits is whether some individual differences are related inversely and are reciprocally exclusive, or whether others are directly correlated or mutually dependent on one another. The belief in mental compensations or antagonisms is a popular one; for example, it is thought that the person who is blind is endowed congenitally with, or acquires, special sensitivity in regard to auditory experiences, and that the individual richly endowed with imagination is useless at abstract work. The belief in the mutual dependence of mental characteristics, although apparently incompatible with the belief in mental compensations, is no less general: it takes the form of maintaining that there is some fundamental capacity of general intelligence which enables an individual possessed of it to apply it successfully in whatever mental sphere he desires.

In original nature, as Thorndike states, the rule is correlation, not compensation.[2] Such popularly accepted antagonisms or inverse relations as have been specifically investigated have not been confirmed.[3] As an illustration we may cite the investigation of Winch,[4] who sought to determine how far substance-memory, that is, memory for ideas irre-

[1] *Educational Psychology*, vol. iii. p. 379.
[2] *Ibid.*, p. 363.
[3] Cf. *ibid.*, p. 361.
[4] *British Journal of Psychology*, vol. iv. pp. 95–125.

spective of their verbal expression, is in school children compatible with imagination, in the sense of invention or productive imagination. He shows, contrary to popular opinion, that there appears to be considerable positive correlation in school children between the two functions, or sets of functions, employed in memorising the substance of stories and in inventing stories under given conditions.

As instances of direct correlation or of the mutual dependence of traits on one another we may enumerate the following. Certain qualities of attention, for example, appear regularly to accompany certain description types; the fixating quality of attention, for example, is apparently the cause of the describing and analytic types of apprehension. The synthetic and the analytic methods of learning may stand in close connection with the synthetical and analytical forms of attention. Sense-memory congenitally strong in one department determines the one-sided imagery type, an all-round developed sense-memory the mixed type; acoustic-motor imagery facilitates in retention the formation of successive series, visual imagery the simultaneous reproduction of concrete content. Rapid adaptation of attention seems to be accompanied by rapid loss of adaptation. These results have been obtained with adults and still require confirmation in respect to children.

Investigations on these lines should provide us with the data necessary to determine comparatively the typical differences in the child and the adult. We are still without means of determining whether, for example, the child's excessive use of concrete imagery is responsible for his slow development in abstract thinking and his slow rate of reproduction in association tests; also whether the child's limited capacity for learning, in comparison with the adult, is due to weak concentration of attention or to some property of memory independent of attention; or, again, whether the more permanent retention of the child is a result of the greater number of repetitions required in learning, or indicates a special property peculiar to the child's memory. Experimental Education must, for the present, be content with raising these questions.

The results of certain experimental investigations on the question of compensating for defects by means of training are available and worthy of mention. A typically slow adapting learner, it has been found, can become a typically rapid adapting learner ; a defect in the capacity to withstand distractions can to a large extent be remedied by habituation ; and the extension and distribution of attention may also be improved by training. The attempt to cultivate a fixating type of attention in an individual of the fluctuating type, however, meets with but slight success, and weak elements in concrete visual imagery may be strengthened without any effect on verbal imagery.

As a practical outcome of this, means should be found to discover early any defect in the child's endowment, and suitable exercises devised whereby the child, however endowed, may be trained to satisfy the normal requirements of the school. From the results of memory tests, and from the fact of the dependence of imagery type on training, it is maintained that much may be done by formal training of the laboratory type ; and when by adequate analysis of the work of the child in the various school subjects we are able to discover the cause of weakness in a given subject and to apply appropriate remedial training, there will, Meumann suggests,[1] be no excuse for any child not mentally deficient remaining backward in school work.

The doctrine of individual differences demonstrates that variations in the endowment of children are too great to be disregarded. To what extent they will affect the curricula and organisation of schools it is impossible at present to determine. Meumann maintains that these latter conditions must be decided not merely from the standpoint of individual differences and endowment types, but that practical and ethical requirements must also be taken into consideration. With too little faith in the conclusions of the science which he did so much to establish, he would hesitate to accept a one-sided psychology requiring such a degree of individualisation of instruction as to be incompatible with class instruction.[2] Practical educationists have no such hesitation. The Montessori system has abandoned the use of class instruc-

[1] *Vorlesungen*, vol. ii. pp. 755–756.
[2] *Ibid.*, p. 120.

tion. In the *Schools of To-morrow* Dewey gives accounts of various forms of individualised instruction, and experiments in individualised instruction in the higher school subjects have been more than justified.[1] The conclusions of psychology are thus coming to be confirmed by the latest, and doubtless the best, educational practice.

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[1] *Mind in the Making*, pp. 253–255.

CHAPTER XII

ENDOWMENT

THE metaphysical question of the relation of inheritance and environment appears in educational science as the question of the relation between natural endowment, or innate ability, and educative influences. The educator no longer believes that the mind of the pupil is a *tabula rasa,* and that he can make of the pupil what he will; nor, on the other hand, that the pupil's progress is the result of the spontaneous evolution of innate capacities, and that it is quite unaffected by the teacher's efforts. But exactly how much is to be attributed to native ability, and how much to the influences of education, is the question which Experimental Education has set itself to determine.

The standard usually applied by teachers and others to estimate a pupil's endowment is the school work of the pupil. The unsatisfactoriness of such a standard is evident in the limitations and reservations which commonly accompany the statement of such a principle—for example, that an intelligent pupil, owing to bad health, unfavourable home influences, or other causes, may not excel in school work, whereas a less intelligent pupil by great zeal may stand well in class. The fact that the teacher's estimate of a pupil's ability is frequently falsified in later life also indicates that not all the factors necessary to estimate endowment fully have been taken into consideration.

To Binet and Simon is due the credit of devising a scale the purpose of which was to enable the degree of native ability of a child to be determined. The tests were arranged on an age basis, and this conduced considerably to the popularity of the scale, since the results obtained by its use could be expressed in definite and easily intelligible terms; thus an eight-year-old child who could successfully pass only the tests for six years of age is two years behind the requirements for his age, and is consequently bordering on deficiency. The scale has the further advantages that no costly instruments are necessary for its application, and the instructions which it is necessary to follow are expressed in simple terms.

From the following abstract of the tests the general nature of the scale can be inferred:—[1]

Mental age three years.—Indicate nose, eyes, mouth. Repetition of two digits. Description of scenes in pictures. Surname. Repetition of a sentence.

Five years.—Statement of sex. Naming of familiar objects. Repetition of three digit numbers. Estimation of comparative lengths of two lines.

Five years.—Comparison of weights. Copying with ink a square. Repetition of two unconnected sentences. Counting four pennies. Reconstruction of rectangle out of diagonally divided card.

Six years.—Knowledge of significance of terms "morning" and "afternoon." Definitions of simple objects. Copying diamond figure. Counting thirteen pennies. Determination of which of two decidedly contrasted faces of women is the prettier.

Seven years.—Indicate right hand, left ear. Description of pictures. Execution of three commissions. Cost of three penny and three halfpenny stamps. Names of colours—red, blue, yellow, green.

Eight years.—Stating distinction between paper and cardboard, a fly and a butterfly, wood and glass. Counting backwards from 20 to 0. Recognition of such missing features in drawn figures, as nose, eye, ear, arms. Date. Repetition of series of five digits.

Nine years.—Giving of change. Definitions. Names of nine coins of different denominations. Naming of months of year. Statement required of what should be done in certain emergencies.

[1] For full 1911 scale see *A Method of Measuring the Development of the Intelligence of Young Children*, by Alfred Binet and Th. Simon. Authorised translation by Clara Harrison Town.

Ten years.—Comparison of five graded weights. Drawing designs from memory. Detection of absurdities in given statements. Judgment on certain problems. Construction of sentence or of two sentences to contain three given terms —for example, Paris, fortune, stream.

Twelve years.—Comparison of series of lines suggesting regular increases in length. Inclusion of three given terms in one sentence. Naming at least sixty words in three minutes. Definition of such abstract terms as charity, justice, kindness. Arrangement in proper order of jumbled words of a sentence.

Fifteen years.—Repetition of series of seven digit figures. To find in one minute three words rhyming with "obey." Repetition of two unconnected sentences. Interpretation of pictures. Inferences from given facts.

Adult.—Drawing of appearance of a sheet of paper out of which when folded in four a triangle has been cut. Drawing form of a triangle as it would appear when placed along the hypotenuse of a similar triangle. Statement of difference between given abstract terms—for example, idleness, laziness, Difference between King and President. Reproduction of sense of a passage read.

The mental age of a child is the age-level at which he passes all the tests or all but one, since failure with a single test being possibly caused by a lapse of attention is not reckoned, a year being added for every five tests passed above that level. If a child's mental age shows a retardation of two years as compared with his chronological age, or of three years when he himself is nine years of age or more, there is, according to Binet, serious deficiency. As with imbecile and feeble-minded children mental development is arrested, Binet maintains that the imbecile does not progress beyond the mental age of seven and the feeble-minded or moron beyond the age of nine; the upper limit of moronity has also been placed at twelve.

The supernormal child has not been definitely defined in terms of mental age. Petzoldt defines a gifted child as one who, without detriment to his health, can accomplish two years' work in one.[1] This is, however, a *hysteron proteron.* What we should know is what child should be encouraged

[1] Cf. *Journal of Educational Psychology*, vol. vii. p. 299.

to perform two years' work in one. When the supernormal child has been detected, we must determine whether he possesses a specific aptitude, for example, has a talent for mathematics, or is a musical prodigy, or whether it is in general ability that he is conspicuous. The treatment would probably differ in these cases.[1]

The criticism of the Binet scale by Ayres,[2] from the point of view of the content of the tests, falls under six heads: (1) The tests predominantly reflect the child's ability to use words fluently, and only in small measure his ability to perform acts. (2) Five of them depend on the child's recent environmental experience. (3) Seven depend on his ability to read or write. (4) Too great weight is given to tests of ability to repeat words and numbers. (5) Too great weight is given to "puzzle tests." (6) Unreasonable emphasis is given to tests of ability to define abstract terms.

The main defects of the scale, according to Meumann,[3] are: (1) The single tests are not rightly graded according to their difficulty. (2) The tests determine quite different capabilities, that is, they are not systematically arranged according to definite points of view. (3) The tests of each kind are not sufficiently numerous, and the tests of a definite class are not systematically repeated for each year. (4) Abnormal children with quite specific defects, mental or moral, are not detected. (5) The tests are adapted to a definite *milieu*. (6) What exactly the aim of the whole testing is, has not been definitely decided.

Difficulties attend the method of calculating the mental age and the interpretation of the results. All the age levels do not contain a like number of tests, the four-year-old comprising four, the others five;[4] it may be easier to pass three

[1] *Cf.* Stern, "The Supernormal Child" (*Journal of Educational Psychology*, vol. ii. pp. 143–148, 181–190).

[2] *The Binet-Simon Measuring Scale for Intelligence: Some Criticisms and Suggestions.*

These objections may not all be valid, as has been contended by various writers, notably by Miss Clara Schmitt in *The Pedagogical Seminary*, vol. xix., and F. Kuhlmann in *Journal of Psycho-Asthenics*, vol. xv.

[3] *Vorlesungen*, vol. ii. pp. 278–283.

[4] In 1911 scale, which is better in this respect than the earlier 1908 scale.

out of four than four out of five tests. At the top of the scale there are not the same opportunities for recovering from one's failures as there is lower down the scale, where a wider range of higher tests is available. The absolute amount of retardation, that is, the difference between the mental age and the chronological age, is not a comparable quantity when different age-levels are in question. As the development of the feeble-minded is slower than the normal development, the same deficiency shows an increasing amount with increasing chronological age. A twelve-year-old child with a mental age of nine is not of the same degree of feeble-mindedness as an eight-year-old child with a mental age of five. This was recognised by Binet himself.[1] To compare such cases Stern has suggested the use of the mental quotient ?[2] "This quotient shows what fractional part of the intelligence normal to his age a feeble-minded child attains. Mental quotient = mental age ÷ chronological age. An eight-year-old child with a mental age of six has, then, a mental quotient of $\frac{6}{8} = 0 \cdot 75$. A twelve-year-old child with a mental age of nine has the same mental quotient." The mental quotient is valid, however, only when development is still in progress. It is useless to calculate the quotient for idiots whose mental development has been arrested long before the ages at which they are subjected to examination.

A more exact method of evaluating the answers to the Binet tests and of estimating the mental standing of the pupils tested is the point-scale procedure devised by Yerkes.[3] Instead of crediting a satisfactory answer merely with a "pass" and of designating a test unsatisfied as "failed," marks are awarded in accordance with the degree of merit of the answers returned; thus, in the test on the detection of missing features in which four drawings are exhibited with the omissions of arms, nose, mouth, eyes, one point is allowed for each omission detected, four points being the score for an

[1] *Mentally Defective Children*, English trans., p. 64.

[2] *Psychological Methods of Testing Intelligence*, trans. by Whipple, p. 80.

[3] R. M. Yerkes and H. M. Anderson, "The Importance of Social Status as indicated by the Results of the Point-Scale Method of Measuring Mental Capacity" (*Journal of Educational Psychology*, vol. vi. pp. 137–150).

absolutely correct answer, three when one omission is not detected, and so on. In the test which requires the repetition backwards of the digits 20–1, four points are allowed for a perfectly correct recital, three points when only the numbers 15–1 can be said backwards, two points for 10–1, and one point for 5–1. The maximum score for the twenty tests arranged on this plan is a hundred points, and the individual's performance is expressed in terms of the number of points obtained. Norms for the various ages for pupils of different nationalities, social status, etc., have been deduced, and a pupil's "coefficient of intelligence" is the ratio of his point-scale score to the expected score or norm of his age, etc. Yerkes approves of the suggestion that the physiological age should be adopted in the point-scale procedure.[1]

A further difficulty attending the use of the Binet scale arises from variations in the range of distribution of the tests satisfied. The stage of development of two children may be indicated by the same mental age yet represent quite different performances, the tests being in one case irregularly distributed over a wide range of ages, in the other case being closely distributed. The area of irregular distribution is very much wider with the feeble-minded than with the normal child; by some investigators it is regarded as twice that of the latter. This distribution should also be taken into consideration in estimating the value of the five additional higher tests which must be passed to add a year to a pupil's mental age. The five tests might in one case comprise three from the year immediately above that at which all were passed and two from the age level two years above, in the other case one from each of these years, and three from the age level three years in advance of that at which the whole tests for a year were passed. The intelligence of the latter child is evidently of a higher type than that of the former, although both are by calculation at the same mental level. Stern has suggested a method for overcoming this difficulty,[2] but it deprives the scale of one of its chief recommendations, namely, ease in calculating the results.

[1] R. M. Yerkes and Louise Wood, "Methods of Expressing Results of Measurements of Intelligence: Coefficient of Intelligence" (*Journal of Educational Psychology*, vol. vii. pp. 593–606).

[2] *Psychological Methods of Testing Intelligence*, pp. 107–108.

The instructions for applying the scale, although apparently simple, are not free from ambiguity. In a test for five-year-old children, for example, an oblong card is cut in two across the diagonal, and the two pieces are arranged so that the two hypotenuses form a right angle. Although it is stated that neither half must be turned over, various arrangements satisfy this instruction, for example,

and the difficulty of reconstituting the original rectangle is not the same with each arrangement. The apparent simplicity of the scale may itself constitute a defect. It may come to be applied by untrained individuals, ignorant of the conditions of exact experiment; and the results obtained by such observers will not only be valueless, but positively misleading.

In spite of these defects the scale has been applied in practically every civilised country, has received wide general approval, inspired a considerable amount of discussion, and initiated new types of investigation.[1] It enables a rough classification of pupils to be made in a comparatively short time by relatively simple means. Its value is practical and pedagogical rather than theoretical and psychological. It is without doubt a considerable advance on the estimates of intelligence based on school performance or on the one-sided and uncontrolled judgments of teacher or parents.

The suggestions for the improvement of the scale are bewildering in number and variety. They take the form, as by Johnston and Bobertag,[2] of a rearrangement of the tests,

[1] Meumann's treatment of the Binet scale extends to over 160 pages —*Vorlesungen*, vol. ii. pp. 131–299.

An annotated bibliography by S. C. Kohs in *Journal of Educational Psychology*, vol. v. (1914), gives references to 254 articles dealing with the Binet scale. The reader is referred to this bibliography for a fuller survey of the work on the Binet scale than could be attempted here.

[2] K. L. Johnston, *Journal of Experimental Pedagogy*, vol. i. pp. 24–31; O. Bobertag, *Zeitschrift f. angew. Psych.*, vol. v. pp. 105–203; vol. vi. pp. 495–537.

lowering the early age tests which are found too easy, raising the tests at the higher levels which are too difficult, and transposing some tests from one age to another, a suggestion anticipated, and adopted, by Binet himself in his 1911 scale; or of additions to the scale, as by Goddard,[1] who advocates the introduction of the form-board;[2] and by Terman and Childs,[1] who propose ten tests for each age with systematic repetition of each, and suggest the use of the completion test —filling in the missing words in a mutilated text,[2] definitions of words, the interpretation of fables, and others.

More radical improvements have been recommended by Seashore, Pyle, and others. These writers demand a more fundamental analysis and exacter determination of mental ability than is possible by means of the Binet scale in its original forms. Thus Seashore writes:[3] "Retardation does not follow a common, flat level any more than growth does, nor even nearly so much. A child develops one capacity several times as fast, and often at the expense of another faculty. This differentiation is even more striking in retardation. What is more, those who employ the tests for practical purposes should not be satisfied with a flat mental age. . . . In a study of the normal individual we seek to discover his *fortes* and his faults, in short, to discover his particular deviation from the norm of the common level. There is no reason why the Binet-Simon tests should not develop into specific measures of the relative rank, or age, of more specific capacities and powers, such as reasoning ability, sensory observation, memory, imagination, initiative, emotional life, self-control, etc. A child may be at the mental age of six in one capacity and twelve in another, and the important thing to know about the individual is this difference and direction of unsymmetrical development. It may be that a general flat-age test must be retained for certain purposes, but even that must be interpreted in the light of measures

[1] H. H. Goddard, *Journal of Psycho-Asthenics*, vol. xv. pp. 17–30; L. M. Terman and H. G. Childs, *Journal of Educational Psychology*, vol. iii. pp. 61–74, 133–143, 198–208, 277–289.

[2] For illustration of form-board see Whipple, *Manual of Mental and Physical Tests*, part i. p. 299; and for examples of completion tests, part ii. pp. 283–300.

[3] C. E. Seashore, *Journal of Educational Psychology*, vol. iii. p. 50.

of specific capacities. Only by extension in recognition of this principle can any set of tests be of permanent value."

Pyle argues to the same effect.[1] "There is not in the Binet tests or any of the modifications yet proposed sufficient system—no common plan running through the tests for the successive years. . . . We should plan a series of tests for determining the degree of development of logical memory, rote memory, attention, imagination, association, and two aspects of mind more complex, learning capacity and reasoning. . . . It is more important, it seems to me, to know specifically the condition of the child with reference to the development of the separate mental traits than to know his average performance with respect to them all."

Binet himself recognised these deficiencies in his scale.[2] He writes in regard to the mental age: "It has no bearing on the cause of the retardation, nor upon its particular nature, nor upon the means of rectifying it." And in regard to the fallacy of regarding retardation as merely equivalent to a lower mental age he writes:[3] "A defective child does not resemble in any way a normal one whose development has been retarded or arrested. He is inferior, not in degree, but in kind. The retardation of his development has not been uniform. Obstructed in one direction, his development has progressed in others. To some extent he has cultivated substitutes for what is lacking. Consequently such a child is not strictly comparable to a normal child younger than himself."

Much then that passes for criticism of his work would have been welcomed by Binet as an extension of it. The line of such development has been somewhat comprehensively indicated by Meumann.[4] His proposals fall under the following heads:

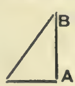
A. Endowment or Intelligence Tests proper,
B. Tests of Development in the narrower sense,
C. Tests of Environment, (*a*) such as determine the influence of school training, (*b*) such as establish

[1] *Journal of Educational Psychology*, vol. iii. pp. 95–96.
[2] *Mentally Defective Children*, English trans., p. 12.
[3] *Ibid.*, p. 13.
[4] *Vorlesungen*, vol. ii. pp. 286–288.

the influence of the home and family, (*c*) tests which show what the child relatively influenced by his environment has acquired through spontaneous observation and the working up of his observations.

In comparison with the (*a*) and (*b*) tests, which are concerned with adaptation, the (*c*) tests are tests of spontaneity.

It must be kept in mind, Meumann warns us, that with all these divisions we are not dealing with completely separable phenomena, since there is no endowment which is uninfluenced by development, and endowment as well as development is influenced by environment. Nevertheless endowment, development, and environmental influences are three different causes of the general intellectual constitution of the child, and we must attempt to establish as definitely as possible the relative contribution of each. None of the earlier applied intelligence tests need be discarded; rather to each type should be assigned its special function in the general estimation of the mentality of the child.

Under A, Meumann includes tests on (1) concentration and fixation of attention; (2) the immediate retention of verbal and non-verbal material; (3) the combination test by the improved Ebbinghaus method; (4) imagination and thinking by means of descriptions of pictures; (5) concentrating on, and employing, visual images in spatial problems, as in the folded paper test (Binet's first test for adults), or, better, such a test as: What kind of solid figure is produced when a right-angled triangle like this 

is rotated around A B as axis? (6) thinking, by means of controlled association tests; (7) concentration and synthesis through comparisons and differentiations of different difficult objects both in the presence of the objects and in recollection. These psychical functions should be proved at each age by means of direct tests.

Under B, as development tests, could be applied: (1) the range of attention; (2) vocabulary tests; (3) memory span; (4) reproduction of words, for example, as in opposites test; (5) tests on temporal orientation.

As environment tests, under C, might be valid : (1) school knowledge (knowledge of number, of coins, of days of week, of date, of names of month, writing from a copy, and writing to dictation ; (2) knowledge acquired at home : meaning of words designating household articles, above and below, right and left, before and after, testing errors in speech, correctness of speech, number of fingers ; (3) spontaneous observation, by making inventories of mental contents.

Meumann's further recommendations refer to the methods of reckoning the results and with the technique of applying the tests, matters partly dealt with above.

Of a type similar to those in the Binet scale are the tests devised by de Sanctis.[1] They were designed primarily to measure not the level of intelligence, but the degree of mental defect. The tests are :—

I. *Give me a ball.* (Present five balls, each of a different colour. Note the time of response.)

II. *Which is the ball you just gave me?* (Show the same five balls arranged in a row. Note time of response.)

III. *Do you see this block of wood?* (Show a wooden cube.) *Pick out all the blocks like this from the pile on the table.* (Show five cubes mixed with three cones and two parallelopipeds.) Note the time required for selecting and arranging the cubes.

IV. *Do you see this block?* (Show a cube.) *Point out a figure on the form chart*[2] *that looks like it.* (Show the form chart, and note the figure to which the subject points. If he points to one of the small squares, proceed as follows) : *Take this pencil and point out all the squares on the chart as fast as possible without missing any, taking the figures line by line.* (Note the time, the mistakes and omissions.)

V. *Here are some more blocks like those you have pointed out on the chart.* (Spread the blocks out on the table in such a manner that the distance between the cubes is not more than two centimetres. Each cube should be just one-half centimetre longer on each side than the next smaller one.

[1] *Cf.* S. de Sanctis, "Mental Development and the Measurement of the Level of Intelligence" (*Journal of Educational Psychology*, vol. ii. pp. 498–507).

[2] For illustration of form chart see *Journal of Educational Psychology*, vol. ii. p. 506.

To make the test more difficult one may (*a*) increase the number of cubes scattered on the table, or (*b*) decrease the differences in size.) *Look at them carefully and tell me:* (1) *How many there are;* (2) *which is the largest?* (3) *which is the furthest away from you?* (Note the time, the errors, and the omissions.)

VI. *Do large objects weigh more or less than small objects? Why does a small object sometimes weigh more than a large one?* (The second question is put if the first has been answered correctly.) *Do distant objects appear larger or smaller than near objects? Do they only seem smaller or are they really smaller?* (This question will show whether the subject is aware of optical illusions.)

If the subject does not pass the second test the mental deficiency may be considered of a high grade. If the subject cannot go beyond the fourth test, or if he makes many mistakes or is very uncertain in the fifth, the mental deficiency may be considered slight. Finally, if the sixth test is completed without mistake, the subject may be said to present no mental deficiency.

Instead of "mental age" Burt has adopted [1] as a measure of backwardness and mental deficiency the standard deviation (σ) [2] of normal pupils, that is, of pupils who are in the usual class for their chronological age, for example, are at seven years of age in Standard I. The standard deviation he finds to be about one-tenth. "In educational ability normal children tend to vary above and below the average level for their age as follows:—

> at the age of 10 by at least 1 year,
> at the age of 5 by just ·5 (half) of a year,
> at the age of 15, in all probability by nearly 1·5 years,
> and throughout, by about one-tenth of their age." [3]

A child who is retarded by more than three-tenths of his age is regarded as qualified for a special (M.D.) School,[4] and,

[1] C. Burt, *The Distribution and Relations of Educational Abilities*, (King & Son, London).

[2] See Chapter II., above.

[3] *The Distribution and Relation of Educational Abilities*, p. 31.

[4] *Ibid.*, p. 35.

"for practical purposes, 'backward' may be taken to denote children who, though not 'defective,' are yet unable, in the middle of their school career, to do the work even of the class below their age; or, more exactly, children who deviate below the normal by at least one and a half times the 'standard' deviation of individuals of the same age-group; and therefore are retarded by 15 to 30 per cent. of their age."[1]

The determination of endowment and the measurement of general intelligence have been approached in quite a different fashion, namely, in a more strictly psychological manner than by the use of the Binet scale, for the tests constituting such a scale are in the opinion of Myers "tests of production" rather than "psychological" tests. "They determine,"[2] he says, "how *much* an individual can work, how *much* he knows—not *how* he works, *how* he knows. A man's productivity, of course, is what we want to ascertain in everyday life. We do not care how a man comes to use or to acquire his powers; we are content with a mere dynamometric or other record of his prowess. But this aspect cannot properly be called the psychological aspect."

Certain psychological tests devised to investigate special mental functions were found to give results varying generally with the degree of intelligence of the subjects. When this was discovered they were diverted from their original purpose, employed as methods of diagnosing endowment or general intelligence, and classed under the general title, "Test-Methods."

The test methods fall into two classes: (1) isolated tests, and (2) serial tests. The former were the first to be employed. It was found in investigations on sensory discrimination that generally the most intelligent subjects had the lowest thresholds, and it was concluded therefrom that one had only to measure, for example, the sensitivity to differences in pitch, or the spatial threshold, to determine the degree of intelligence of an individual. Memory tests, association tests, etc., were also thought to give results indicative of the degree of intelligence; but extended applications of these methods usually resulted in contradictory conclusions. An exceptionally good memory is often found to coexist with very low intelligence,

[1] *The Distribution and Relation of Educational Abilities*, p. 82.
[2] *British Medical Journal*, No. 2613, pp. 196–197.

and in reaction-time tests rapidity may frequently be accounted for by the fact that the responses made are of no value qualitatively.

Wundt holds that attention is the central function of mental life. Burt[1] regards the irregular dotting test, a test specially devised to secure voluntary attention, as a better index of general intelligence than any sensory or memory test. From the results of a later investigation he concludes that reasoning tests seem to give correlations with intelligence which are as much superior to attention tests as these are to the sensori-motor tests.[2] Meumann likewise maintains[3] that the more a test proves the imaginative and thinking capacity of an individual the more valuable is it for the diagnosis of endowment.

The results obtained by the application of the isolated test methods are of doubtful value. Stern, indeed, maintains,[4] that "no single test, no matter how good it may be, should ever be made the instrument for testing the intelligence of an individual." "Negatively," he adds,[5] "it must be declared that the method of isolated tests, the idea of basing everything on a single test, is methodologically no better than such a procedure as judging the total character of a man on the strength of the single arbitrarily selected symptom of his handwriting." The chief defects of the isolated test-methods, according to Meumann,[6] are: (1) we do not know what part the function tested plays in endowment; (2) only the average results of such tests have significance; (3) the results of the separate tests cannot be summed to give a definite estimate of general capacity; (4) they do not enable us to determine the actual constitution of the endowment of an individual, for the reciprocal action of the various abilities on one another is ignored.

In spite of these defects the advantages of the isolated test-methods, Meumann adds, should not be overlooked. These comprise: (1) the isolated tests can sometimes be employed as preparatory tests to sort out individuals for more exact

[1] "Experimental Tests of General Intelligence" (*British Journal of Psychology*, vol. iii. pp. 94–177).

[2] *Child-Study*, vol. iv. p. 93.

[3] *Vorlesungen*, vol. ii. p. 708.

[4] *Psychological Methods of Testing Intelligence*, p. 19.

[5] *Ibid.*, p. 22.

[6] *Vorlesungen*, vol. ii. pp. 320–325.

examination; (2) they retain their value as means for determining quantitatively particular capacities.

The serial tests or systems of selected, graded, and connected tests of a psychological nature have much greater value than the method of isolated tests. By grading the tests in order of value, and by constructing new tests suitable for the higher mental functions, it has been contended that we are provided with the means of solving the question of the existence and measurement of general intelligence.

The most interesting system of tests is that of Rossolimo.[1] Its value lies not in the originality of the tests nor in their grading and classification, but in the means whereby the results are represented graphically.

Rossolimo's method assesses numerically eleven psychical processes, the values assigned varying from zero to ten. The eleven processes comprise attention, will, apprehension, visual memory, memory for the elements of speech, numerical memory, comprehension, conbination, mechanical sense, imagination, and observation, with several subdivisions of each which need not be enumerated here. Ten tests for each process or partial process are put to the subject, and the score for each process is indicated by a mark on a table. The points are joined up, the resulting figure being a "mental profile" of the individual.

	0	1	2	3	4	5	6	7	8	9	10
Attention . .	.	.	.	.	.	.	.	.	.	.	.
Will . . .	.	.	.	.	.	.	.	.	.	.	.
Apprehension .	.	.	.	.	.	.	.	.	.	.	.
Memory—											
Visual . .	.	.	.	.	.	.	.	.	.	.	.
Auditory . .	.	.	.	.	.	.	.	.	.	.	.
Numerical . .	.	.	.	.	.	.	.	.	.	.	.
Comprehension .	.	.	.	.	.	.	.	.	.	.	.
Combination . .	.	.	.	.	.	.	.	.	.	.	.
Mechanical sense .	.	.	.	.	.	.	.	.	.	.	.
Imagination . .	.	.	.	.	.	.	.	.	.	.	.
Observation . .	.	.	.	.	.	.	.	.	.	.	.

[1] "Mental Profiles: A Quantitative Method of Expressing Psychological Processes in Normal and Pathological Cases" (*Journal of Experimental Pedagogy*, vol. i. pp. 211–214). *Cf.* Stern, *The Psychological Method of Testing Intelligence*, pp. 25–26.

The above illustrates in simple form the scheme suggested by Rossolimo.[1]

As illustrative [2] of the attempts to grade mental tests in order of value for diagnosing general intelligence we may cite the investigations of Burt.[3] His first investigation was carried out at Oxford with thirty elementary school pupils and thirteen preparatory (junior secondary) pupils. The general intelligence of the thirty elementary school pupils taking part in the investigation was estimated by the Headmaster of the school on the basis of the school marks and of his personal experience and knowledge of the boys. A second grading was furnished by their class masters, and a third by two of their schoolfellows. In the case of the thirteen boys from the preparatory school the Headmaster's estimation was again based on the class orders, and a supplementary grading was supplied by two boys holding responsible positions in the school, not themselves on the list. The tests applied, with the nature of the process tested and the degree of correlation with intelligence as estimated above, may be set forth thus :—

[1] For more complete illustrations see *Journal of Experimental Pedagogy*, vol. i. pp. 211–214, or Meumann, *Vorlesungen*, vol. ii. p. 336.

[2] No attempt is made here to deal exhaustively with the doctrine of endowment, as may be inferred from the fact that Meumann's treatment extends to almost 700 pages. *Vorlesungen*, vol. ii. pp. 94–781.

[3] C. Burt, "Experimental Tests of General Intelligence" (*British Journal of Psychology*, vol. iii. pp. 94–177) ; "Experimental Tests of Higher Mental Processes and their Relation to General Intelligence" (*Journal of Experimental Pedagogy*, vol. i. pp. 93–112) ; "The Experimental Study of General Intelligence" (*Child-Study*, vol. iv. pp. 33–45, 92–101).

Nature of Process Tested.	List of Tests.	Correlation with Intelligence.	
		Elementary School.	Preparatory School.
I. Sensory Tests.			
Perceptual discrimination.	1. Discrimination of two points upon the skin	·13	–·06
	2. Discrimination of lifted weights . . .	–·13	–·19
	3. Discrimination of pitch	·40	·37
	4. Comparison by eye of lengths of lines .	·29	·17
II. Motor Tests.			
Simple Reactions .	5. Tapping . . .	·47	·43
	6. Card-dealing . .	·44	·29
III. Sensori-motor Tests.			
Reactions complicated by discrimination.	7. Card-sorting . .	·52	·56
Reactions complicated by recognition.	8. Alphabet finding . .	·61	·80
IV. Association Tests.			
Immediate Memory .	9. Immediate retention of—		
	(*a*) Concrete words .	·58	·84
	(*b*) Abstract words .	·48	·78
	(*c*) Nonsense syllables .	·43	·75
Formation of associations during motor activity.	10. Mirror test . .	·67	·54
Formation of associations during perceptual activity.	11. Spot pattern test .	·76	·75
V. Test of Voluntary Attention.			
Maximal effort of sustained attention.	12. Dotting irregular dots	·60	·84

A further investigation was undertaken at Liverpool with tests of an even higher and more complex order than those previously used, the subjects being sixty to seventy-five pupils between eleven and a half and thirteen and a half years of age attending a mixed school, and it gave the following correlations :—

Alphabet	·42
Division of Lines—	
1. Cutting off one-half	·08
2. Cutting off one-third	·19
3. Cutting off one-quarter	·25
4. Cutting off two-fifths	·21
Erasure of Letters	·39
Addition	·25
Multiplication	·41
Speed of Reading (aloud)	·26
,, ,, (silently)	·21
Speed of Writing	·42
Association of Words	·13
Answering Questions	·35
Formation of Sentences	·62
Completion of Analogies (group)	·52
,, ,, (individual)	·50
Completion of Sense (story)	·48
,, ,, (argument)	·53
Reconstruction of Pictures (group)	·72
,, ,, (individual)	·46
Syllogisms	·45
Apprehension of Number	·64

From his extensive investigations Burt concludes :[1] "By means of some half-dozen brief experiments we are able independently to arrange a group of strange boys in an order of intelligence which shall be decidedly more accurate than the order given by scholastic examinations, and probably more accurate than the order given by the master, based on his personal intercourse with them during two or three years, and formulated by him with unusual labour, conscientiousness, and care."

The main assumptions implied in these investigations are that there exists such a mental capacity as "general intelligence," and that the teacher's estimate of it is a valid standard

[1] *Child-Study*, vol. iv. p. 93.

with which to correlate the results of the psychological tests. Both assumptions have been questioned.

In regard to the latter, Meumann affirms [1] that we should expect that the serial order of the pupils as determined by the psychologist should not agree beyond a certain point with that of the teacher, since the two estimates are arrived at from different standpoints, one regarding endowment in a purely psychological fashion, the other as expressed in the limited form of school work. A high correlation between the two, instead of confirming both, may only signify that both estimates are equally one-sided and share the same error. The teacher's estimate has notwithstanding, as Meumann admits,[2] a value, as it provides the psychologist provisionally with an objective control, not yet indispensable, for the results of his investigation ; even when better results are secured by means of the endowment tests the teacher's estimate will have an independent value in furnishing a judgment on the pupil's actual achievements, as experiment does not reach the concrete aspects of the child's mental life, but tests the individual with means which are after all artificial. The teacher's estimate may also be improved by training on the lines suggested by Binet, Stern, and others.[3]

It is mainly to the efforts of Spearman in applying, and extending the use of, the correlation formula that the possibility of a General Common Factor in all mental performances has been mathematically demonstrated.[4] He showed that the correlations of special abilities with general ability display a correlation one with another, and inferred that this was due to the existence of a common factor pervading all. Burt, employing in his investigations the methods of Spearman, concludes [5] from his investigations that there is a general function—a greatest common measure—permeating, to a greater or a less extent, the various special functions measured by his tests ; that the measurements obtained are measurements, more or less indirect, of a single capacity, and not

[1] *Vorlesungen*, vol. ii. p. 735.
[2] *Ibid.*, p. 725.
[3] *Ibid.*, pp. 728–737.
[4] *Cf.* B. Hart and C. Spearman, "General Ability, Its Existence and Nature" (*British Journal of Psychology*, vol. v. pp. 51–84).
[5] *Child-Study*, vol. iv. pp. 97, 101.

determined purely by different capacities in different cases; and that the notion of an all-round mental efficiency applicable in many directions is a legitimate conception. It may be defined, he states, as an all-round innate mental efficiency, and can be most readily measured by tests of the higher and more complex levels of mental activity. He admits that his conclusions are still largely hypothetical, but claims that they form a hypothesis which is founded upon experiment, and that by experiment alone can they be firmly established, fully extended, or finally overthrown.

Thorndike does not admit the existence of the common factor denoted by the term "general intelligence." "This doctrine," he states,[1] "requires not only that all branches of intellectual activity be positively correlated, which is substantially true, but also that they be bound to each other in all cases by one common factor, which is false. The latter would require that no two intellectual abilities or branches of intellectual activity should be more closely related to each other than to the fundamental function by which alone they are supposed to be related. . . . But unless one arbitrarily limits the meaning of 'all branches of intellectual activity' so as to exclude a majority of those so far tested, one finds traits closely related to each other but with their common element only loosely related to the common element of some other pair. . . . The mind must be regarded not as a functional unit, not even as a collection of a few general faculties which work irrespective of particular material, but rather as a multitude of functions each of which involves content as well as form, and so is related closely to only a few of its fellows, to the others with greater and greater degrees of remoteness."

Meumann likewise criticises[2] the method of Spearman, contending that he only translates an arithmetical result into a physiological postulate which is for us merely an unknown x, and that a psychological explanation is necessary and possible.

In attempting to explain the nature of the Common Factor of general intelligence, assuming its existence to be proved, Spearman and Burt tend to fall back upon physiological

[1] *Educational Psychology*, vol. iii. pp. 364–366.
[2] *Vorlesungen*, vol. ii. pp. 721–722.

analogies and interpret it in terms of neural energy or structure. Thus Burt says:[1] "Its basis may be pictured as a tendency to integration in the structure of the central nervous system; and hence that child will be the most generally intelligent who inherits a brain which has been throughout laid down for development along the most systematic lines." Meumann takes a practical and psychological standpoint in interpreting the concept "intelligence."[2] The intelligent man, he says, is the one who in knowledge can construct new theories, and in life and industry can originate new aims and create new values, who knows how to overcome the difficulties which obstruct his creative activity and who can avoid mistakes in action. The psychological conception of the endowment of the intelligent man leads to the same results as the practical. Along with thinking, imagination is the most important psychical activity for the devising of new courses, then come the intensity of the intellectual life and its emotional bases, thereafter certain formal volitional qualities like perseverance. Of much less significance, both for practical life and for the psychological determination of intelligence, are the purely apprehending and reproductive processes. The concept "intelligence" then, for Meumann, has a threefold content: (1) qualitative, the existence of certain powers of thinking; (2) intensive, namely, a certain degree of intensity of the mental life; (3) emotional, the volitional and emotional life of the individual being favourable to the development of superior endowment.

The difficulties in proving the existence of general ability, in defining its nature, and in measuring its amount must not deter us from its further study and investigation, for its significance for education and sociology are great.[3] The Binet tests, for example, have demonstrated the absolute intellectual dependence of the child on the social position of the parents; the poorest Moscow children were intellectually four years behind the better class Petrograd children. Meumann consequently concludes that a common school for the children of all classes would thus be a social injustice of

[1] *Child-Study*, vol. iv. p. 101.
[2] *Vorlesungen*, vol. ii. pp. 714–717.
[3] *Cf.* Meumann, *Vorlesungen*, vol. ii. pp. 764–770.

the worst kind. When, however, we separate endowment from development, it appears that it is the development of the poor child that is slow in comparison with the child of the wealthier parents, and this does not preclude the possibility of the slow-developing child ultimately attaining the same heights as the rapid-developing child. It is generally agreed that every child should have the opportunity of adopting that career for which his endowment is adapted, consequently the highly endowed children of the primary school should, irrespective of the social position of their parents, have access to higher education. The neglect of such children is a national loss, and for their right selection trustworthy tests of endowment are required.

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CHAPTER XIII

ECONOMY AND TECHNIQUE OF LEARNING

IN the past Education has concerned itself with methods of teaching: now it is turning to consider methods of learning, for the suspicion has dawned upon us that the pupil's method of learning may not correspond with our methods of teaching, that he may in fact be learning not because of, but in spite of, our methods of teaching. In the future we shall consequently have to talk less of the teaching process and more of the learning process, and for guidance in method we shall have to depend on the psychology of learning instead of on "formal steps" and the logical analyses of knowledge.

We cannot, however, straightway assume that the child by his own undirected efforts will adopt the most economical and most efficient methods of learning. As Meumann asserts in regard to memorising [1]—and the same is true of all departments of the child's mental work—" Memorisation should not be a matter of accidental success as it has been in the past; nor should it be given over to the blundering efforts and the unsystematic groping of the child. It should not entail the waste of time and of energy which necessarily results from a desultory and fortuitous procedure. The teacher must raise it to a higher plane; and this he can do by directing his pupils in their process of learning and by adapting their activity to conform with the results obtained from investigations of the conditions of economical learning."

For the various types of learning we must determine the means at the pupil's disposal, for example, the relevant aspects

[1] *The Psychology of Learning*, English trans., p. 336.

of his endowment, and the external conditions under which learning takes place, so that the one may be harmonised with the other and the child attain the most effective learning with the minimal expenditure of time and energy. This task includes investigations into observational learning, that form of learning employed in lessons on such a subject as Nature Study, wherein it is necessary to observe and record the details of the content of perception—objects, persons, and processes; into immediate memorising, implied in dictation, drawing, and in all forms of teaching employing oral questioning, where the pupil must retain the question long enough to apprehend its meaning; into associative learning, involving prolonged retention of disconnected material like arithmetical tables, formulæ, vocabularies, or of connected material like poetical and prose passages, in which the words which are the vehicles of the meaning must be retained *verbatim*; into rational learning by logical apprehension, wherein the combination of ideas only, and not the words by which they are conveyed, need be retained, as in much of the modern teaching of geography; and lastly, into the acquisition of skill, a field of investigation almost solely occupied by American psychologists.

Where alternative methods of presentation or of exposition are possible to the teacher he will be required to adopt that mode of procedure which is best adapted to the method of learning of the pupil, and thus out of a technique and economy of learning will be derived a new technique of teaching.

The first type of learning for which a technique and economy are necessary is that termed observational noting or recording [1] —the imprinting on the mind of perceptual content by means of observation alone. In spite of object-lesson, and observation-lesson teaching, tests have disclosed that the pupils' observation when left undirected gives most inadequate and unsatisfactory results, and have proved that pupils stand in need of systematic guidance in observation, that they must

[1] The German term is "das beobachtende Merken." "Discernment," as employed in *Elements of Psychology* by Mellone and Drummond, translates "Merken." "Observational" is not to be regarded as confined to visual recognition, but applies to any form of attentive awareness.

acquire a technique of observing and learn to record their impressions methodically.

The success of observational recording depends on the success with which the features of the object attended to are originally observed. We must, then, consider the conditions with which observation must conform to become efficient. Observation differs from simple apprehension in the fact that it has always some definite end which prescribes the point of view from which the object is regarded. Apart from the fact that the external conditions of observation, in respect to light, etc., in the case of visual presentation, should be the most favourable possible, successful observation depends on the systematic regulation of the act of apprehending by the end in view; the pupil must consequently be trained to maintain this consciously before him throughout the act of apprehending, and thus prevent his attention from wandering to other aspects or objects. "A systematic and methodical observation," says Meumann,[1] "is attained chiefly by having a great number and variety of view-points or categories of observation, and by knowing how to employ them in a systematic and methodical manner."

In cases which admit of it, there should be a mental preparation for the act of observation, but when such internal preparation is not possible, as in the case of a suddenly appearing object, the ability to divert attention rapidly to the new stimulus is the determining factor; in expectant observation we are not forewarned of the specific object to be apprehended, but we are prepared for something, and here the main condition of success is for the observer to keep himself free from definite prepossessions and develop a receptive mood for the expected stimuli and an energetic attitude to the act of observing. Meumann counsels us against the introduction into the school-room of exercises in the formal training of involuntary observation, and suggests that "pupils may be taken out for walks, where every opportunity which presents itself, as when moving objects suddenly come into view, should be utilised." [2]

Such are the general conditions determining the efficiency of observation: for the methods which condition the successful

[1] *The Psychology of Learning*, p. 65. [2] *Ibid.*, p. 70.

recording of the observed data, inferences suggestive for the educationist may be drawn from the results of experiments originally applied with other ends in view. The interval elapsing between the calling to mind of the goal-idea of observation and the presentation of the object must be neither too long nor too short; in association tests an interval of two seconds secures an optimal condition of attention for the reception of the stimulus. In comparing two objects, the optimal length of interval between their presentations has yet to be decided; in the case of the comparison of two tones, the most favourable interval is again two seconds. To secure the most reliable report, about ten to fifteen seconds should elapse after the primary impression: Meumann accordingly concludes:[1] "In teaching, we should therefore always allow pupils a certain time in which to work over the perception-content in a purely memorial fashion, and not begin to question them immediately after the act of perception."

When a series of presentations is successively exhibited, it is found that we neglect to observe elements in the later presentations which were present in the earlier; this has been expressed in the law[2] that "intensity and affective tone being equal, the dissimilar members of a group of stimuli which act upon consciousness at exactly or approximately the same time are given the preference; while those which are similar or identical inhibit one another." Teachers must consequently recognise that the pupil finds greater difficulty, and requires more concentration, in apprehending and comparing groups constituted of like elements than in apprehending groups comprising sharply contrasted features. Analogous to this principle is the fact that distractions of a like nature to the presented stimulus are in observational noting more disturbing than distractions of a quite other mode.

The main conditions determining the efficacy of observational noting are the concentration of attention, the process of imprinting, the formation of supporting associations, and the will to observe and note. The second condition—

[1] *The Psychology of Learning*, p. 96.
[2] By Ranschburg.

the process of imprinting—has most significance for immediate reproduction of impressions, whereas the supporting associations have the greatest significance for permanent retention.

The above conclusions have been derived from investigations with stimuli of a very elementary nature : it is only with some hesitation that they can be applied to the observation of the complex objects and processes which form the subject-matter of teaching, but the methods which have been successful in the simpler case may, we hope, when applied to the latter prove themselves as applicable and as fruitful.

Our knowledge of the conditions of associative learning is derived from investigations to which is usually given the name of memory experiments. It is necessary to distinguish investigations into immediate reproduction from those concerning permanent retention, since the factors ensuring success in the one case are not identical with those which are effective in the other.

The conditions affecting immediate reproduction, apart from the mode of presentation and the type of imagery employed in learning and retention, which we reserve for special treatment, include the following : (1) The nature of the material presented, that is, whether it is understood or not. Intelligible material is, as is to be expected, more easily retained and reproduced than unintelligible material. (2) The amount of material presented. This should not exceed the span of apprehension, otherwise retro-active inhibition sets in and the whole may be forgotten. Thus children who can successfully retain and reproduce seven words can only reproduce one or two when the series is increased to eight words. This phenomenon supports the demand for short questions in oral teaching. (3) The rapid disappearance from consciousness of verbal material heard only once. This obliviscence is increased when the words are not clearly apprehended or understood, especially in the case of dull pupils, or when the subject is suffering from mental fatigue. Meumann consequently concludes—and here his inference is at variance with the usual rules of teaching method—"On account of this fading of their ideas from consciousness they find it impossible to reflect upon the question. This constitutes a reason for the frequent repetition of questions and for the asking of incidental and subordinate questions." [1]

We now proceed to consider the technique and economy of learning by repetition or memorising. It is to Ebbinghaus that we owe the beginnings of experimentation on this subject, and the methods which are now adopted remain essentially the same in principle as those originally devised by him.[2] The conditions, both external and internal, which have to be observed to secure uniform conditions for comparative investigations cannot be fulfilled in practical teaching, and while necessary for the technique of experimentation, are unnecessary for the technique of learning. We shall consequently confine our survey to results which have practical bearing on learning and teaching.

The method of learning adopted is an important condition in memorising. There are three main methods, termed, respectively, the entire method, the sectional method, and the mixed method.[3]

According to the entire method, one learns by repeating the material right through from beginning to end. With the sectional method the material is divided into sections—for example, verses of a poem; each section is memorised independently, and then all the sections are connected. Of these two methods the "entire" is by far the more advantageous. In it attention is more uniformly sustained than in the sectional learning, since new material is continually being presented as we pass from the beginning to the end. In sectional learning there is a tendency to repeat the first sections oftener than the succeeding, whereas with the entire method this uneven distribution of repetitions is avoided. In entire learning no redundant associations are formed, only those connections being made which are operative in the final reproduction; whereas, in sectional learning, associations are formed between the last word of the section and the first word, not of the succeeding section, but of the same section; these are quite valueless, and hinder the successful

[1] *The Psychology of Learning*, English trans., p. 146.
[2] *Cf.* Ebbinghaus, *Memory*, English trans., by Ruger and Bussenius.
[3] *Cf.* Offner, *Das Gedächtnis*, pp. 62–66; Watt, *Economy and Training of Memory*, pp. 48–53.

reproduction of the whole. Lastly, by the entire method the material is impressed on the mind as a whole; the sense of the passage thereby affords some assistance in learning. Many individuals also learn better when sections are regarded as members of a whole. The entire method has, however, the disadvantage that sections already memorised are repeated; thus the whole has to be repeated throughout until the difficult passages are mastered. A further objection to the entire method is that the distribution of attention is not uniform throughout; the intensity of attention appears to be regularly relaxed towards the middle and to be somewhat greater towards the beginning and the end of the passage: the middle part thereby tends to suffer in memorising.

The mixed method seeks to secure the advantages of both the entire and the sectional methods while avoiding their defects. It requires that the material should be divided into sections, and that after each section a pause should be introduced in the reading; the principle of entire learning is nevertheless followed, as the individual reads through continuously from beginning to end. With this method attention is not so liable to fatigue as with entire learning, and the weakness of associations in the middle sections is thereby avoided. When the material is divided into sections and a difficult section occurs, this can after a suitable pause be attacked with renewed attention, and if the section is not immediately repeated, no unnecessary associations are formed. When great irregularities in the material occur, the entire method should first be adopted, until the learner becomes conscious of the definite parts which are of special difficulty; these should then be learnt separately, and thereafter a return should be made to the entire method. The grade of endowment of the child appears, according to Neumann,[1] to affect the method of learning: with highly intelligent children, and those who learn easily, the advantage of the entire method is most quickly and clearly seen.

The entire method and the mixed method are each considered better than the sectional method for both immediate reproduction and retention; but in regard to the comparative

[1] Günther Neumann, *Zeitschrift für die experimentelle Pädagogik*, vol. iv.

values of the two former there is not the same unanimity of opinion. Meumann's view is that for immediate reproduction the mixed method is most favourable, and that for retention the entire method and the mixed method are of equal value; although he admits that with very uniform material the entire method may have the advantage for retention, yet he maintains that this advantage is lost through the additional number of repetitions required for learning material of unequal difficulty, and he accordingly concludes that the mixed method must, on the whole, be regarded as the most economical.[1]

The appropriateness of the material, in respect both to quality and to quantity, determines to some extent the ease of learning. With unintelligible material it is found most economical to make the quantity learnt at one time as great as the powers and training of the learner allow. Tests on an adult, to determine the most economical unit for committing poetry to memory, show [2] that with passages up to 240 lines learning by wholes is without exception more economical than learning by parts. The relative saving, it appears, is much greater with long sections that require more than a single sitting, the most economical method in this case being to devote thirty or forty minutes at a sitting, the exact amount of time depending upon the general condition of the learner. In the learning of selections longer than, say, 240 lines, the most economical procedure, it is suggested, might be to divide the matter into large units which in themselves constitute thought-wholes, to commit these to memory

[1] *Vorlesungen*, vol. iii. p. 98. It is interesting to compare this result with the advice of Quintilian: "The committing to memory of a long speech," he says, "will be best effected by parts, as thus memory will be less sensible of its burden. But these parts should not be scraps or sentences, for so, their multitude by dividing, would harass memory too much. I cannot well prescribe their extent, but it may be as each passage shall end, unless perhaps this passage is so long, as to require likewise to be divided. Certain rests, however, should take place, that frequent meditation may continue the series of the words (the hardest thing to be mastered in this matter), and afterwards the repeated order join the parts together" (*Institutes*, book xii. chap. ii.).

[2] W. H. Pyle and J. C. Snyder, "The Most Economical Unit for Committing to Memory" (*Journal of Educational Psychology*, vol. ii. pp. 133–142).

separately, and then to memorise some device to hold together the separate parts. Experiments of a similar nature require to be undertaken with children of various ages to determine the most economical unit, in regard both to the amount of material of various kinds to be presented, and to the time to be spent at the various stages of memorising.

Intelligible material is considerably easier to learn than unintelligible material, and the more connected the material the greater the ease of learning. Learning of intelligible material is therefore dependent on the degree of understanding brought to the material. The first readings of a passage serve mainly for the understanding and arranging of the material. Certain outstanding features are first observed, and these serve as props for the whole, or as points around which the rest of the content gathers. The more definitely and rapidly we apprehend these main steps in the train of thought, the more quickly the mental appropriation proceeds. It consequently follows that, in teaching, all the material should be exhaustively explained, and reference made to the construction or form of development of the poem or piece of prose. When the main ideas of a passage are clear to the child, half the work of memorising is done, since, when these are fixed in their relative order either logically or concretely in imagination, the rest of the content may readily be added.

The first reading or presentation of the subject-matter is all-important. It appears [1] that the length of time required for a learner to master all the points in a given piece is in part dependent on the number of original errors which have to be unlearned. Learning thus regarded is a process of eliminating mistakes.

The distribution of repetitions is an extremely important factor in learning. The question is whether the repetitions should be spread over a long period of time in which after one or more repetitions a pause ensues, or whether time and repetitions are saved when the repetitions are accumulated at a single sitting. Ebbinghaus found that for a single 12-syllable series of nonsense syllables 68 immediately successive repetitions had the effect of making possible an errorless

[1] W. H. Pyle, "One Function of the Teacher in Memory Work" (*Journal of Educational Psychology*, vol. i. pp. 474–476).

recital on the following day after 7 additional repetitions. With distribution of the repetitions over several days such an errorless recital was possible after 6 repetitions when the number of repetitions necessary for the production of this effect was 38. "For the relearning of a 12-syllable series at a definite time, accordingly, 38 repetitions, distributed in a certain way over the three preceding days, had just as favourable an effect as 68 repetitions made on the day just previous. . . . It makes the assumption probable that with any considerable number of repetitions a suitable distribution of them over a space of time is decidedly more advantageous than the massing of them at a single time." [1]

Jost also found that the more extended distribution gave the most favourable results; thus 2 repetitions a day for 12 days were better than 4 repetitions a day for 6 days, and the latter were better than 8 repetitions for 3 days.[2] Miss Perkins[3] sought to ascertain if there was a limit to the degree of distribution that might be advantageous, and to determine, in cases where more than one repetition was made on a single day, if learning was easier when more than one day was allowed to intervene between the groups of readings, and to discover, if possible, the most favourable interval. Her results indicate that the highest percentage of success is obtained by the use of one reading at each sitting, and, in general, the smaller the number of repetitions used at a sitting, the higher the percentage of success. As to the interval between sittings, the most favourable interval seems to be between two and three days for cases in which either one or two repetitions are used at a sitting; for cases in which four or eight repetitions are used at a sitting, the longer intervals of three or four days have a value equal to, or greater than, the shorter intervals.[4]

Many reasons have been adduced to explain this superiority of the distributed over the cumulative arrangement of

[1] *Memory*, English trans., p. 89.

[2] *Zeitschrift für Psychologie*, vol. xiv. p. 452.

[3] Nellie L. Perkins, "The Value of Distributed Repetitions in Rote Learning" (*British Journal of Psychology*, vol. vii. pp. 253–261).

[4] *Cf.* also D. O. Lyon's conclusions on "The Relation of Length of Material to Time for Learning" (*Journal of Educational Psychology*, vol. v. p. 161).

repetitions. With fewer repetitions at a time loss of interest and fatigue are not so likely to ensue, but although these are the most obvious conditions, they are probably the least effective. One main factor is the age of the associations involved. The older the associations, the more efficacious are they and the more easily can they be reproduced. Thus, when repetitions are extended over a considerable period, on the second day associations of twenty-four hours' standing are being dealt with, and on the third day associations of two days' standing. The more the repetitions are distributed, the more does one work with old associations, whereas when all the repetitions come together, recent associations only are employed, and the effect of their consolidation is lost.[1]

Another contributing cause may be that in distributed learning there is involved a larger number of first repetitions or impressions, and these have greater efficacy than later repetitions, for with increase in the accumulation of repetitions, it has been demonstrated, the effectiveness of each distribution decreases. Thus on the first day of learning a certain number of repetitions may be found necessary; to relearn the same material the following day fewer repetitions are required, and these may be regarded as additional to those of the first learning. But if the material has to be so learnt the first day as to be reproduced on the second day without relearning, the number of additional repetitions is out of all proportion to the usual number required for relearning. Ebbinghaus states[2] that for every three additional repetitions which he spent on a given day on the study of a series, he only saved, in learning that series twenty-four hours later, on the average, approximately one repetition. This ratio must not, however, be regarded as constant. In school practice it is important to recognise that the number of repetitions necessary for perfect reproduction cannot be regarded as the standard for continuous retention; the latter requires many more repetitions. Extreme concentration of attention during the process of learning, it may be remarked, reduces the number of repetitions necessary for immediate reproduction, but for prolonged retention the number of repetitions seems to be the determining factor.

[1] *Zeitschrift für Psychologie*, vol. xiv. p. 452.
[2] *Memory*, English trans., p. 57.

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The chief reason for the superiority of the distributed repetition is doubtless the presence, and the greater frequency, of the pauses that ensue in distributed learning. The act of forming one association immediately after the formation of another association interferes with the fixing or consolidation of the one first made. A certain time seems to be necessary for the process to set—about forty-eight hours after one or only a few repetitions gives the best results—and, if this is denied it, retention is not firmly established. Even looking through a book of commonplace pictures is said to lessen the effect of any preceding memorising.[1] Other forms of work display the same phenomenon. In investigating the effect of practice upon the Müller-Lyer illusion Lewis found [2] that the influence of a day's pause was to accelerate the rate of decrease in the illusion, and an exceptionally rapid and regular decrease was found with one subject who took readings of the illusion on alternate days. This has been confirmed in the case of other illusions. In his "Experimental Study of General Intelligence" [3] Burt found that with the mirror-test which he used "the children had begun their first series at an average speed of 103 seconds for the first tracing, and left off at an average speed of 39·6 seconds for the sixth tracing. After three months' interval they resumed with a speed of 34·5 seconds for the first tracing of the new sitting, actually faster than the speed with which they left off." The same effect is noticeable in the acquisition of skill. The person who is keen on some sport finds that after an enforced period of abstinence his play has not deteriorated as he had feared, but has actually improved, and the progress is frequently quite marked. This experience led Professor James to cite the paradox that we learn to swim during the winter and to skate during the summer.[4]

One explanation of this progress during the intermission in learning is, it has been suggested, that it results from the evanescence of the traces left on the mind by the unsuccessful efforts, thus leaving the mind free to utilise the successful

[1] Watt, *Economy and Training of Memory*, p. 67.
[2] *British Journal of Psychology*, vol. ii. p. 301; vol. v. p. 45.
[3] *Child-Study*, vol. iv. p. 43.
[4] *Principles of Psychology*, vol. i. p. 110.

method; during this period, in accordance with the "law of subjective selection," "bad habits" of learning and harmful inhibitions lose their force and disappear, and the mind can then more easily attend to the good habits. The more general explanation is, however, that every mental process, like every note in music, has a reverberation which is cut short if another mental act immediately succeeds. Ballard explains the effect of the pause by the metaphor of inertia, maintaining that by reason of the inertia of the nervous system it does not yield to an influence at once, nor does the inertia stop yielding at once.[1]

The inference for teaching practice, no matter what the explanation, is obvious. Pauses should be inserted between the method-wholes in instruction and also between lesson periods.[2] The duration of the pauses for the various subjects and for the pupils of different ages still remains to be determined, but it may be mentioned that from the tests on illusions, to which reference has been made, it has been found that the most beneficial pauses in the acquirement of a habit are shorter for children than for adults,[3] and that with difficult forms of work longer pauses do not give better results than the pause found most beneficial for easy forms of work.[4]

From certain experiments[5] it seems that recall during the process of learning, or immediately afterwards, is a great economy in memorising. This, however, has been questioned,[6] Thorndike finding no demonstrable superiority in the method involving recall. The averages for eleven adult subjects were as follows:—

	Time.	Number Correct.	Time.	Number Correct.
	Minutes.		Minutes.	
Studied by Recall .	18·6	13·9	14·7	14·6
,, ,, Repetition	16·1	16·9	15·8	15·7

[1] *Obliviscence and Reminiscence*, p. 82.

[2] *Cf.* Offner, *Das Gedächtnis*, p. 100.

[3] *British Journal of Psychology*, vol. iv. p. 45.

[4] *Ibid.*, vol. ii. p. 189.

[5] Edwina E. Abbott, "On the Analysis of the Factor of Recall in the Learning Process" (*Psychological Review*, Monograph Supplement, vol. xi. No. 1).

[6] *Journal of Educational Psychology*, vol. v. pp. 596–597.

This conflict of evidence suggests that a reinvestigation of the problem is desirable. The value of recall, not as a means of learning but as an aid to retention, has been investigated by Myers,[1] with the result that it appears there is a decided gain in final recall as a result of intervening recalls without representation of the stimuli. A second recall after five minutes gives a better result than the first immediate recall, and the effect of intervening recall is very much greater when the final recall is taken after thirty minutes or one hour than when taken at the end of three weeks.

Other conditions affecting the powers of memorising include the rate of learning, the employment of rhythm, the influence of vocalisation, the method of testing and the general condition of the learner.

The views of experimenters are not unanimous in respect to the *tempo* of learning. Some maintain that the quicker the learning the better; but it may be objected that the more rapidly one learns, the less effective, by reason of its transitoriness, will be the single repetition, and that the time saved in reading will have to be expended on a greater number of repetitions. Meumann maintains that the *tempo* should be adapted to the stage of learning; that at the beginning of any process of learning involving memorising it will be found economical to take plenty of time to make the impression clear and vivid and to get the right meaning before proceeding to repetition, and thereafter to increase the rate as the learning proceeds.[2]

All experimenters have found that learning without rhythm is considerably more difficult than rhythmic learning; in fact, some individuals find it quite impossible to learn without rhythm.

With regard to the influence of vocalisation, learning half aloud has been found most favourable, but with young children speaking in an undertone is in a surprising degree preferable.

Knowledge of the manner in which they are to be tested influences the method of learning of individuals. The attune-

[1] G. C. Myers, "Recall in Relation to Retention" (*Journal of Educational Psychology*, vol. v. pp. 119–130).

[2] *Vorlesungen*, vol. iii. pp. 79–80.

ment of the individual to the learning varies according to the nature of the test, consequently the method by which the learning is to be tested should be announced before the individual enters upon his task.

The general physical and mental condition of the learner also influences his power of learning, a learner in good condition accomplishing more than one in poor form; it is consequently absurd to require the same amount of mental effort from children in different states of health.

An interesting phenomenon in memorising is the appearance at the right time of the feeling that the material has been mastered. In the emergence of this feeling there are great individual differences: with quick learners it comes early and induces premature testing; with cautious natures it often appears too late and the subjects themselves are surprised at their ability when called upon to repeat what is being learnt. Through practice in learning this feeling becomes a more reliable index of perfect learning. Teachers can here assist pupils by requiring them to attend to this inner signal, and, according to the temperament of the child, repress those in whom it comes too early and encourage the over-cautious.

For the pedagogy of learning it is useful to indicate the stages into which memorising falls.[1] The first stage is that of adaptation and orientation. The first reading serves for adapting the learner to the task and enables him to know what is required of him. In the learning of nonsense syllables it serves for discovering the most effective learning rhythm and becoming acquainted with the forms, visual and acoustic, of the syllables. The second stage is that of passive reception. The learner impresses the material by reading, hearing, and speaking, and maintains throughout a receptive attitude. Then follows the third stage, that of attempting to reproduce, or what may be termed anticipatory testing. This stage is observed in the procedure of the subject who tends to turn aside from the material and anticipate what is coming. The fourth stage consists in impressing on the mind the passages which are found to be imperfectly learned and in fixing the associations binding the whole together; on the successful attainment of this the above-mentioned feeling of the ability

[1] *Cf.* Meumann, *Vorlesungen*, vol. iii. p. 124.

to reproduce is based. In this last stage the emotional disposition of the learner alters markedly. The first stage is characterised by displeasure and tensions, or is accompanied by changing moods, but as the learning proceeds, these give place to pleasurable feelings.

The technique and economy of learning by logical apprehension or by the rational combination of ideas is still in such a backward condition that almost the only suggestion that can be offered is that where attention can be directed to the meaning, the verbal and sensory elements, or to both form and content, the first alternative is the most advantageous. "Even in individuals of dominantly verbal memory an act of learning which proceeds by merely noting the words is always somewhat more disadvantageous than a learning which relies upon meaning." [1]

The acquisition of skill has been investigated by various psychologists, chief among whom are Bryan and Harter,[2] Swift,[3] Book,[4] and Ruger.[5] The experiments included typewriting, tossing and catching balls, solving mechanical puzzles, and, for purposes of comparison, learning a language. The progress of learning was in each case carefully recorded, likewise any data available as to the methods adopted.

Progress in learning, it is found, is never uniform, rapid advances alternating with periods of retardation, sometimes even of retrogression. These periods of non-improvement are the most characteristic features of the learning curves, and are technically termed "plateaus." Their cause and significance in the learning process are of the utmost importance in education.

The early stages of practice are characterised by rapid and continuous improvement. The lack of adaptation or attunement to the novel conditions might be expected to militate against rapid progress at the outset, but these initial difficulties are compensated for, or more than counterbalanced by, the

[1] Meumann, *Psychology of Learning*, English trans., p. 302.

[2] *Psychological Review*, vol. iv. p. 27; vol. vi. pp. 346–375.

[3] *Mind in the Making*, chap. vi., "The Psychology of Learning."

[4] *The Psychology of Skill* (University of Montana Publications in Psychology, No. 1).

[5] *The Psychology of Efficiency* (Columbia Contributions to Philosophy and Psychology, vol. xix. No. 2).

interest aroused by novelty and the enthusiasm with which a new form of work is usually undertaken.

This stimulation of interest is nevertheless only temporary; the novelty wears off, the difficulties accumulate and obtrude themselves upon consciousness, and the monotony of the plateau succeeds. This stage of discouragement persists for varying periods, some quite lengthy, and escape is secured by the adoption of some device which in our random efforts has proved itself efficient, the selection of the improved method being usually fortuitous.

After the new habit of manipulation has been in operation for a time the subject usually becomes aware of the variation which has brought success, but there is a difference of opinion amongst the investigators as to the effect of consciously attending to, and purposely adopting, the new method. Book[1] quotes the introspective account of one of his subjects to this effect: "I find that I have to let the thing do itself. When a new way of doing the work is noticed and I purposely try to use it or to assist, it never goes right." Ruger,[2] however, maintains that advance is coincident with consciously adopted variations rather than with "unconscious" ones. Swift, while maintaining that the method by which the reaction is improved originates unconsciously,[3] nevertheless records of one of his subjects in the ball-tossing experiments that a plan entered upon unconsciously was then consciously adopted, and as a result of finding a successful plan early in the work his progress was rapid and his curve the most regular of all. The corollary he draws implies that the consciously adopted variations are the more profitable, and is in agreement with Ruger's above-quoted dictum. "We see in this," Swift says,[4] "the value of suggesting good ways of doing things while the learning is still in its early stages. If the learner goes on he will finally develop a plan of his own, but only after a good deal of wandering, and even then it may not be the best. But the suggestion to be effective should be given at the time when need for it is keenest, at the 'psychological moment.' It is then that its value will be felt."

The advance which results from the adoption of a successful

[1] *Op. cit.*, p. 171.
[2] *Op. cit.*, p. 15.
[3] *Op. cit.*, p. 213. *Cf.* p. 182.
[4] *Op. cit.*, pp. 182, 183.

variation is succeeded by another plateau period which persists until further favourable variations emerge. These plateau periods consequently occupy the greatest part of the learning curve, and challenge consideration. We are led to inquire whether they are necessary and valuable stages in the learning process, or whether they can be dispensed with and ought to be short-circuited. Our attitude must depend on our analysis of their cause.

Bryan and Harter, from experiments in typewriting, conclude that a plateau in the curve means that the "lower-order" habits are approaching their maximal development, but are not yet sufficiently automatic to leave the attention free to attack the "higher-order" habits. This view implies that advance to a higher level is only possible when all the lower-level habits are completely perfected. The pedagogical application is that new ground should not be broken till the old is completely mastered, and it would justify the method of mechanical practice or "drill."

Swift [1] refuses to accept this separation into different levels of "lower" and "higher-order" habits, and Book [2] agrees that the lower-order habits are not perfected before the higher-order habits are adopted. "The elementary habits," he states, "are not completed before the higher-order habits begin to form. The development of the higher and the perfection of the lower go hand in hand throughout the whole course of the learning. Lower-order habits are developed in and through the formation of the higher, as a further development of the higher is dependent upon the careful and final perfection of the lower." If this view of the plateau period is accepted, the treatment will be quite different from that resulting from Bryant and Harter's view of the significance of the plateau. Book consequently concludes,[3] "To try to crowd ahead before the elementary habits are sufficiently mastered to make safe the taking of a forward step, or to fail to perfect the elemental associations which must be combined to form the higher and more direct methods, is fatal to progress or interest. To be caught by the law of habit and continue to think or work on a low plane when new possi-

[1] *Op. cit.*, p. 209.
[2] *Op. cit.*, p. 171.
[3] *Op. cit.*, p. 178.

bilities of improvement lie ahead is just as fatal. It is, therefore, imperative that the learner should always practise with the highest-order habits he can use."

Ruger's [1] view of plateaus is that they occur where there is a shifting back and forth between rival methods, more or less consciously employed, or where some feature remains untractable to control. Plateaus of a uniform type occur where a single method (which is not the most efficient one for the situation) becomes well established.

The plateau is evidently the teacher's opportunity. His first duty is to discover its cause. If the plateau is regarded as a stage of stagnation in which variations fail to appear, the teacher must suggest new methods. If the plateau is due to the adoption of a chance variation which is not the most efficient, he must strive to prevent the method becoming automatised, analyse the activities involved, and reconstitute them in a better fashion. If the plateau is a necessary and unavoidable one, he must seek to prevent the pupil from becoming depressed and thus increasing the length of the plateau period. To this end he should introduce alternative methods of rendering the elementary habits automatic, and at the same time make the pupil conscious of the higher-order habits which will coincidently be perfecting themselves.

Among the conditions affecting the efficiency of the work is the physical condition of the subject. In the ball-tossing experiments of Swift the influence of the physical tone was observed by all of the participants. In this investigation it was the delicate movements of the hand that were affected by low physical condition, and in typewriting it was the newly formed group-associations that suffered most from this cause. Under similar conditions Swift infers,[2] "a child who in learning to read has advanced so far as to recognise words at sight without spelling them, would be reduced to the spelling stage. When we remember that it is the latest acquisitions, those that mean most for the learner's progress, which first feel the effect of lowered physical tone, the significance of the problem for education becomes apparent." Book [3] has also pointed out the significance of physical fitness

[1] *Op. cit.*, p. 20.

[2] *Op. cit.*, p. 208.

[3] *Op. cit.*, p. 180.

for furthering the occurrence of variations in method. In his experiments the upward change of level came on "good days" and as a result of the variations which then occurred. In dealing with puzzle problems variations in method were likewise found by Ruger [1] to be dependent on high-level attention, and the latter to be decidedly affected by the physical tone.

Fatigue likewise is disastrous to the finer acquisitions which characterise growth in skill as it is to the higher forms of associations in intellectual learning. It is important also to recognise not only that fatigue brings a lowering of the day's score, but also that the entire process of learning is prejudiced by it.

The ascertainment of the kind of practice that is effective for progress in the acquirement of a dexterity is important pedagogically. For progress in learning it is not practice that counts but, as Swift [2] says, successful practice. "Practice then," he concludes, "instead of being carried on to the point of ennui or fatigue, should always cease while the learner is still fresh and enthusiastic. The books of school children should be closed the moment there is any indication of lassitude. Carried beyond this point, study tends to delay progress by starting erratic impulses that end in confusion."

The determination of the lengths of the periods of practice and of the intervals of rest is consequently one of the most important issues for learning, and investigations have been instituted to determine whether the principle of the distribution of repetitions and lengths of periods which holds in the case of learning of nonsense syllables applies to other forms of learning.[3] Starch found that in associating a number with each letter of the alphabet, the more numerous the periods of work the more rapid is the improvement. Pyle,[4] varying only one factor at a time, has sought to determine the best length of periods for learning and the most profitable intervals of rest.

[1] *The Psychology of Efficiency*, p. 15. [2] *Op. cit.*, p. 215.

[3] D. Starch, "Periods of Work in Learning" (*Journal of Educational Psychology*, vol. iii. pp. 209–213); W. F. Dearborn, "Experiments in Learning" (*Journal of Educational Psychology*, vol. i. pp. 373–388; also vol. iv. pp. 229–230).

[4] W. H. Pyle, "Economical Learning" (*Journal of Educational Psychology*, vol. iv. pp. 148–158).

His subjects, who were adults, practised transcribing a piece of prose, substituting certain invented characters for the letters of the alphabet. In the first test the practice was performed daily, the varying factor being the length of periods of learning. The quantity done in the same absolute amount of time was computed, with the result that the thirty-minute period was found to be the best length for daily work, the fifteen-minute period being too short, the forty-five minute period too long, and the disadvantage of an hour being apparent. A second test sought to determine the best interval between practice periods, the length of practice periods being kept constant. It was found that daily practice gave better results than practice on alternate days, but that a second practice on the same day is not quite as beneficial as the first practice, and that, after a few practices, further practice on the same day is useless. As would be expected, if practice twice a day for a given time, say thirty minutes, is compared with practice once a day for the same period, namely, thirty minutes, that is, if the time devoted daily to the practice is double in amount, then the advantage undoubtedly lies with twice-a-day work. But as the total time at the teacher's disposal is limited, the question that interests him is how best to utilise the pupil's time, not what he could do with double the time.

It is quite probable, too, as Pyle suggests, that in the later stages of habituation the length of the practice-period could be shortened and the interval of rest lengthened with practically as much return as in the maximal periods indicated above.

A test with school pupils in practice of addition was also made by Pyle. One group of pupils was given ten minutes' practice for two weeks in the morning only ; the other group practised in the morning and in the afternoon for one week only. The results are again in favour of practice once a day. The intensive study of the beginning of a subject recommended by some educationists has, it appears, its limits.

The more subjective conditions which favour success in the acquisition of a dexterity include confidence in one's own ability and effort. Swift notes that "a growing feeling of confidence usually precedes a permanent rise. The subjects feel that they are going to do it." The depression associated with the monotony of the plateau period, while it is not the cause of the plateau, tends to prolong this period. The general principle seems to be that nothing succeeds like success.

Knowledge of the results, or of the progress made, likewise acts as an incentive to effort and improves the work done. Judd found in mirror-drawing tests that no progress was made when the subjects were kept ignorant of the accuracy of their work.

Effort also counts, the reason being that up to a certain point of intensity it is generally successful effort. "The necessary pre-condition for taking a forward step in the learning," says Book,[1] "was effort, carefully applied to the work on a good day"; but "great effort wrongly or carelessly applied is even more detrimental to progress than a simple lapse in attention and effort."[2]

The conclusion Book draws[3] is, that if one wants to improve at the most rapid rate, he must work when he feels in good form and likely to succeed, then lounge and wait until it is again profitable to work. It is when all the conditions are favourable that the forward steps or new adaptations in learning are made.

In addition to analysing the cause of the plateaus in learning, it is thus incumbent on the teacher to determine the most favourable lengths of the periods of practice and the most profitable periods of rest for the various school subjects and for the various stages in the learning of these. The physical condition and mental tone of the pupil should also receive his attention, as the emotional disposition and the will to advance are important for progress in learning; the teacher can also assist the pupil in learning to learn by providing proper incentives at the critical stages.[4]

Two questions of a general nature on the economy of learning having important consequences for pedagogical practice have been reserved for separate consideration, the one, the type of

[1] W. H. Pyle, "Economical Learning" (*Journal of Educational Psychology*, vol. iv. p. 171).

[2] *Ibid.*, p. 179. [3] *Ibid.*, p. 181.

[4] *Cf.* Book, "Rôle of the Teacher in Economic Learning" (*Journal of Educational Psychology*, vol. i. pp. 183–199).

imagery that should be employed in learning and retaining, the other, the doctrine of formal training or of transfer of training—whether the training of one mental function improves others, or whether the improvement of one is transferred to others.

On the first question there have been considerable differences of opinion amongst experts and more erroneous inferences amongst practical workers in education. When imagery types were first found to have practical significance a false simplicity was assumed. Each individual was supposed to belong to one type exclusively, the existence of mixed types not being suspected; the modification of the ideational type either by development or by training or by both influences was likewise ignored; as also the possibility of the employment of one form of imagery for one mode of learning and another for another. The popular view assumed that the mode of presentation or the nature of the stimulus determined the type of imagery employed in retention, whereas an individual whose imagery is predominantly of the auditory type may forthwith translate stimuli presented visually into auditory imagery and retain the impressions auditorily.

To illustrate the diversity of opinion amongst psychologists in regard to the employment of imagery we need only refer to the law of Münsterberg and Bigham, that we remember well in proportion as we have recourse to many associative aids, that is, it is most advantageous to employ as many sorts of images as we can; and oppose to it the statement of Watt:[1] "It must be emphasised that there is not the slightest use in multiplying forms of imagery in the process of learning. . . . Energy should be concentrated on one method so that it becomes reliable."

Before presenting a conclusion on the question we must first examine the facts. Pure imagery types have never been found amongst children, and only very rarely amongst adults, purity of type being even regarded as a defect;[2] most individuals belong to the mixed types, and tend to rely on different forms of imagery according to the differences in the material apprehended, being visual when dealing with objects and auditory or motor in the case of words. This

[1] *Economy and Training of Memory*, p. 101.

[2] *Cf.* Meumann, *The Psychology of Learning*, English trans., p. 198.

specialisation of function is encouraged by the fact that impressions presented belong to different modalities, and for each modality the corresponding imagery is called into service, thus we naturally ideate colours visually and sounds auditorily.

If we are endowed only in a weak degree with a certain type of imagery, we can improve it by training. A modification of one's imagery type has been found to result from long-continued experimentation in psychology, and it has been suggested that school teaching appealing predominantly to auditory imagery tends to modify the individual's endowment. In some cases it is necessary for economical learning purposely to train pupils to employ a type of imagery with which they may not originally be highly endowed.

The form of the presentation of the material naturally suggests, but does not determine, the type of imagery to be employed, for an individual may translate the impressions into a modality not corresponding with the given, when, for example, he remembers a tune by a spatial arrangement of the notes, or the voice of a person by the movements which accompanied the utterance. The result in most cases is not, however, a translation of one form of impression into another mode of imagery, but rather a compromise between, or joint product of, the mode of presentation and the ideational type of the subject.

The attempt to employ a type of imagery with which we are not well endowed, or in the use of which we have not attained facility, is troublesome, and results in a loss of efficiency; thus it comes about that for verbal retention an auditory-visual presentation may be superior to visual-auditory-motor if the individual is not highly endowed with motor imagery or has not acquired facility in its use.

We consequently arrive at the conclusion that the individual should depend upon the ideational type or types with which he is congenitally endowed, that if generously endowed in respect to the various types, he should employ all he is capable of calling into service, but that he should not attempt to employ those with which he is not well endowed or has not developed facility in using. This conclusion to some extent removes the sharpness of the antinomy set forth above, for the law of Münsterberg and Bigham may be accepted if we presuppose that it applies to the several associative aids or forms of imagery which are equally facile and familiar to us, and these are the forms which Watt counsels us to employ and to perfect, although nothing appears to be gained by intentionally restricting ourselves to the use of one only.

The individual should then depend upon his own ideational type and upon the images corresponding thereto, so far as he can, and attempt to effect a compromise between these and the modality of the presented datum only when the latter does not coincide with his ideational type.[1] This is the conclusion that we arrive at from the learner's standpoint, but from the teacher's standpoint we should be justified in presenting the material of instruction in as many ways as possible, not, however, because we expect the pupil to use all the corresponding forms of imagery, but rather because in the class we are likely to have pupils variously endowed in respect to the different types of imagery. Thus Pohlmann and Meumann agree that in the treatment and evaluation of pupils their ideational types must be taken into account, but not in the teaching itself.[2]

As visual imagery is subject to relatively little falsification in reproduction children should be trained, so far as possible, to employ visual imagery in observational learning. No general rule can be laid down as to what particular method of presentation is the most favourable for immediate retention: "the advantages accruing to any particular method depend, in part, upon the sort of material presented, in part, upon the ideational type of the observer, and, in part, upon the mode of presentation itself."[3] The retention of objects is found to be more successful than that of words—a phenomenon which, as Meumann notes,[4] has a direct bearing upon the use of illustrative material in teaching. Auditory presentation appears to be superior in the lower classes of school, and visual presentation in the higher classes. This may, however, be the result of the prevalent methods of teaching. With unfamiliar words visual presentation was found by Pohlmann to be the most satisfactory, and from this he infers

[1] Meumann, *The Psychology of Learning*, English trans., p. 97.
[2] *Ibid.*, p. 155. [3] *Ibid.*, p. 144. [4] *Ibid.*, p. 152.

that visual presentation is preferable in foreign language teaching to the purely auditory method or the vocal method.[1] These are the only safe inferences that can at present be drawn in respect to economy of learning from studies of imagery type.

One naturally expects that a consideration of the economy and technique of learning will throw some light on the question of disciplinary education, formal training or transfer of training, a doctrine which under these various titles has been much discussed in pedagogical literature.

Subjects of instruction are included in the curriculum on one of two grounds: (1) their intrinsic worth, that is, their value in contributing to the satisfaction of social requirements and social needs; (2) their value as affording training of the powers or faculties of the mind, or their capacity for sharpening the wits. It is acknowledged that we cannot directly prepare the child to meet all the manifold situations of life, and it is assumed that the best we can do is to put him in possession of the instruments which, we hope, he will be able to apply as occasion requires.

If we consider the history of the curriculum, we shall find that no subject was ever introduced into the curriculum on the grounds of its value as training, but the retention of subjects originally introduced for their intrinsic merits, when they had outlived their usefulness, has frequently been defended on the ground of their value as instruments of training.

The assumption that ability acquired through the study of one subject would transfer, and could be applied, to other forms of mental work also derived support from the faculty doctrine in psychology. According to this doctrine the mind is constituted out of a number of faculties—attention, observation, memory, inagination, reasoning, etc.—and improvement in any one aspect of a faculty was regarded as improvement in the faculty itself.

So long as no demand arose for the inclusion of new subjects in the curriculum the doctrine of disciplinary education sufficed for explanatory purposes; but when new subjects began to claim admission to the curriculum, and could only justify their claim by dispossessing other subjects, the grounds on which the latter were included came to be questioned.

[1] Meumann, *The Psychology of Learning*, English trans., p. 155.

Two forces were at work in casting doubt on the theory of formal training; first, the abandonment of the faculty doctrine by psychologists, and, second, the insistence, mainly by the Herbartians, on the importance of the content of instruction. Formal training then became one of the burning questions in Education. Instances from ordinary life were adduced in support of it, and contradictory examples at once opposed to these. The aptest illustration usually carried the day, and the cleverest refutation on these lines is to be found in Adams's *Herbartian Psychology*.[1]

When experimental methods came to be adopted in Education it was natural that they should be applied to resolve this difficulty. At first, however, the results were hopelessly inconsistent;[2] transfer was disclosed where it was least expected, and found wanting where on *a priori* grounds it was generally assumed.

The doctrine which was becoming obsolete in theory, if not in practice, was rehabilitated in a surprising, though only temporary, fashion by the experimental investigations of Ebert and Meumann. They first of all tested the special memories of six adults in respect to immediate retention and prolonged retention, and thereafter subjected them to a period of thirty-six days' training on nonsense syllabus. A second test was then made of the various special memories of the individuals trained, to discover whether these special memories had profited from the training. Certain of the subjects were again trained for eighteen, others for a further period of thirty-six days, in the memorising of nonsense syllables, and then a final quantitative determination of the special memories was made.[3]

The results, according to Meumann,[4] were "unequivocal and positive." An improvement in all the special memories was found after the first period of training, and a still more decided improvement after the second period of training. In the tests in which one presentation only was allowed the

[1] *Herbartian Psychology*, chap. v.

[2] *Cf.* (*a*) Heck, *Mental Discipline*; (*b*) Sleight, *Educational Values and Methods*, chapters ii., iii.; (*c*) Coover, *Formal Discipline from the Standpoint of Experimental Psychology*.

[3] For fuller account of technique see Sleight, pp. 33–41.

[4] *The Psychology of Learning*, p. 352.

greatest improvement of the third series over the first occurred in the case of numbers, the least with poetry; in tests in which several repetitions were allowed to learn the material, the order of improvement of the third series over the first was as follows: optical figures, German and Italian words, prose, and, last of all, poetry. From these results Meumann concludes that " there are no doubt related memory functions which can be perfected upon any material involving the use of memory, the development taking place proportionately to the degree of relationship between the practice and the test material."[1]

In accounting for this transfer Meumann admits that there are certain psychical functions involved in the training which are common to all forms of learning, and on whose co-operation the memory activity is dependent. These include attention, development of a favourable general attitude, suppression of superfluous movements and tensions, use of the most appropriate forms of imagery, acquisition of uniform emotional disposition, avoidance of mental uneasiness, acquisition of greater self-confidence and of the ability to accomplish the task. These, however, he refuses to regard as supplying an adequate explanation, since they do not explain the greater improvement of the more closely related memories. He consequently infers that there exists a close psycho-physical relation amongst the various memories, which is greater according as the memory functions are the more closely related, and which makes possible the concomitant training of allied functions.

On his results Meumann bases a claim for the formal training or disciplining of memory. He, however, rejects the suggestion of van Biervliet, the Belgian psychologist, that formal training on artificial material should be introduced into school work, on these two grounds: (1) " There simply is not time for it, because what may justly be demanded for memory may with equal justice be demanded for other mental capacities; and if we introduce formal mental training, why not also exercises in apprehension, judgment, speaking, etc.? " (2) " Purely formal memory exercises with meaningless material must necessarily train the child's mechanico-meaning-

[1] Quoted by Sleight, p. 36.

less method of learning; and he would never discover the correct use of the most important factor of memory—the proper reinforcement by the meaning of the material." Only, then, in so far as formal training of memory and a systematic improvement of method of learning can be combined with the material already contained in the school curriculum does Meumann favour formal mental training "The materials which are already prescribed by the curricula of the schools must be learned in such fashion as will contribute as much as possible to a formal training of memory; and the act of learning must be performed in a manner which is psychologically sound."[1]

Investigations by Winch[2] supported the conclusions of Ebert and Meumann. From his results it would appear that improvement through practice in rote memory, with and without meaning, is followed by improvement in substance memory for stories. But, like Meumann, he suggests that pedagogically the fact of "transfer" should not lead us to adopt indirect or formal training methods, unless the improvement thereby secured is greater than that to be obtained by direct attack on the matter really required to be known.

Thorndike and Woodworth[3] also subjected the question of transfer of training to experimental investigation; four subjects were trained in judging the areas of rectangles ranging from 10 to 100 square centimetres in size, the material used for the preliminary and the final tests being geometrical figures of various shapes and sizes. Thorndike's conclusions are in conflict with those of Meumann and Winch, in that they do not support the doctrine of formal training, transfer only taking place when there exist identical elements in the training and the testing series. Fracker,[4] who has also subjected to special investigation the problem of the transference of training in memory, attributes the transference, where such exists, to the use of identical elements in different tests,

[1] *The Psychology of Learning*, English trans., p. 351.

[2] *British Journal of Psychology*, vol. iii. pp. 386–405. Cf. *Journal of Educational Psychology*, vol. i. p. 588.

[3] "The Influence of Improvement in the Mental Function upon the Efficiency of Other Functions" (*Psychological Review*, vol. iii.).

[4] Fracker, G. C., "On the Transference of Training in Memory" (*Psychological Review*, Monograph Supplement, vol. ix. pp. 56–101).

and of these elements the most essential is individual imagery.

In view of these discrepancies in the explanation of "transfer," Sleight[1] reinvestigated the question of formal training in memory work, at the same time subjecting to critical analysis the methods used by Meumann, Winch, and others. The results of his own extensive investigation lead him to conclude that there appears to be no general memory improvement as the result of practice, nor any evidence for the hypothesis of a general memory function. There would seem instead to be a very large number of related and unrelated memory functions, of a more or less complex kind, and it is even suggested that some forms of practice may have the effect of diminishing the power to memorise other material.

Sleight has examined very thoroughly the various explanations advanced to account for "transfer" where it is found to function.[2] He finds himself unable to admit that, wherever common elements occur, there transfer takes place; he will only go so far as to agree that common elements exist wherever transfer takes place. Consciousness of the common elements is likewise not the cause of transfer, for transfer occurs when one is not conscious of the common feature; but, as transfer is greatest where the common feature is identified and consciously used, every effort should be made by teachers to secure the identification and conscious use by their pupils of the common element.

The usable common element is, in Sleight's opinion, the determining condition, and this he believes is to be found in the "form" or method of learning. "It is evident," he says,[3] "that part of the teacher's function will consist in doing what he can to augment the effects of practice by helping his pupils to focus attention upon their methods of procedure, and in general upon the means to be adopted in order to get the greatest value from school training. . . . He must seek, not only to bring such common elements as his pupils have failed

[1] W. G. Sleight, "Memory and Formal Training" (*British Journal of Psychology*, vol. iv. pp. 386–457); or *Educational Values and Methods*, chapters ii.–v.

[2] *Educational Values and Methods*, chap. iv. [3] *Ibid.*, p. 96.

to make use of to their attention, but to do the same for those which they have used only mechanically and unreflectively. Instead of trusting to the formal training power supposed to be inherent in a given subject, we shall be forced to direct all our efforts to the building up of general ideas of method of a kind which will admit of wide application."

The calling to consciousness on the part of the pupil of his concepts of methods and of the mode of their application to extended spheres, which Sleight suggests, is but one example of the new duties that will devolve upon the teacher as a result of the studies in the economy and technique of learning. The educative process is summed up in the correlatives, teaching and learning, but to these must now be added the correlatives "teaching to learn" on the teacher's part and on the pupil's "learning to learn" or "learning to study," and in the new aspect of teaching will be found a use of the term "formal training," to which no objection can be taken. "To teach how to learn" will be one of the main functions of the teacher in the future, and any revolution in teaching that may occur will be in this department of the future teacher's work and study.

In this regard Meumann mentions[1] that "when we have determined the ideational type to which a child belongs, and have also determined his type of attention, it is then desirable to bring the essential features of his method of learning to the notice of the child himself, and to show him the advantages and disadvantages of his procedure." In mechanical memorising the child should be brought to see the difference between aimless ineffective repetition and the success resulting from attentive consideration of the material repeated; in memorising significant material the need for the complete understanding of the material before repetition commences should be impressed upon the pupil, and for both types of material the advantage of the whole, over the part, method of learning should be brought home to him. In the acquisition of skill he should be led to realise the significance of the initial spurt and of the plateau, so as not to be unduly elated at the former nor depressed by the latter, as both conditions are unfavourable for the successful acquirement of a dexterity. In this way the

[1] *The Psychology of Learning*, English trans., p. 338.

pupil will be led to devise a procedure in accordance with the best psychological knowledge and in harmony with his own individual endowment, and thus be in a position to further the teacher's efforts in school, and be able later to depend upon himself.

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CHAPTER XIV

CONDITIONS AFFECTING MENTAL WORK

A CONSIDERATION of the influences determining the quantity and quality of mental work, or the doctrine of mental hygiene, as it is termed, is best approached by reviewing the factors which an analysis of the work-curve discloses.

If mental work of a uniform nature is undertaken and continued for an appreciable time, and if the amounts performed in equal intervals are so indicated that they can be compared graphically, certain general features will become noticeable. At the outset achievement will be considerable; this is a consequence of the initial spurt,[1] and arises from the novelty and enthusiasm with which one enters upon a new task. The curve will immediately thereafter fall somewhat, rise gradually again as the individual settles to his work, and then maintain a certain level with but small variations. If the work is continued for any considerable time so as to be affected by fatigue, there will occur a gradual fall in the curve. If an appropriate intermission in the work is allowed, sufficient to allow of the evanescence of the effects of fatigue while the benefits of incitement or getting under way and also of practice are retained, it will be found that after the interval there is a marked rise in the curve. If the work is resumed, the curve will gradually fall as fatigue appears, and only the intercalations of periods of rest can stay the gradual falling of the curve. A final spurt occurs when the subject is warned that the end of the period is approaching.

[1] The existence of the initial spurt has been questioned, but has been confirmed by J. C. Chapman in the case of Addition (*Journal of Educational Psychology*, vol. vi. pp. 419–426).

If distractions should arise in the course of the work, they may cause either a rise or a fall in the curve; the former paradoxical result is explained by the fact that when the distraction is not too disturbing the individual may exert more energy than is necessary to overcome the distraction and thus increase the output of work; when, however, the subject cannot dispel the disturbance, his efficiency diminishes. Stimuli of a like nature to those constituting the work have a greater distracting effect than those belonging to a different modality; thus an auditory distraction is more difficult to resist in the case of work of an auditory nature than in the case of work performed visually.

Such are the more noticeable features of the work-curve, but different attitudes to the work may throughout be adopted; one subject may take things easily and work lackadaisically, another may exert himself strenuously and his whole bodily condition may be tense. This difference of attitude is best denoted by the term " attunement " (*Einstellung*).

Incitement, to which we have already referred as accounting for the rise in the work-curve due to the worker settling down to his task, is evinced at the outset of any form of work that is undertaken, and may be expected in any and every lesson to which the teacher turns. There is, however, in addition a general change of attitude to the conditions of mental work when this is long continued, to which the term " adaptation " is applied. Thus, whereas incitement is present at the outset of every lesson, adaptation denotes, for example, the settling down of the pupil to school work in general as the day proceeds; it affects the pupil's capacity for work, and counteracts to some extent the progressive fatigue which we should expect to appear as the morning or afternoon session advances.

In addition to the above factors—fatigue, adaptation, distraction, and intervals in work—we must further consider such subjects as the comparative merits of individual and class working, effects of examination conditions, etc.

The importance of investigations on fatigue for school organisation was early recognised by teachers, and the results of such investigations helped to enlist the interest of teachers in the modern movement towards a scientific pedagogy. We shall consequently commence our consideration of the conditions affecting the mental work of the school pupil with the subject of fatigue.

The concept "fatigue" has to be distinguished from the subjective experience of tiredness or lassitude. Fatigue and tiredness are not synonymous. Fatigue implies the actual diminution of energy in the organism; tiredness or lassitude is the feeling which is experienced when the organism has more or less exhausted its powers. Lassitude usually acts as an index to the state of fatigue, but the two do not necessarily coincide. An individual may be fatigued without feeling tired and *vice versa*, the feeling of tiredness arising at the beginning of work and coexisting with quite fresh energies. This incongruity between the feeling of tiredness and the actual state of fatigue is characteristic of many individuals;[1] there are some who feel tired when their energies have not been in the least exerted or certainly not exerted to the utmost, and others seldom, if ever, become aware of more than a very slight degree of exhaustion. This latter condition is an extremely dangerous one, because the feeling of tiredness acts as a protection against the excessive expenditure of energy, and its absence when there is real fatigue may cause an individual to continue working to the point of exhaustion.

Boredom, a condition which may be mistaken for fatigue, is doubtless the result of a low degree of fatigue combined with a high degree of lassitude. McDougall[2] regards it as standing at one end of the scale of diminished efficiency and expressing inadequate appeal to the nervous and mental resources of the subject. At the other end stands exhaustion, a state in which the sources of energy have been very largely used up, and in which the resistances which these energies have to overcome, have also been greatly increased. Between these two extremes lies the whole scale of fatigue, ranging from simple boredom to exhaustion.

Fatigue is a necessary concomitant of work, and, when not excessive, is harmless. It has even a protective function,

[1] Thorndike states that, from a comparison of the reports of subjects taking part in an investigation on Mental Fatigue, it appears that the relation between the feeling of fatigue and the fact of fatigue is not at all close (*Journal of Educational Psychology*, vol. ii. p. 71).

[2] *London County Council Report of the Proceedings at the Annual Conference of Teachers*, 1914, p. 34.

preventing overwork. When, however, fatigue becomes excessive, it makes mental work valueless, and if the degree of fatigue exceeds a certain limit the physical and mental life of the individual may be permanently injured. McDougall suggests [1] that the true test of excessive fatigue as compared with fatigue pure and simple is its progressive or cumulative character. If fatigue is so great that in the intervals set apart for rest and recreation the fatigue is not completely abolished, then it exists in a dangerous degree.

The general symptoms of fatigue in children are well known. The various stages have been indicated thus by Dr Taylor: [2] "The picture of a naturally fatigued child is characteristic—his tired, drawn look, his clumsy movements, his listless conversation, his aversion to exert himself, and his readiness to fall asleep. When the condition is passing into a chronic state another set of signs begin to manifest themselves. Thus the morning finds him sleepy and languid, his eyes are dull, his pupils large, and his expression limp and wearied. He drags himself to school slowly, without alertness, his walk is 'tottery' and awkward. In school he lacks attention and responds feebly, his gaze wanders, his attitude is slouching, and he becomes peevish. The same causes continuing to act, matters aggravate, and he arrives at the borderland of actual disease. He becomes pale and pinched, suffers from headache, there is muscular twitching or inco-ordination, he is more liable to colds and susceptible to infectious disease; stomach troubles ensue, with loss of sleep, and exhausting dreams." It is impossible, however, to rest content with merely a knowledge of the general symptoms: definite measurements are essential if our knowledge is to have scientific value. To estimate rightly the significance of such measurements it is necessary to consider the methods by which they have been secured.

The methods used in measuring fatigue may be divided into two classes, namely, direct and indirect. According to the direct methods, the fatigue which ensues on mental work is measured by mental work itself, and, where possible, through

[1] *London County Council Report of the Proceedings at the Annual Conference of Teachers*, 1914, p. 33.

[2] D. M. Taylor, "Fatigue in School Children" (*The Child*, vol. i. pp. 410–414).

work similar in nature to that which induces the fatigue. According to the indirect methods, the fatigue occasioned by mental work is measured through some subsidiary attendant or resultant phenomenon of the fatigue. Each has advantages and disadvantages. The advantages claimed for the direct method are that we obtain a much more unambiguous and trustworthy measure of mental fatigue when we measure mental fatigue by mental work than when we measure it indirectly by means of some physical or psycho-physical symptom. Thus we can determine the degree of fatigue which has resulted from an hour's arithmetic by getting the class to work similar problems and comparing the number of mistakes made in a given time before and after the hour's work ; and this is better than testing the spatial threshold or the motor activity, which may also be influenced. The effect of mental work on mental work is comparatively well known. In arithmetic, for example, under the influence of fatigue more errors will occur and the quantity done in a given time will diminish. The influence exercised by fatigue on the spatial threshold or on muscular activity is not so clear. To the direct methods there are, nevertheless, several objections ; the chief difficulty is the evaluation of the results ; for standards by which to measure psychical processes are not so readily available as those by which physical characteristics are measured. The indirect methods have, consequently, the advantage that the results can be easily registered : there is no difficulty, for example, in counting the pulse or the rate of breathing, if these are taken as indications of fatigue. But the defects of the indirect methods consist in the difficulty of determining what subsidiary physical or mental processes are affected by fatigue and whether the change in these is exactly proportional to the degree of fatigue.

Three forms of the direct method of measuring fatigue can be distinguished, but the first only is strictly direct. We can determine the state of fatigue by changes in the mental work itself. This can be done in the ordinary course of the work without special tests ; or by means of special tests which may either be with similar material or with material of a different nature. In illustration of the first method, we can note the amount performed, and the number of mistakes made, in the course of the first ten minutes of an hour's arithmetic and compare these with what is accomplished in the last ten minutes. The second method employs special tests of the same nature as the work causing the fatigue ; thus, to determine the fatigue resulting from arithmetic, special addition or multiplication tests are given before and after the ordinary arithmetic lesson and the results compared. The third method employs another form of mental work than that inducing the fatigue : thus, to test arithmetic, exercises in dictation or in erasing certain letters in a text can be given before and after the arithmetic lesson and the results noted. The measurement of fatigue by mental work of a different kind to that causing the fatigue involves the assumption that each kind of mental work induces general and not merely local fatigue, and only if this is the case is the use of a different type of material as a test justifiable.

Opposed to the direct methods stands the group of methods using as an index of fatigue a psychical or physical symptom quite different from the work whose fatigue effect it is sought to determine. These methods fall into two classes, employing respectively a psychical characteristic as the standard of measurement, or a physical symptom like rate of pulse or of respiration. These latter methods likewise presuppose that fatigue arising from mental work causes not merely a local but also a general fatigue. This view, maintained by Mosso,[1] is not, however, always justified, as there are cases where after mental work the power of physical work increases considerably ; after two or three hours of study, for example, one may with greater zest than usual turn to some favourite game. The measurement of mental fatigue by physical work is consequently somewhat uncertain.

In treating the various means used in measuring fatigue we shall consider, first, examples of the indirect methods, a common form of which is the æsthesiometric method—the æsthesiometer being the instrument for determining the spatial threshold.[2] It has been claimed that the smallest distance at

[1] Mosso, *Mental Fatigue*, English trans., p. 243.

[2] For description and illustration of instrument see Whipple's *Manual*, part i. pp. 245–246. See also Whipple's translation of Offner's *Mental Fatigue*, pp. 31–39, for discussion of method and results.

which a double touch can be distinguished on a given part of the skin serves as a measure of mental fatigue. This method has the advantage of simplicity and ready application. Its value, however, has been much disputed, and it may be questioned whether the capacity for spatial discrimination varies proportionately with fatigue, or whether the ratio between the two factors is constant; there is also the difficulty of determining what threshold should be taken as the standard. An investigation on mental fatigue during school hours undertaken by Miss Martin, with seven girls chosen from the fifth standard of an elementary school, showed that, as tested by the æsthesiometer, the fatigue of the school day did not cause any constant variation in the sensitivity of the children. The only tendency that was observed was a slight increase in the sensitivity after morning and afternoon school.[1]

The accuracy with which movements are reproduced has also been suggested as a test of fatigue.[2] The subject is practised in making angular movements of the forearm; he has, when fatigued, to reproduce such movements blindfold, and the range of departure from the standard movements indicates the degree of fatigue. Meumann maintains that this method discloses a symptom only, and that it is uncertain whether it provides a real measure of fatigue.

The "Dotting Apparatus" devised by M'Dougall[3] has also been employed in investigations on fatigue. The subject is required to mark with a pencil or pen an irregular zigzag row of dots, lithographed in red upon a paper tape, carried past the field of view at a speed regulated by the clockwork arrangement which rotates the drum to which the paper tape is affixed. The process demands sustained attention, and the failure to mark the dots correctly as they pass before the subject indicates with considerable exactness the degree of fatigue.

The rate at which by voluntary control the change in a

[1] Gladys W. Martin, "The Evidence of Mental Fatigue during School Hours" (*Journal of Experimental Pedagogy*, vol. i. pp. 137–141).

[2] *Cf.* Offner, *Mental Fatigue*, Whipple's translation, pp. 39–41.

[3] W. McDougall, "On a New Method for the Study of Concurrent Mental Operations and of Mental Fatigue" (*British Journal of Psychology*, vol. i. pp. 435–445).

reversible-perspective figure can be effected is a fairly delicate index of fatigue, and it is claimed that it can be applied as a group test with children.[1]

A further group of indirect methods are employed to measure by means of physical work the fatigue occasioned by mental effort. This procedure rests on the assumption that physical work decreases under the influence of mental fatigue. The simplest method of so measuring fatigue is to determine by the use of the dynamometer the gripping power of the hand.[2] With this instrument, however, the number of muscles tested is too large, and the measurements recorded are unreliable if different muscles are brought into play in different tests. Mosso sought to overcome this difficulty by making use of the ergograph.[3] This instrument enables us to measure the amount of work done by the movement of one finger only, the other fingers and the arm being clamped to a table. By the movement of the free finger a weight is raised, and the height reached by the weight before exhaustion of the finger muscles ensues measures the work done. Quite apart from the difficulty of preventing the subject bringing accessory muscles into play, it has been shown that the ergogram, or record traced in the process of lifting the weight, is influenced by the volitional attitude and feelings of the subject. Of the instruments for recording the diminution of physical work under the influence of fatigue the ergograph is the most satisfactory, and it has been extensively applied. The results obtained are, however, not always trustworthy, as the general objection to the indirect methods holds with the ergograph: it provides an objective symptom of mental fatigue, namely, the reduction in muscular effort, but this is no measure of the degree of fatigue.

[1] J. Drever, "A New Test of Fatigue" (*Child-Study*, vol. ix. pp. 41–45, 54–56, 77–79, 89–93).

[2] For account of instrument see Whipple's *Manual*, part i. p. 101; and for discussion of method, Offner's *Mental Fatigue*, pp. 23–24, and Mosso's *Fatigue*, English trans., pp. 82–83.

[3] For illustration see Mosso's *Fatigue*, English trans., pp. 84, 86, 88; Whipple's *Manual*, part i. p. 121; Myers' *Introduction to Experimental Psychology*, p. 104; Myers' *Text-Book of Experimental Psychology*, part ii. p. 59. For discussion of methods and results see Whipple's translation of Offner, pp. 24–28.

The rate of tapping has also been used to test fatigue.[1] Here the rate of tapping when fatigued is compared with the normal rate or with the quickest possible rate, and conclusions are drawn therefrom as to the state of fatigue. The objections to the previous methods apply here also, and a state of excitement may be induced by the task, which increases the work done and masks the effects of fatigue.

Of the physiological symptoms indicating fatigue the blood pressure has been instanced: under the influence of mental work the blood pressure is diminished. Such diminution is recorded by the plethysmograph; the forearm or the upper arm is inserted in a closed chamber containing air or lukewarm water, and the apparatus is so arranged that any variations in the volume of the arm, due to changes in the blood pressure, are transmitted to a recording lever.[2] Meumann states that in his own case there is a considerable diminution of blood pressure after an hour's exacting work.

The retardation and diminution of the pulse and the shallowing of the respiration are also considered to be symptoms of fatigue. They are measured by the sphygmograph and the pneumograph respectively.[3] Increase in the range of accommodation of the ocular muscles has also been suggested as an index of fatigue.[4] The symptoms are nevertheless merely indications of physical fatigue, and in the indirect methods we have no measure of fatigue which can be regarded as entirely free from objection.

The estimating of fatigue by the direct methods, that is, by changes in mental work itself, is not free from difficulties. These difficulties arise mainly from variations in the work-curve indicated above. The effect of practice, for example, increases the amount of work done as the task progresses; incitement, or the process of getting under way, may at the outset lessen the amount accomplished; spurts may increase the work at various points, and the usual terminal spurt

[1] See Offner, English trans., pp. 28–30, and for procedure Whipple's *Manual*, part i. pp. 130 *et seq.*

[2] *Cf.*, for description, Myers' *Text-Book of Experimental Psychology*, part ii. p. 101.

[3] *Ibid.*, pp. 101–102, and *Introduction to Experimental Psychology*, pp. 70–71.

[4] Offner, *Fatigue*, Whipple's trans., p. 30.

tends to counterbalance the effect of fatigue. The results which have been obtained by the direct methods of measurement show at times, instead of a continuous diminution of work, a stage of fatigue in which the work increases quantitatively, while at the same time decreasing qualitatively. It is only at a later stage that the work also shows a quantitative decrease. The results obtained from the direct methods are nevertheless regarded as more trustworthy than any from the indirect methods, since the methods of determining mental fatigue by dissimilar forms of mental work assume that special work concomitantly affects other powers and fatigues these; and since this assumption is not definitely established, the method of measuring fatigue by means of the same kind of work would seem to be the most satisfactory.

Different forms of mental work naturally induce fatigue at different rates, and the following rules have been stated in this connection. The greater the practice-effect in any work the greater the fatigue; thus, work of which the individual is master may be performed almost automatically without any fatigue. Wimms, however, in his investigations into the relative effects of fatigue and practice produced by different kinds of mental work, found [1] that, whether the task was easy or hard, high improvability frequently occurred with little fatigue, and low improvability with a high degree of fatigue. Work found to be difficult, especially such forms as do not harmonise with the subject's endowment, fatigues more quickly and to a greater extent than that which is adapted to his endowment. Work which is undertaken reluctantly, and which is consequently displeasing, fatigues more than work performed cheerfully.

A recognition of the stages in fatigue is important. In the first stage the quantity of work increases, but the quality degenerates; in the second stage the quantity likewise diminishes. If work is still continued there follows a third stage, which varies according to the nature of the individual and the conditions: either exhaustion and inability to work, or a condition of mental excitability and a state of fatigue-fever, occur. In this condition of increased stimulation the amount of work is again increased, but is hurried and irregular

[1] *British Journal of Psychology*, vol. ii. pp. 153–195.

and accompanied by abnormal symptoms, the pulse being weak and rapid, respiration shallow and quick, the muscular system unstable, and movement inco-ordinated.

From measurements of fatigue more practical applications have been made than from any other class of experiments in child psychology or experimental pedagogy. These must at present be accepted with caution. In spite of the uncertainty of these measurements, their practical significance must nevertheless to a certain extent be recognised. Their value depends on the fact that many of the above-mentioned investigations have been carried out on considerable numbers of subjects, and that the practical conclusions rest on the average of such measurements. Such averages sometimes disclose general variations when individual measurements give no clear result. The average should obviously be calculated in a manner free from objection, and this has not always been the case. To acquire value the measurements require to be arranged in groups, under certain points of view ; for example, for intelligent children, normal children, and backward children, and also for children of various ages. Only the general results of measurements of fatigue can be dealt with here ; for results obtained by the various methods separately, the reader is referred to works dealing exclusively with the subject.[1]

In respect to the influence of age it is found that the younger children are more liable to fatigue than the older. Children of six often show signs of fatigue after an hour's or even half an hour's instruction, whereas such symptoms are evident with pupils of thirteen or fourteen only after the third hour's instruction. The fatiguability of children appears to diminish with age. During the pubertal period, however, fatiguability again increases, and this should be recognised in school ; and as the age of puberty is different with boys and with girls, a difficulty arises in co-education.

It is found that very often the physical work of the pupil causes a higher degree of mental fatigue than mental work lasting the same time. After a morning session, in which gymnastics or physical exercises have been engaged in, a high degree of fatigue has been found—the ergograph registering

[1] For example, M. Offner, *Mental Fatigue*, English trans., by Whipple.

only half the normal amount of work.[1] The effects of a high degree of fatigue last much longer than those of a low degree, and work performed in a state of fatigue is more injurious than a heavier task performed under normal conditions. The effect of physical work on the volitional process is said to cause psycho-motor excitement, whereas after mental work the result is psycho-motor inhibition.

Of the psychical processes memory is usually instanced as the one to be first, and most, susceptible to fatigue, but Meumann has found that in his own case this is not so. All the processes involving attention are highly susceptible to fatigue effects. The associative and reproductive processes and the power of judgment are also easily and lastingly affected. School subjects involving these processes, for example, answering questions, writing composition, etc., will consequently be readily affected by fatigue. Meumann has also noticed [2] that print under the influence of mental fatigue appears smaller, and reading less correct and more conjectural. Mosso has found in his own case that when he was obliged to write immediately after a lecture the letters were larger and the lines less firm than usual;[3] but Meumann instances[4] as symptoms of fatigue a surprising reduction in the size, and in the rate, of handwriting.

Attempts have been made to arrange the school subjects in order of fatiguability. The general results indicate that the mathematical subjects are the most fatiguing; next come the language subjects; then the realistic subjects; lastly, and least fatiguing, the technical subjects. Were fatigue the only influence affecting the working power of the pupil, the arrangement of the subjects in the school day would be comparatively simple, but this task is complicated by the presence of other influences, chief amongst which is adaptation. Thus, although

[1] Mosso states (*Fatigue*, English trans., p. 200): "In my own case I have observed that great muscular fatigue takes away all power of attention and weakens the memory. I have made several ascents. I have been once on the summit of Monte Viso and twice on that of Monte Rosa, yet I do not remember anything of what I saw from those summits."

[2] *Vorlesungen*, vol. iii. p. 285.

[3] *Fatigue*, English trans., p. 254.

[4] *Vorlesungen*, vol. iii. p. 251.

the early periods of the school day would be the most favourable for work if the effects of fatigue alone were considered, the later periods of the morning session have the advantage when the factor of adaptation is taken into account. The best period of work will be the resultant of the two factors, fatigue and adaptation.

Even when we know what are the best periods and what are the most exacting subjects, the best arrangement still remains to be determined. Investigation[1] has indicated that the sentiment in favour of putting arithmetic and other supposedly difficult subjects near the opening of the morning and afternoon sessions, with an emphasis upon the morning session, has not been sufficiently substantiated. Indeed, the most suitable period for arithmetic as determined by Winch's tests on adaptation[2] is the later part of the morning session. On this fact alone the teacher cannot, however, build a scientific time-table; he must also know which subjects should precede and which should follow. The general impression amongst teachers at present is that heavy and light subjects should alternate, but as general impressions in Education when scientifically tested are frequently found to be unjustified, the various permutations of subjects should be enumerated and investigated and the best arrangement determined. This is a task which the teacher may well set the experimentalist.

Most authorities agree that under normal conditions there is, with primary school pupils, no marked fatigue at the close of the school day. Meumann found with Zurich primary school children surprisingly little fatigue, but in certain cases, usually with weak children, at the end of the afternoon session, when four hours' instruction had been given in the morning, and especially when drill or gymnastics was included therein, there was an excessive degree of fatigue. This result was, however, obtained only with physically weak children. In every class there are generally to be found children, usually the mentally and physically backward, specially susceptible to fatigue; some of the more intelligent, who at the same time are physically weak, especially at periods of rapid growth, also evince conditions of excessive fatigue.

[1] Heck, *A Study of Mental Fatigue*, p. 27.
[2] Winch, *Journal of Educational Psychology*, vol. iv. pp. 17–28, 71–84.

Winch has found[1] that the degree of inefficiency attributable to fatigue as tested by immediate memory is not great; that with the older pupils in the primary school the effects of fatigue as measured by arithmetical reasoning is very small indeed. Heck[2] has also found that fatigue is so slight as to be almost negligible in school management. "With sound bodies, a hygienic school, proper classification, frequent relaxation, a vital and varied curriculum, and live teachers, most children—he states[3]—will show no problem of fatigue in relation to the daily school programme. However, the individual variations in fatigue in children of the same class are so great that the teacher is under constant obligation to watch the easily fatigued child and decrease his work whenever necessary below the requirement for the class as a whole."

Even if we admit that fatigue in primary schools at the end of the school day is negligible, nevertheless, to secure the greatest efficiency, teachers ought to know how best the school day can be apportioned; what arrangement and length of intervals are the most economical; what should be the length of the morning session; and if, for certain ages, the afternoon session is not abandoned, what should be the length of the mid-day recess. Offner maintains[4] that the afternoon session, if not entirely dispensed with, should begin at the very least two hours after the noon meal, that is, at three o'clock, and not at two o'clock; and Heck concludes from the result of his New York investigation[5] that, for the noon intermission, two hours are preferable to one. As regards the length of lessons the results of fatigue measurements are comparatively clear. The length of lesson should vary with the age of the

[1] *Journal of Educational Psychology*, vol. iii. pp. 18–28, 75–82; *British Journal of Psychology*, vol. iv. pp. 315–341.

[2] *A Study of Mental Fatigue*. "A Second Study of Mental Fatigue in Relation to the Daily School Program" (*The Psychological Clinic*, vol. vii. p. 29–34). "The Efficiency of Grammar-Grade Pupils in Reasoning Tests in Arithmetic at Different Periods of the School Day" (*Journal of Educational Psychology*, vol. v. pp. 92–95). "A Third Study of Mental Fatigue in Relation to the Daily School Program" (*The Psychological Clinic*, vol. vii. pp. 258–260).

[3] *A Study of Mental Fatigue*, p. 28.

[4] *Mental Fatigue*, English trans., p. 88.

[5] *A Study of Mental Fatigue*, p. 28.

pupil; doubtless also with the subject taught and the stage of the subject at which the pupil is. The length of the intervals in the work is dependent on the length of lesson periods. The recuperative effect of pauses decreases as fatigue increases; consequently the later intervals in the school day should be longer than the earlier ones. Through pauses a lack of adaptation or readiness for work occurs, and this to some extent counteracts the gain from recuperation, so that too frequent interruptions of work may not be ultimately beneficial. The intervals should be utilised for rest in the open air or free play, but not for gymnastic exercises.

On the value of the afternoon session the opinions derived from measurements of fatigue are not quite unanimous. The majority of writers, however, maintain that there is a considerable increase in fatigue in the afternoon, and that the afternoon session is physically harmful and educationally valueless.

Holidays and free afternoons have also an effect on the fatiguability of the pupils. Mondays and especially Tuesdays are the days of best work; efficiency diminishes on and after Wednesday, and some schools recognise this by making Wednesday afternoon a half-holiday.

For schools under Government control in Britain we should suggest, in view of these results, that, for infants, afternoon sessions be abandoned; that, in the case of junior pupils, time in the forenoon session, in excess of that necessary to secure the attendance mark, should be allowed to compensate for a shorter afternoon session; and that permission be granted to give a weekly half-holiday on Wednesdays or Thursdays, and to substitute for this a Saturday morning session.

The same favourable condition in respect to fatigue which we have suggested characterises the primary school, cannot be said to hold for higher schools, classical or modern: fatigue to an injurious degree has been found in such schools, and this fatigue continues throughout the school year. Winch[1] found that evening school students, who were at work throughout the day, were so fatigued after the first half-hour's instruction as to render the remainder of the

[1] *Journal of Educational Psychology*, vol. i. pp. 13–23, 83–100.

evening's instruction practically valueless, and this in spite of the opinions of some of the teachers that their pupils were so fresh that even at 11 p.m. they could not be induced to go home.

Tests have been applied to estimate the fatigue of the pupil; they ought also to be applied to determine the fatigue of the teacher. The changes in teaching methods have probably made the pupil's work more intelligible and lighter—although a school lesson is more exacting if the size of class is reduced, as then the pupils are called upon oftener and have to know their work better. Recent changes in teaching methods doubtless demand a greater expenditure of mental energy on the part of the teacher than did the older methods. His mind must constantly be on the alert; he will consequently tire more quickly, and if the teaching is to be effective and economical, rest periods for teachers may have to be introduced into the school day. The increase of nervous disorders amongst teachers would also seem to justify the demand for such an investigation.

Recuperation is especially important for the hygiene of school work. Nothing is more effective in this connection than sleep, for which indeed there is no adequate substitute. Generally children between the ages of seven and nine require eleven hours sleep, ten- to thirteen-year-old children ten hours, and older pupils nine hours.

The effects of loss of sleep upon mental efficiency have been investigated experimentally, with the result that the strain caused by loss of sleep increases the effect of certain work as long as the tension lasts. This success is followed by a marked falling-off as soon as relaxation comes. This falling off extends over a considerable period apparently disproportionate to the initial fatigue, and this fatigue bears no relation to subjective feelings, diminished efficiency not having passed away when the feeling of efficiency had returned. As a result of the effects of the loss of sleep to which Miss May Smith subjected herself for this investigation she is led to ask whether the impaired health and nervous breakdowns which are attributed to "higher education" may not be due in part to the habit of staying up late.[1]

[1] *British Journal of Psychology*, vol. viii. p. 348.

Change of work, it should be noted, even when that change is from mental to physical, is not rest. Both forms of work cause fatigue; and although there may apparently be a temporary increase in efficiency owing to the excitement induced by the change, fatigue nevertheless increases. This seems to be contradicted by the common experience that after exacting mental work many individuals seek recuperation in physical games. The contradiction is, however, only apparent, since in games there may be no physical strain, and a direct recuperative effect may result from increased respiration and blood circulation, and the rapid removal of waste products caused by fatigue. McDougall has suggested [1] that whereas the adult by reason of the greater integration of his nervous system is more capable of using the whole resources of his nervous system, and therefore capable of overdoing it more easily than the child, it may well be that the principle of change of work as recreation may be true of children, especially of young children, while it may become increasingly dangerous when applied in later life.

The diurnal rhythm of energy, physical and mental, should be taken into account in arranging school work, and the neglect of this factor has probably vitiated the results of some investigations into fatigue.

Throughout the day there appears to be an ebb and flow of energy, and the curves for physical and for mental efficiency do not coincide. Physical energy is, as is generally known, lowest in the early morning between 2 a.m. and 4 a.m., and those that wait upon the sick yearn for the morning light, knowing that the first ray of dawn brings to their patient access of strength, and that maintenance of life for another day is usually assured. This flow of energy reaches its maximum in the forenoon, then follows the ebb, to be succeeded by another flood-tide of physical energy greater than the former, and reaching its highest point in the afternoon between 2 p.m. and 4 p.m. From this result another point is gained for the scientific arrangement of the daily programme of school work. As there is a rapid rise of motor energy in the afternoon while mental work is still

[1] *London County Council Report of Proceedings of Annual Conference of Teachers*, 1914, p. 34.

at a low level,[1] the afternoon school sessions should be devoted to instruction in the manual and domestic arts and to physical training.

This increase of physical energy in the afternoon must be taken into consideration in investigations on fatigue. When the dynamometer is employed in testing fatigue a rise in the work curve is sometimes interpreted to mean the absence of fatigue, but if the reading is taken in the afternoon the measure of fatigue is the difference between the rise in the curve and the greater rise that would otherwise have taken place by reason of the fluctuations in the course of physical energy. To disclose the presence of fatigue it is not necessary that the curve should fall, and this proves the need for control tests to be undertaken at periods, for example, during vacations, when the subjects of the experiment are not engaged on mental work.

The fluctuations in mental energy are not so securely established as those for physical energy. It appears, however, that the former increases till midday, then decreases till five in the evening, rises again till nine p.m., and finally decreases till midnight.

In addition to the daily variations there are seasonal variations in the course of physical and mental energy, and here again there is not exact correspondence. For memory work and concentration of attention the most favourable period is from October to January, then a decrease of mental power sets in, continuing to June, to rise again from June onwards. Temperature and mental power appear to vary inversely. The physical energy like the mental increases from October to January and decreases from January to March, but unlike the mental it improves again from March to June and decreases from June to September.

A treatment of the mental work of the school child would not be complete if the influences of the environment in which the child works were not taken into account. As illustrations of this we shall select the influence of collective working and of examination conditions.

The question we have to determine is, How does the child

[1] *Cf.* Meumann, *Vorlesungen*, vol. ii. p. 69, and *Journal of Experimental Pedagogy*, vol. iii. pp. 372–373.

work individually and as a member of a class, or how does he work at home and at school? The question can be further specialised according to the age of the child, the individuality, the grade of endowment, the emotional and volitional disposition, the physical constitution, the sex, and the character of the work, especially in respect of the mental activities involved in it. The influence of collective teaching may also vary according to the size of the class.

The only method for determining the value of work done under such varying conditions is to apply tests of equal difficulty, both qualitatively and quantitatively, in the different circumstances.

The results obtained by Mayer and Schmidt at Würzburg demonstrate generally a great superiority of school work over home work and of collective work over individual work. In the class, and as a member of a community, the child accomplishes more and better work in the same time than at home and in isolation.[1] These results are not to be explained by the unfavourable conditions under which home work is executed, for it has been demonstrated that the majority of pupils quickly habituate themselves to the distractions at home, and are but little influenced by them. In general, the weaker children and those who are slow workers gain most by class work: the younger, too, gain more than the older, since they are more in need of the stimulus of the class and of the teacher. The work of the pupils is rendered more uniform, both quantitatively and qualitatively, by class work; fewer differences in the rate of working are exhibited; and the extremes of the mistakes made are not so wide as in home work. This uniformity resulting from collective working accounts for the fact that the weaker pupils gain most by class work. In consequence of this, however, there arises the danger of over-pressure with the weaker pupils, and so the exceptionally weak, or those specially liable to fatigue, should be placed in special classes. It has, on the contrary, been suggested that a certain mixing of the grades of endowment has a beneficial effect, as the weaker are stimulated by contact with the more capable. There are, according to Meumann's

[1] *Cf.* Meumann, *The Psychology of Learning*, English trans., pp. 345–346.

cbservation, certain children in each class who do better work in the restful environment of home, because they are not in a position to overcome the inhibitions aroused by class work.

The effect of examination conditions on the work of the child has been investigated by Lobsien.[1] Fifty-four pupils were required to perform certain arithmetical tests under ordinary conditions and also under examination conditions. The scholars were arranged in three groups—good, average, weak—and the amount of work done and the time taken were considered. The results showed that with the "good" group the work done under examination conditions was about 22 per cent. worse than that done under ordinary conditions; with the average group the loss was 17 per cent.; and with the weak group 22 per cent. Examinations, it is concluded, do not therefore provide a reliable test of the capacity of pupils, and the evil effects of examinations are not confined to the weak pupils. Lobsien's results would doubtless have been more reliable had the method of parallel groups been adopted in the investigation.[2]

The unreliability of examinations as tests of progress in the acquisition of skill has been indicated by Swift.[3] "Examinations given during periods of retardation—the plateaus of the curve—do not in any way show the progress of the learner. For this reason tests of proficiency should always be given at a time when the pupils have been showing special proficiency for a few days, when they are well along in the upward movement of the curve. Since the progress of different children does not coincide from day to day, the disadvantages of class examinations is obvious."

After the fashion indicated above the various questions of school organisation may be investigated, for example, the influence of the presence of members of the opposite sex on the work of pupils, this being one aspect of the general problem of co-education, the influence of the size of classes, and even the personal equation of the teacher. When this has been fully accomplished, a scientific basis for school organisation will be available.

[1] "Examen und Leistung" (*Zeitschrift für die experimentelle Pädagogik*, vol. i. pp. 30–35).
[2] See above, Chapter II.
[3] *Mind in the Making*, p. 211.

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CHAPTER XV

PSYCHOLOGY AND PEDAGOGY OF THE SCHOOL SUBJECTS

READING

IN proceeding to consider Reading we are entering upon that branch of Experimental Education which treats specifically of the methods of the various school subjects, and which we may term Experimental Didactic. Here, however, we shall confine ourselves chiefly to the consideration of reading, writing, orthography, and arithmetic.

Reading is the instrument whereby the content of recorded language is communicated to us. Language by means of which man expresses his ideas takes two forms, gesture language and spoken or articulate language. Recorded language has likewise taken two forms corresponding somewhat with gesture language and articulate language respectively. It takes, as it did originally in the history of the race, and as it sometimes now does in the early development of the child, the form of picture writing; or it may consist of phonograms or sound symbols, the first part of the pictograph becoming the letter and corresponding with the first part of the word.

The arbitrary character of the graphic forms of words is evident from a study of the history of the alphabet. The sounds of words might be quite otherwise represented, as, for example, in some systems of shorthand, or by dots and dashes, as in telegraphic codes. Not only, however, is the connection between sound and symbol purely arbitrary or conventional, but it is not consistent, so that suggestions towards simplification are continually being made. These may accept the conventional symbolism and try to render it consistent, as, for example, Simplified Spelling; or in the attempt to bridge the gulf between the sound and its graphic representation, introduce a new set of symbols whose forms are connected in some way with the sounds, as, for example, organic symbols fashioned after the shape of the organs in producing the sound; or, lastly, looking at the question from the standpoint of the visual perception of the graphic characters, we may seek to devise a new set of symbols the chief recommendation of which would be that they could be easily distinguished and readily apprehended by the eye.

The present English alphabet has practically every possible disadvantage, and any simplification should be supported. Here, however, in our consideration of reading we must accept the present alphabetic representation.

Before we can proceed to a consideration of the pedagogical aspects of reading, a psychological analysis of reading must be undertaken. The psychological analysis has also the recommendation of impressing upon the teacher—with whom the act of reading has doubtless become so automatic as to be regarded as simple—the complexity of the reading process, and leading him to realise at how many points his instruction in the subject may fail.

Psychological analysis discloses three factors in reading, namely, (1) the meaning, (2) the vocal expression of the meaning in sounds, (3) the graphic representation of the spoken word. These three factors must be so intimately associated that at the sight of the visual form the sounds corresponding therewith will be immediately reproduced and the meaning revived in consciousness.

Any one of the three main processes—the visual, the linguistic, and the ideational—may fail and make reading difficult, if not impossible, for the child. The child who reads a passage orally without grasping the meaning is frequently met in school; not so common, although he does appear sometimes, is the pupil who can apprehend the words visually, and derive the meaning therefrom, but only with the utmost difficulty can pronounce the words, and when concentrating on the oral reproduction, loses the sense.[1]

[1] *Cf.* case quoted in Welton, *The Psychology of Education*, pp. 360–361. For various forms of speech defects, see Leonard G. Guthrie, *Functional Nervous Disorders in Childhood*, chap. xxi.

Reading by the eye alone is undoubtedly the ideal method of reading, although it has not yet been proved to be possible, and has even been said to be impossible,[1] for reading by this method is quicker than by any other method. In rapid reading, too, the comprehension of the content does not suffer, as exact tests show. The almost fixed idea amongst teachers that reading means reading aloud and not reading for meaning has doubtless caused the retention in schools of methods which make slow readers. Investigators agree that it is both possible and desirable to increase a person's speed of reading, and for this reason opportunities for training in rapid reading, for example, as in silent reading, ought to be provided in schools.

From the general analysis we now turn to the experimental analyses of reading. The experimental treatment of reading has two aspects: one deals with the single act of reading and what can be apprehended in the momentary exposure of words exhibited by means of the tachistoscope; the other with continuous reading, and especially with the eye movements involved therein.

The single act of reading has been investigated mainly by the use of the tachistoscope. Two methods may be adopted. The time of the presentation of a word may be increased from a momentary exposure, when the subject fails to read it, to a period of exposure when it can be readily recognised, and the time necessary for reading so determined; or momentary presentations only may be allowed, and the number of exposures necessary for the correct reading of the word registered, and the various misreadings that occur recorded. For the psychological analysis of reading the latter mode of procedure is the more valuable. The method of momentary exposures enables the act of reading to be resolved into its component parts, and thus permits of the isolation of what is visually apprehended from what is added by the assimilative factor in reading.

In tachistoscopic reading it has been observed that misprints are to a great extent overlooked. Thus in words of twelve or fourteen letters as many as eight letters can be altered, and the word is nevertheless read as if it were

[1] Meumann, *Vorlesungen*, vol. ii. p. 566.

unchanged ; the subject has also the impression that the whole word appears objectively in its correct form. Instead of "Hallucination," Zeitler wrote "Hallneiuotion," yet the word was read as "hallucination." It may be remarked in this connection that it is not a matter of indifference at what points in the word the wrong letters are placed, for the recognition of the word is conditioned by certain "dominating" letters which cannot easily be changed without the knowledge of the subject. In the recognition of the word, initial and final letters are, according to Zeitler and Huey, the dominating factors ; then come long letters above the line, then the letters extending below the line, and lastly medium-length letters. Miss Bowden,[1] who classifies words into linear —those with medium-length letters only, for example, "were" ; super-linear, for example, "child" ; sublinear, for example, "going" ; and super- and sublinear, like "dog," found, however, that of six children taught by a word-method four learned more of the linear words than of the other groups, and that in only one case were superlinear words, which Messmer holds to be more easily recognised, learned more readily than those of any other group. The upper half of the word is also more important for recognition than the lower, the left half more important than the right. This is easily tested by covering the upper half, then the lower half of a word ; in the former case the word is practically illegible, whereas in the latter it is easily recognisable.

The visual articulation is, however, as Messmer was the first to point out, the most important factor in determining recognition. If we compare a word like "consciousness" with "individuality," it is at once evident that the former word appears only as a broad uniform streak or band, whereas the latter presents a definite visual contour, resulting from the alternation between the long letters and the medium-length letters. The form of the visual articulation serves as the most important factor in the recognition of the word, and the reading of the adult probably consists exclusively in the rapid apprehension of this characteristic. It suffices in the case of the relatively practised reader to reproduce the whole of the word, the visual image, its sound value, and the meaning.

[1] "Learning to Read" (*The Elementary School Teacher*, vol. xii. p. 28).

With children, according to Miss Bowden, the length of the word is the most important feature, but this is doubtless the result of their method of learning reading. Recognition of words turned upside down was also found by Miss Bowden to be less difficult than recognition of words in which there was substitution or transposition of letters. According to statements made by the children, the inverted forms of words appeared exactly the same as before inversion.

From the tachistoscopic experiments we learn that as visual apprehension is very fleeting, abundant opportunity is afforded for reading into the context what is conjectured. The adult consequently reads in a construing manner, assimilating the text to the expected words rather than attempting to obtain an objectively true apprehension of them. The interpretation in most cases fits the text, whereas with children the assimilative factor and the visual impression do not coincide, and the child consequently appears to be a more subjective and conjectural reader than the adult.

The investigations also disclose individual differences, on the basis of which a classification into "reading types," that is, types of readers, is possible.

(i.) We can distinguish the rapid from the slow reader. The rapid reader reads both nonsense material and intelligible material more quickly than the slow reader, and he likewise apprehends the sense more quickly. With adults these differences in the rate of reading are very considerable, but it is not yet known on what they depend; the differences are only to a small degree eliminated by practice.

(ii.) The hesitant reader has also been distinguished from the fluent. Even with cultured and well-practised adults Meumann found readers of surprising hesitancy who could not read aloud fluently without repeated hesitations. With such, attention may be so centred on the apprehension of the sense that the vocal-motor innervations may be inhibited.

(iii.) There is also the difference between the typical misreader, or subjective reader, and the objectively true reader, but this difference perhaps coincides with the important fourth type, namely, the fluctuating and the fixating readers.

(iv.) These two types, the fluctuating and the fixating, are distinguished by the following differences in their manner of reading long words in tachistoscopic tests with momentary exposures. A reader of the fixating type reads at the first exposure a small definite part of the word lying in the direction of the fixation point, observing nothing of the remainder of the word ; when the exposure is repeated he adds a definite continuation of the parts of the word lying on either side. This type of reader is seldom induced to complete the partially apprehended word by guessing. Thus a reader of the fixating type read as follows in four consecutive presentations of the word " characterization " :[1]—

(1) . . z . . . ation
(2) . . . . zation
(3) . . . rization
(4) characterization.

A reader of the fluctuating type proceeds quite differently. He notices, sometimes even at the first reading, letters which stand at the extreme left and extreme right, along with certain others in the middle of the word ; these parts he combines, by guessing, into the word conjectured. Thus, a reader of this type read as follows in consecutive presentations of " characterization " :—

(1) ch..et...r.z..t..i..a
(2) characteri . . tion
(3) characterizianum
(4) characterization.

From this it is evident that the word as a whole is read from the first in a series of guesses.

The reader of the fixating class can as a rule specify exactly the part of the word fixated : the fluctuating reader is under the impression that he apprehends at once the whole word. If the former has not at the outset chosen the correct fixation point, he fails to recognise the word at all : his attention is centred on the optical fixation point and shifts as the visual fixation alters. His range of attention is circumscribed : of unrelated letters, in momentary exposure he reads but

[1] Examples from article, " Über Aufmerksamkeitsumfang und Zahlauffassung," by F. W. Freeman in *Pädagogisch-psychologische Arbeiten*, vol. i. pp. 116, 119.

three ; and of intelligible material, words of twelve letters, or even of as many as fifteen letters, if the words are familiar to him. His attention is directed outwards and is in this sense "objective." The reading of the fixating type is characterised by objective fidelity and is also objective in the sense that it is not supplemented by guessing. With the reader of this type a distinct time interval elapses between the visual apprehension and the assimilative interpretation or meaning of the word, and he can definitely distinguish the two factors.

The reading of the fluctuating type has just the opposite characteristics. A reader of this type cannot specify the fixation point ; his attention is not directed to the place of fixation but wanders over the word and has an extensive range, apprehending at a glance five nonsense characters or words of twenty-seven or more letters. The detachment of the attention from the fixation point is clearly demonstrated by the fact that a representative of this type can read words in indirect vision, whereas the fixating reader cannot do so. The fluctuating reader almost invariably reads whole words, seldom parts of words ; he is unable to distinguish between objective perception and subjective additions: his reading is mainly a matter of guessing, and no interval appears between the visual act and the mental apprehension. His attention is directed not outwards, but inwards ; he does not analyse the word presented, but analyses his own mental content to discover a word wherewith to interpret the fleetingly apprehended impression. He is therefore a "subjective" reader.

These two types do not probably coincide with the slow and rapid readers, as there are fluctuating readers who read relatively slowly, and readers of the fixating type whose reading is relatively rapid. The objectively true reader is likewise not necessarily a slow reader.[1]

According to Messmer all relatively practised children are of the fluctuating or subjective type ; they display an inadequate observation of the visual characters. And the limited vocabulary which the child has at his command intensifies this subjective tendency. It is not, as with the

[1] *The Elementary School Teacher*, vol. xii. pp. 275–276.

adult, that his attention is directed to the meanings of the words. In opposition to Messmer's view, that all children are fluctuating readers, Meumann declares that he has frequently found children of a pronounced fixating type. In this difference between fixating and fluctuating attention we seem to have a fundamental difference of intellectual endowment which holds even in the case of the child, although, for the reasons given above, the distinction is not so noticeable as with adults. In general, however, with the child the apperceptive and assimilative type of reading preponderates over the apprehensional and observational.

When we consider the differences that differentiate the reading of the child from that of the adult we find that the reading of the beginner, taught according to synthetic methods, differs from that of the adult in that it is a form of reading by letters. Whereas the adult reads a complete word-form that is apprehended in one psychical act, the child must apprehend visually each letter separately, find the isolated sound values for each, and also perform the various motor acts of pronouncing them; the reading of words is only possible through the fusion of these isolated psychical processes by the child. At the outset, then, the child reads synthetically, whereas the adult, in a certain sense, reads analytically; or, rather, the adult has not to analyse because he reads complete word-forms. The main difference, however, is psychical: the beginner requires for the reading of a word as many independent innervations as there are letters—each letter requires a special innervation to apprehend and express it—but with one general innervation the adult apprehends and pronounces a whole word or group of words. With good readers of the elementary school, reading by letters disappears before the eleventh year, thus indicating that the method of the child passes early to that of the adult.

In the case of a relatively practised adult, reading by letters no longer exists: in one act of apprehension the total impression of a word or group of words is obtained. The facts supporting this statement are based on the oversight of misprints and of omissions of parts of words or short words in reading; the alteration of words in accordance with the conjectured sense, or "misreading"; the possibility of the substitution of letters leaving the form of the word unaffected; reaction time tests which demonstrate that the reading of single words takes practically the same time as the reading of single letters, and that the time required for the recognition of single words is appreciably longer if the words are read in isolation than if read in sentences.

Various devices have been adopted to investigate and register the eye movements in reading.[1] The movements can be followed in a mirror, or the more complicated arrangement of Huey may be employed.[2] In the latter the corneal surface of the eye was rendered insensitive with holocaine or cocaine and a small ring was fitted to the cornea; the subject was thus left free to read, but to the ring was attached a delicate lever, whereby the movements of the eye were transmitted to and recorded on a smoked drum, which rotated slowly.

The results of the observation of eye movements may be briefly recapitulated. The eyes in reading do not move regularly forward, but alternate between jerky movements and short rest pauses; the movement of the eye passes along the line of print and, according to Javal,[3] in such a manner that the fixation point does not travel along the middle of the letters, but along the upper part; the eye does not, however, traverse the whole lines, but only their inner portion.

The fewest rest pauses in a line are one, the most about seven,[4] and the shortest adequate fixation pauses are between 70 and 100 thousandths of a second.[5] The more difficult the text, the greater the number of rest pauses made. A practised reader fixates a half, or a third, often even only a fifth, of the actual words. The fixation point lies frequently between two words, and from this it is evident to what extent the fixation of single words has become a matter of indifference in reading.

[1] For these see Huey, *Psychology and Pedagogy of Reading*, chap. ii.

[2] *Ibid.*, p. 25. For consideration of technique of recording eye movements see R. Dodge, "An Experimental Study of Visual Fixation" (*Psychological Review*, Monograph Supplement, vol. viii. pp. 79–95).

[3] *Cf.*, however, Huey, p. 27.

[4] See Huey, pp. 20–21.

[5] Dodge, *Psychological Review*, Monograph Supplement, vol. viii. p. 48.

According to Dockeray's tests,[1] the average limen of clear vision for all letters on both sides of the fixation point was for his first subject 21·5 millimetres, for the second 22 millimetres, and for a third 20 millimetres, or less than an inch. According to Dearborn's results the greatest distance between fixations was 19·3 millimetres, and the least 9·65 millimetres. Huey found for two subjects that the average distance was 20·4. With a few exceptions the distance between fixations lies within the limen of distinct vision. This would seem to indicate that all that is read must come within the field of distinct vision in normal reading. In fact, it would appear that the fields of distinct vision for different fixations may overlap.

The reading process is not solely dependent on direct vision, that is, on what falls within the fovea centralis of the eye, but indirect vision, or what falls on the lateral parts of the eye, also assists the process. To determine the part played by indirect vision in reading, Meumann had spectacles so constructed that in reading with them subjects could see only with the fovea centralis, and lateral reading was completely excluded. Under such conditions it is found that subjects continually lose the lines and that the reading is of an exceedingly clumsy nature. The rate of reading is considerably retarded, yet it is noteworthy that even in this case a form of reading by letters does not make itself evident, but the subject tries to apprehend as large divisions of the words as possible, and to link these one to another. Indirect vision thus seems to have the task of guiding the eye along the lines. In proof-reading, misprints are sometimes noticed five or six lines ahead. From this it may be inferred that indirect vision gives us fleeting impressions of what is about to be read, and as it must likewise furnish images of what has already been read, it thus serves to make reading a continuous process.

The foregoing description deals mainly with the eye movements of the adult. The child who is taught according to a synthetic method follows with the eye letter after letter. He has no proper reading field, and therefore links single impressions to one another to build up from these the image of

[1] *Journal of Educational Psychology*, vol. i. pp. 123–131.

the word or the group of words which the adult apprehends at a glance.

Many children on commencing to read from books become confused by the number of visual stimuli, lose the line, and consequently the word. Our analysis has shown that it is the function of indirect vision to guide the eye over the line, and that the child's field of vision, and consequently of indirect vision, is limited. To assist the child in keeping the line, a reading slide has been recommended; it consists of a card with aperture which leaves only one line open to view. The distracting stimuli from other lines are thus excluded and the child is enabled to concentrate on the word read. The slide is moved along the line as the child reads, and the aperture can be gradually increased in length and breadth until its aid becomes unnecessary.

In continuous reading, the same differences as characterise the reading of the child and of the adult in the single act of reading are exhibited. With one innervation the adult can read a group of words, whereas the child requires a separate innervation for each. For a group of words the practised reader, too, only requires a slight stimulus from the dominating letters or visual articulation of the words; as his attention is not concentrated on single letters, his reading field is continually extending, and indirect vision consequently plays a greater part in his reading than in the reading of the beginner. The apperceptive guidance in reading is also greater with the adult.

The pedagogical conclusions[1] derived from the results of investigations on eye movements are that a more or less uniform habit of eye movement should be acquired at the outset in reading, and that for this purpose shorter lines than those usually employed are necessary. Dearborn, although admitting that his data are not sufficient to warrant any conclusions upon this point, thinks favourably of a line of 75 to 85 millimetres, that is, about three inches.[2] The length of the lines should be uniform, lest a cautious habit of eye movement, difficult to overcome, may be acquired and lead to slow reading. Many primers violate this principle of uniformity, breaking up the line with the illustrations and

[1] Huey, pp. 44–46. [2] The lines of this text are 94 millimetres.

often making a paragraph, with its unequal lines, for every sentence. Dearborn and Cattell both agree, however, that a small indentation of a few millimetres in every alternate line would help to differentiate the lines and prevent their confusion.

The size of print, character of type, nature of paper, and the other hygienic requirements with which school-books should conform have been investigated and determined by a Committee of the British Association, and will be found in the *Report* of that body for the year 1913.

The general characteristic of adult reading is, as we have seen above, that it is a reading by word-wholes and not by letters. The question then arises: As the adult reads by word-wholes, should not the child learn to read in the same fashion? Certain methods of teaching reading imply this principle. They require the child to recognise words as wholes just as he recognises any other perceived object. Such methods are classified under the general title, Analytic Methods.

The analytic methods proceed generally from the whole word or even from the whole sentence, and the elements are, where possible, made known to the child only as components of the word and never in complete separation from it.

In the word method[1] certain typical words are presented to the child as wholes; they are also written as wholes, and even the first observation lessons deal with the corresponding objects. The title under which the word method is best known in Britain is the Look-and-Say method. The sentence method is another form of the analytic method where the sentence is taken as the unit.[2] To these analytic methods we must further add those which take as their starting-point the most important part of expressive reading, namely, the association of the visual form and the vocal expression with the meaning. Setting out from the psychological fact that the adult does not read single letters, but whole words or groups of words, and that the visual form of the letters and words does not represent the sound and meaning, but is only related thereto conventionally, one form of the method introduces reading to the child by requiring him to draw in

[1] See Huey, p. 272. [2] *Ibid.*, pp. 272–274.

outline the forms of certain common objects and then to inscribe in these the equivalent words; for example, in an ellipse the word "egg" is written, and the child thus, after a fashion, reads the pictures. When the picture-reading becomes fluent the drawings which surround the script are dropped and the word is read by means of the written characters alone.

Many advantages are claimed for the analytic methods. They follow the ordinary development of perception, beginning with the whole and proceeding to the parts by differentiation of the whole. They deal with what is already familiar to the pupil, namely, words or names; what is involved in reading, then, is merely the association of a graphic form with a name already known. They lead to intelligent reading, for meanings are always uppermost in the mind. They likewise allow a reasonable choice of words for practice, whereas other methods limit the choice to words sounding similarly or containing similar letters. Lastly, they do not demand that tampering with the speech mechanism of the child to which is attributed much of the stuttering met with in schools.[1] "Prevalent methods in phonics and in teaching to pronounce and to read aloud," it has been maintained,[2] "call the child's attention to the particular movements and processes concerned in speaking, and this consciousness of the 'how' of speaking arises whenever, in reading or talking, the thought is directed to anything else than meanings. Any analytic work of this sort, done before the speech habits have well set, brings in its train the abnormal functions that always attend the attempts of consciousness to tamper with processes which are meant to function automatically."[3]

It is generally admitted that by the analytic methods the child rapidly learns to read and that the methods can be rendered interesting, but it is objected that such methods do not make accurate readers. The child is not led by them carefully to examine the word read: a glance at the shape

[1] *Cf.* Huey, pp. 352 and 396. [2] *Ibid.*, pp. 398–399.

[3] Articles in support of analytic methods: Edmund J. Gill, "Methods of Teaching Reading" (*Journal of Experimental Pedagogy*, vol. i. pp. 243–260); Benjamin Dumville, "The Methods of Teaching Reading in the Early Stages" (*British Association Report*, 1912, pp. 699–701); Barbara Foxley, "How Children Learn to Read" (*British Association Report*, 1912, p. 702).

or contour of the graphic form suggests the word. The result is that words that look alike are readily and frequently confused. The child naturally reads in a highly assimilative fashion, as the investigations of Messmer at Zurich have demonstrated, construing the text in accordance with the conjectured meaning; and analytic methods of teaching reading encourage this tendency instead of repressing it and training the child to the exact observation of the perceptual content.

To these objections it is replied that when the need for exact perception and for distinguishing between words of similar form arises the child himself is led to analyse the words and further analysis is unnecessary. It is sometimes urged that this fuller analysis is necessary for the teaching of spelling. On investigation this has not been substantiated.[1] The arguments, and evidence, for analytic methods are evidently strong, but before giving a final decision in their favour we must consider the other class of methods.

The fact that the adult performs an action in a certain way is no reason for inferring that this is the best way for the child to acquire the process. The adult by long practice may have eliminated certain acts which, while unnecessary in the final reproduction, are yet necessary in the learning.

Meumann asserts that the development of the reading process is governed by the law of the fusion or co-ordination through practice of isolated acts into compound acts.[2] The procedure, he maintains, is the same as in all volitional performances: all the external performances and movements become gradually automatic through their continued repetition and practice. The analogy he employs is playing the piano from notes.

Those who accept this view adopt synthetic methods of teaching to read. They begin with the elements, the letters or the sounds, and leave to practice the fusion or co-ordination of these into whole words. As most of us were taught in this

[1] *Cf.* Edmund J. Gill, *Journal of Experimental Pedagogy*, vol. i. p. 315. "The sentence method of teaching reading produces in a much shorter time a spelling efficiency at least equal to that produced by synthetic methods, in equal times a greater efficiency."

[2] The same, as we shall see, holds for writing.

fashion and now read by word-wholes, the result does seem to be attained without intent, just as with the analytic methods the elements come to be distinguished. Analytic methods, it would appear, train the child to recognise word-wholes, leaving to chance the discrimination of the elements: synthetic methods train the child to recognition of the elements, leaving to practice the recognition of word-wholes. There is evidently possible a combination of both methods, training both in recognition of word-wholes and in the discrimination of the elements, and leaving the development of neither to chance. Before discussing this alternative we shall proceed to consider the various synthetic methods.

The first of these methods, and one which unfortunately dominated the elementary schools for centuries, was the alphabetic method.[1] In principle it consisted in learning the names of the individual letter characters and then combining these to form syllables and words. The chief error of the method was that the pupils did not learn directly the sound values of the single letters, but only the sound values of the letter names which contain, but incidentally, the sound values of the letters; and out of the sound value of the name they had to discover, at considerable trouble, the sound value of the letter. The method has now no defenders. Of it Welton says:[2] "No child ever learned to read by that method: he learned in spite of it." And again,[3] "When the 'alphabet' method is followed by the teacher, the child learns just in so far as he disregards the teacher's method."

Along with the alphabetic method, the phonic method early appeared.[4] At first, however, owing to the prejudice of teachers, it obtained no great support. The phonic method and the phonetic method, which is a development of it, seek to make clear to the child the sound values of the letters, so that the visual character may thereby become associated with the sound of the isolated spoken letter. The phonic and phonetic methods are not without difficulty for the child. The sound of the word is not merely the sum of the sounds

[1] For full account of method and criticism, see any work on primary teaching, or Huey, *Psychology of Reading*, pp. 254 and 265–266.

[2] *Principles of Teaching*, p. 115. [3] *Ibid.*, p. 116.

[4] In 1534, see Huey, p. 255.

of the isolated elements, and the fusion of the latter into the complex sound is a source of difficulty. There is also the objection, with the phonetic method, of burdening the child's mind with mnemo-technical material which later must be dropped from memory when the reading has become fluent.

The synthetic methods have nevertheless the advantage over analytic methods that they secure exact perception of the elements and so lead to accurate reading. Facility they leave to be secured through practice.

The only recent investigation the results of which favour the synthetic methods is that of Valentine, who used as material English words written in Greek characters.[1]

A final judgment on the didactic value of the various methods cannot at present be given ; this will only be possible when parallel groups of pupils, equal in age and intelligence, are instructed in accordance with the different methods and when the reading process of the child is analysed experimentally so that the errors peculiar to one or other of the methods may be compared statistically.

The safest conclusion at present seems to be that the best method is a combination of the analytic or word method with the synthetic—phonic or phonetic, method. The procedure recommended by Meumann is that the teaching should commence with exercises in the acoustic analyses of the words, supported by phonetic instruction ; this acoustic analysis should be accompanied by a parallel visual analysis of the word forms ; the synthetic method should then be applied with an adequacy and thoroughness such as would have been employed if the analytic methods had not preceded it. Miss Bowden, who investigated the reading of children taught according to the word method, likewise recommends a combination of both methods. There is an undoubted advantage, she claims, in having words presented at the start as units or wholes. But that a word method can be used very long without some detailed analysis of the structure and parts of the words is, she believes, altogether too common a notion in the theory, if not in the practice, of teaching.

The relation of the spoken word to the meaning must also

[1] *Report of British Association*, 1913, p. 747.

be considered. Advantage should be taken of connections already existing, and, consequently, the choice of words should be determined not solely by their simplicity, but also by the fact that they convey self-evident ideas ; we should, according to Meumann, begin, then, with concrete nouns whose content in the form of independent images is evident to the child. Miss Bowden also found that the content of the word and its use in the sentence are factors which influence the ease with which it is learned, nouns and adjectives appearing to be more easily learned than other parts of speech.

A point to be experimentally decided is, whether for oral reading the sense of the passage should be made known previously : this, it seems, ought to be done by conversation ; otherwise the bungling of the pupil may create a disgust at the sense of the text.

The rate at which instruction should proceed also requires experimental determination. Generally a slow advance is to be recommended, because the elements are thus more accurately apprehended and the assimilation of the partial processes is developed with thoroughness and precision.

The question whether script or print is the more easily read by children is worthy of mention. From the results of investigations carried out at the University of Chicago and reported by Miss Bowden, it appears that almost from the first the pupils could match the word in script with the printed word and *vice versa*. To the child the script is evidently merely another form of print.[1] Dr Montessori has likewise found that the child passes from the reading of script to the reading of print without guidance.[2]

The knowledge which we have gained by our analysis of reading may furnish some suggestion as to the treatment of individual children in the teaching of reading. It is easy, for example, to observe the bearing of the distinction between the fluctuating and fixating types of attention on the method of instruction in reading. Children with strong fluctuating tendencies should be practised in fixation of attention and exact observation ; for exceptionally weak readers of this type formal exercises with the tachistoscope have even been suggested.

[1] *Learning to Read*, p. 31. [2] *The Montessori Method*, p. 301.

It is more difficult to provide for the imagery types in reading instruction. The entire process of reading may possibly be different with children of the visual type from what it is with the auditory and motor. The main difference between the visual and the auditory reading types lies in this: for visualisers the meanings of words are aroused directly at the sight of the words, and the linguistic or acoustic-motor images operate, at most, as secondary factors, whereas for audiles the meaning is first aroused by the sound image. From our present knowledge of the imagery types, it seems highly improbable that a visual type of verbal imagery exists in such a pronounced degree that the sound images are superfluous for obtaining the meaning of the word: it is rather the case, with the great majority of visualisers, that when they think of a word, acoustic-motor images also operate, and all unpractised readers, and more especially unpractised children, are assisted in reading by silent speaking. Consequently specialisation in reading instruction for imagery types is not demanded by our analysis.

Both for evaluating methods of teaching to read and for purposes of scientific inspection and administration of education, standards or norms of achievement in the various school subjects are indispensable. The psychological analysis of reading, as we have indicated, reveals that the factors involved are the visual forms, the vocal expression and the meaning. In testing reading we can accordingly consider either the ability to express in vocal fashion the printed characters or the ability to derive the meaning from the passage read. Standards have been arranged for estimating each of these abilities.

Starch [1] maintains that as we learn to read in order to obtain information, the most important elements in reading are comprehension of the material and speed of reading. To secure standards of measurement of these elements he selected nine passages of equally increasing degrees of difficulty and corresponding with the reading material of the respective grades of the American primary school. The rate of reading is determined by requiring the pupil to read silently for thirty

[1] "The Measurement of Efficiency in Reading" (*Journal of Educational Psychology*, vol. vi. pp. 1–24).

seconds the passage corresponding with his grade and calculating the number of words read in the given time ; the degree of comprehension is estimated by requiring the pupil to write all he remembers of what he has read, and calculating the number of relevant words reproduced. The standard scores which resulted are as follows :—

Grades	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Speed of reading (words per second)	1·5	1·8	2·1	2·4	2·8	3·2	3·6	4
Comprehension (words written)	15	20	24	28	33	38	45	50

Comprehension as determined by Starch's scale is, according to Ballard,[1] difficult to measure, and presupposes a more rudimentary ability which is quite easy to measure, namely, the ability to translate certain visual symbols into sounds. This he regards as the basal and indispensable part of reading, and to secure standards for the measurement of this ability he prepared a one-minute test consisting of 158 unconnected words. The pupil was required to read the words aloud, and the number of words correctly read in a minute gave the score ; if he hesitated for more than five seconds over a word and did not seem to be on the point of saying it, he was prompted and told to pass on, that particular word counting as an error. The norms recommended by Ballard are :—

Age	6–6½	6½–7	7–7½	7½–8	8–8½	8½–9	9–9½	9½–10	13½–14
Boys	18	28	38	48	58	68	76	82	115
Girls	21	33	43	53	63	72	80	86	122

[1] "Norms of Performance in Reading" (*Journal of Experimental Pedagogy*, vol. iii. pp. 153–161), or *Child-Study*, vol. ix. pp. 1–8. *Cf.* for suggested method of recording mistakes in reading tests "A Reading Test," by Mabel Hassall and Lilian Varley (*Journal of Experimental Pedagogy*, vol. ii. pp. 298–301).

With such norms at his disposal the teacher can test different reading methods and also test the results of his own teaching and compare them with those obtained by other teachers with pupils of the same age and of the same social standing.

REFERENCES FOR FURTHER READING.

Huey, E. B., *Psychology and Pedagogy of Reading.*
Clapper, Paul, *Teaching Children to Read.*
Starch, Daniel, *Educational Measurements*, chap. iv.

CHAPTER XVI

PSYCHOLOGY AND PEDAGOGY OF THE SCHOOL SUBJECTS

HANDWRITING

OF the instrumental subjects, handwriting is that which receives most public attention, but this interest is not welcomed by the teacher, as it is confined to condemnation of his efforts: the criticism also is quite unenlightened, and the teacher is suspicious that it may even prove to be unfounded.

Formerly writing was an accomplishment: to-day it is a necessity. This change is even reflected in the terminology, for whereas we used to speak of penmanship, even of caligraphy, now we speak of handwriting; writing has passed from being an art to being a mechanical process. This change in the social requirements has probably not been sufficiently regarded by the school, and the complaints which are made against the present standards of writing are doubtless due to this fact. The methods which produced the beautiful penmanship of former days are inadequate to meet the needs of a writing which, while legible, can be easily and rapidly executed. A method which combines rapidity and ease of execution with a fair degree of legibility is the method for which the changed conditions call. A high degree of legibility is not now required; this can be attained by mechanical means, for example, by the use of the typewriter, and artistic ornamentation which interferes with rapid reading is now a disadvantage.

The study of handwriting has two aspects which we may for convenience characterise as the objective and the subjective or psychological: the former considers the product, the latter the process of writing.

An objective consideration of various samples of handwriting is said to disclose typical sex differences. From the judgment of different individuals on two hundred addressed envelopes, Downey concludes that it is possible to determine sex in perhaps eighty cases out of a hundred.[1]

Originality is held to characterise the man's hand, conventionality the woman's. Consequently masculine handwriting is thought to show a more extensive range of variability than feminine. The typically feminine hand appears to be colourless, conventional, and usually small. The typical man's hand is bold or careless or experienced, and, above all, individual.[2] A study of the cases showing inversions of judgments, for example, where a man's handwriting is regarded as belonging to the feminine type, leads to the belief that the presence or the absence of the so-called sex-signs is, in the case of any one writer, influenced largely by (1) the amount of writing done, (2) age, and consequently, to a large extent, practice, (3) professional requirements, such as are shown by the conventional writing of grade teachers and the rapid hand of book-keepers.

Such differences as are here characterised as sex differences may, however, on further investigation prove to be merely practice effects.

Thorndike has investigated writing on its objective side and sought to establish a graphometer or scale[3] by means of which the quality of a specimen of handwriting may be estimated and valued with comparative accuracy.

The scale which Thorndike presents is the result of some twenty thousand ratings by competent judges. The degrees of difference in the scale are equal in the sense of being called equal by such judges. Zero merit is defined roughly as a handwriting just recognisable as such, but of absolutely no merit. Quality 18, the highest grade, consists of a copy-book model. The scale thus extends from a quality beyond the

[1] June E. Downey, "Judgments on the Sex of Handwriting" (*The Psychological Review*, vol. xvii.). [2] *Ibid.*, p. 209.

[3] E. L. Thorndike, "Handwriting" (*Teachers' College Record*, vol. xi. No. 2).

reach of any pupil to one so bad as to be seldom, if ever, found in school practice. Any specimen of handwriting is measured by placing it alongside the scale and seeing to what sample on the scale it most nearly approximates. The scale includes specimens of as many different styles as could be obtained, so that the merit of any style of writing can be readily ascertained by comparison with the scale.

Amongst the advantages claimed for the use of the scale Thorndike suggests that, in order to assign to a pupil a value in comparison with his fellows or in comparison with his own past achievements, a teacher may use the scale either by giving its numerical measures outright or by indicating the relationship to the scale of such other equivalents, as A, B, C, or 80, 75, etc., per cents., or excellents, goods, fairs, etc.; in this way the values will have not only a definite meaning to the pupil, but also the same meaning as similar ratings by other teachers in the school, and thus indicate the actual improvement month by month and year by year. The relative values of different methods of teaching, of different periods of practice, and the like, may thus be measured. A principal or superintendent of schools can by this scale compare the method of one teacher with that of another, the work within his own school or city with that of other schools or cities, and with that of his own city several years earlier. The pupil himself may profitably know and use the scale, seeing by it what is expected of him and how nearly he approximates to the recognised standard.

Thorndike's scale is a scale of "merit," not of legibility or of ease of execution. The scale measures not some absolute merit but merit as defined in the average judgment of forty or more persons chosen at random from the competent.

A scale—the standard of which is not, as with Thorndike, general merit, but legibility—has been produced by Ayres.[1] The degree of legibility was determined by the rate of reading by ten paid investigators of 1578 samples of the handwriting of

[1] L. P. Ayres, *A Scale for Measuring the Quality of Handwriting of School Children* (Russell Sage Foundations Publications, No. 113). For comparison of relative values of Thorndike and Ayres scales see *Journal of Educational Psychology*, vol. iv. pp. 525–536, 587–595. For method of equating one scale to the other see Starch, *Educational Measurements*, p. 61.

children of the upper elementary grades of forty school systems; the scale was constituted from a selection of these samples.

The scale itself is a strip of paper measuring 9 by 36 inches divided vertically into eight divisions characterised by values 20, 30, 50, 60, 70, 80, 90, and horizontally into three divisions containing samples of writing of the respective percentages in vertical, medium slant, and extreme slant styles. In order to measure the value of any given sample of writing all that is necessary is to slide it along the division of the scale representing a similar slope to the sample until a writing of the same quality is found. The number at the top of the scale corresponding to the quality of writing to which the sample approximates represents the value of the writing being measured.

Starch,[1] assuming that legibility is the most important characteristic of writing, has suggested a means of estimating this by measuring the speed of reading letters without recourse to a scale. The apparatus required consists of a stop-watch and a circular piece of stiff cardboard, 20 centimetres in diameter, into which three round openings, 2·5 centimetres in diameter, have been punched. These apertures are made in a horizontal row, 1·5 centimetres apart, the middle one being at the centre of the card. The legibility of a sample is tested by placing the card in any position upon the sample and by reading as quickly as possible all the letters exposed in the openings. The time of reading and the number of letters exposed are then calculated. This procedure is repeated, and the reading time per letter computed.

This method of estimating legibility by rate of reading letters might be an improvement over that employed by Ayres in the production of a scale, as the increasing familiarity of the contents of the samples may have influenced Ayres's readers in their estimates of the legibility of the later read samples, but as judges employing Starch's procedure may have different reading rates, these require to be reduced to a common scale by using certain common specimens before their results are comparable. The advantage in respect to convenience consequently still lies with Ayres's scale.

[1] D. Starch, "The Measurements of Handwriting" (*Journal of Educational Psychology*, vol. iv. pp. 445–464).

To analyse with a view to remedying the defects in handwriting, Freeman has prepared charts[1] by which samples of writing can be graded in respect to uniformity of slant, of alignment, of quality of line, of letter formation, and of spacing. By means of such charts the specific defects of a pupil's writing can be detected and their amount determined, and the teacher is thus enabled to guide the learning process of the pupil. To the samples reproduced in the charts illustrating differences in respect to the elementary characteristics of writing enumerated above, numerical designations have been assigned; a teacher can thereby assess a specimen of writing numerically in respect to each characteristic, and thus use the charts as a scale.

To determine whether the claims put forward on behalf of the use of a scale are valid it is only necessary to have samples of handwriting judged without reference to the scale and then by means of the scale and to compare the results. For this purpose specimens were submitted to a class of thirty-seven students: to these the students were required to assign values in even tens, a copy-book headline being regarded as 100 per cent. They were later required to value the same specimens employing Ayres's scale, in the use of which they had had no previous experience. The results were—

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

In the case of sample A, the value is evidently 80 per cent. Without the scale, only eight out of thirty-seven students in training for teaching, who had had considerable practice in

[1] *The Teaching of Handwriting*, chap. v. and Appendix.

estimating the handwriting of school pupils, assigned to the sample the correct value, whereas with the scale twenty-six assigned the correct value. The figures in the case of samples B and C demonstrate that when, even with the help of the scale, the correct values are not assigned, the judgments nevertheless vary less from the correct values when the scale is employed.[1] Measurements made by the use of a scale even by inexperienced judges are approximately twice as accurate as those made without a scale,[2] and practice in the use of a scale has been shown to reduce the range of variation and to increase the steadiness of judgment.[3]

The application of the scales admits of comparisons amongst the writings of various school systems and of writings produced by different methods and different amounts of practice; it likewise discloses relations amongst different moments of writing, for example, between speed and legibility, legibility and slope, etc.

Thorndike found that at least three systems, devoting about seventy-five minutes a week to writing, get results no better than those obtained by two systems devoting no time to it, and that another system giving the former time gets results about 25 per cent. better than the three first mentioned. On the whole, he concludes,[4] efficiency in handwriting seems under present conditions to be not very much influenced by the management of the schools. Considering the differences between individuals within the same school system, he suggests that rapidity is in itself a good sign. If we know nothing about a score or so of pupils save that they are rapid writers, and nothing about another score save that they are slow writers, we can prophesy that at the same rate the former group will on the average do writing of a higher quality.

Comparing, with the help of the scale, the writing of two higher classes of a school with the average writing of adult women teachers, Thorndike is led to advocate the heresy

[1] R. R. Rusk, "A Class Experiment in scoring Handwriting" (*Journal of Educational Psychology*, vol. iv. pp. 447–448).

[2] *Journal of Educational Psychology*, vol. iv. p. 455.

[3] C. T. Gray, "The Training of Judgment in the Use of the Ayres Scale for Handwriting" (*Journal of Educational Psychology*, vol. vi.).

[4] E. L. Thorndike, "Handwriting" (*Teachers' College Record*, vol. xi. No. 2, p. 74).

that children are taught to write too well. The time spent in acquiring the highest qualities of handwriting would, he argues, much more than suffice to enable the pupil to type, almost perfectly, at the same rate.

By the application of his scale Ayres has been enabled to draw tentative conclusions in respect to slant and legibility, and to slant and speed of writing, also in respect to relation between general appearance and legibility.[1] Defining "vertical writing" as writing in which the characteristic slant of the letters lay between 90° and 80° from the horizontal, "medium slant" between 80° and 55°, "extreme slant" as ranging from 55° to 30°, and "back hand" as any writing in which the characteristic slant of the letters is to the left of the vertical, he found that in general the vertical writings are the most legible, the medium slants next, then the extreme slants. The number of samples of back hand examined was too small to admit of reliable conclusions being drawn, but the results suggested that the rate of reading of back hand was slower than of any other slant. The extreme slant writings are found to have a slight advantage over the other styles with respect to speed of writing: here again back hand comes lowest.

While extremely legible writings are found to be almost invariably of good appearance, many writings of good appearance are of relatively low degrees of legibility. Analysis of good-looking writings of low degrees of legibility shows that their most common shortcoming is the crowding together of the words on the line. Next to too close spacing horizontally comes too close spacing between the lines. The breaking of lines in the middle of words in such a way as to make one word look at first glance like two words, and the absence of dots over the "i's" and crosses on the "t's," also decrease the legibility of writing.

By the use of scales norms of achievement for the various school grades and ages have been prepared. Wilson employing the Ayres scale has proposed tentative standards of quality of handwriting;[2] and Starch, adopting the use of the Thorndike scale, gives as norms the actual median achievement derived

[1] *A Scale for Measuring Quality of Handwriting*, pp. 14–16.
[2] *Cf.* Freeman, *Teaching of Handwriting*, p. 145.

from 2190 samples of school pupils' handwriting.[1] The norms of quality are :—

Grade	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Wilson (Ayres scale)	35	40	45	50	55	60	65	70
Starch (Thorndike scale)	6	7·4	7·8	8·6	9·2	9·8	10·2	10·4

Norms for the rate of writing have likewise been prepared for the various grades and ages; to secure these the pupils are required to write for a given period some easy sentence like "Mary had a little lamb," and the average or median number of letters written per minute is then taken as the norm for a given grade or age.[2] The period suggested by Starch is two minutes; the other investigators have selected a five-minute period. The norms thus secured are as follows :—

Grade	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Age	..	7	8	9	10	11	12	13
Wilson's proposed standard[3]	30	40	50	60	70	80	90	100
Starch's actual norms[4]	19·3	33·1	34	40·2	50·6	61·6	79·4	84·8
Kimmins's norms for London children[5]—								
Girls	..	18·8	21·4	29·3	36·1	44·5	49·3	61
Boys	..	13·9	17·4	25·1	32·9	40·2	46·6	53·9

We can now turn from the objective to the subjective or psychological consideration of writing, from the product to the process. This latter has been till lately a much neglected

[1] *Journal of Educational Psychology*, vol. iv. pp. 445–470.

[2] *Cf.* F. N. Freeman, "Problems and Methods of Investigation in Handwriting" (*Journal of Educational Psychology*, vol. iii. pp. 181–190); Starch, *Educational Measurements*, chap. v.

[3] *Cf.* F. N. Freeman, *The Teaching of Handwriting*, p. 145.

[4] D. Starch, *Journal of Educational Psychology*, vol. iv. pp. 445–446.

[5] C. W. Kimmins, *Child-Study*, vol. ix. pp. 61–64.

aspect of the subject. Judd, for example, in his *Genetic Psychology for Teachers*,[1] states: "One of the troubles with our teaching of writing has been that we have had our eyes too much on the lifeless, material paper and ink, and not enough on the pulsating human being back of these material things." Dr Maria Montessori, for the results of whose method much is claimed, likewise states:[2] "It need scarcely be said that we should examine the individual who writes, not the writing."

The consideration of the subjective or psychological treatment of writing can be divided into:—

1. The movements involved in handwriting.
2. The pressure exerted in handwriting.
3. The form of control exercised—visual or motor.
4. The mental preparation; that is, the influence on handwriting of whether a person writes from a printed copy or set model, or writes to dictation, or from memory.

In writing there are three movements involved:[3]—

1. The movements employed to form the letters.
2. The movement of the wrist, termed "pronation," which contributes to the continuous writing of a word.
3. The movement in the shoulder joint and at the elbow, which admits of the passage of the hand across the page.

Taking the third movement, that of the arm across the page, we find that the easiest movement of the arm is an outward movement almost at right angles to the forearm. If this movement were adopted and the paper placed parallel to the desk the writing would run upwards. To admit of the easiest movement of the arm across the page and at the same time to keep the lines parallel to the base of the paper it is necessary to tilt the paper until its base is almost at right angles to the forearm.

When the paper is not so tilted, the tendency for the hand to move upwards is counteracted by a movement which draws down the hand and thus enables the writing to keep the lines. This additional movement can be dispensed with by the proper

[1] Page 162.
[2] *The Montessori Method*, English trans., p. 260.
[3] *Cf.* C. H. Judd, *Genetic Psychology for Teachers*, chap. vi.; also F. N. Freeman, *The Teaching of Handwriting*, chap. ii.

adjustment of the paper, and a needless expenditure of energy thereby avoided.

The second movement, termed pronation, is a movement chiefly of the wrist, and results from the fact that a word is written continuously. If we begin to write a word with the palm of the hand flat on the paper, we find that as we proceed the hand turns over till at the end of the word we are writing on the side of the hand. This movement is necessary to preserve regularity of slope, which could otherwise be secured only by repeated changes of position of the whole hand, consequently writing on the palm of the hand should not be strictly enforced, as is sometimes the case.

Experiments have been made by McAllister [1] to determine at what angle the easiest upward or downward movements can be performed—the degree of difficulty being estimated by the time taken to execute the movement. If the movements in the first quadrant of a circle—that is, between 0° and 90°—are taken as the standard, movements in the second quadrant—that is, between 90° and 180°—are found to require 30 per cent. more time, movements in the third quadrant 10 per cent. less, and movements in the fourth quadrant 25 per cent. more than the standard. These measurements condemn "back hand" writing, if the same processes are involved in this form of writing as in those movements investigated by McAllister, since such a slope entails movements comparatively difficult to make, and thus reduces the speed of writing.

The natural movement, it would however appear from a statement by Harman,[2] is a backward slope. "I made a very interesting experiment," he says, "with a number of infants who had never been taught to write. The first day they came into the schools—from the East End slums, where I am quite sure their mothers never taught them anything—we gave them some sand trays, and showed them how to mark vertical lines. Then they tried to do the same themselves, and in every case they drew their chubby little fingers from the top left-hand corner to the right bottom corner, and when

[1] Cloyd N. McAllister, *Researches on Movements used in Writing* (Studies from the Yale Psychological Laboratory, vol. viii. pp. 21–63).

[2] *London County Council Conference of Teachers*, 1913, *Report of Proceedings*, pp. 21–22.

a forefinger was dipped in an inkpot they made lovely smudges right down the page from the top left to the bottom right corner."

Freeman maintains[1] as the result of a later investigation than that of McAllister that the most natural direction for a downward stroke is towards the body. This would result in vertical writing if the base of the paper were placed parallel to the edge of the desk; but if the paper is tilted as indicated above, and the downward stroke is made towards the body, the resultant writing is inclined to the right in the same degree as that at which the paper is tilted. Thus writing with a slope is the writing easiest to execute.

Theoretically, vertical writing has the advantage over sloping writing in legibility; but this advantage is not, according to Freeman, maintained in practice, the degree of legibility depending largely on whether or not the writing conforms to the conditions necessary for ease and rapidity of movement. The practice of teaching writing with a moderate degree of slant seems therefore to be justified by scientific analysis.[2]

The position of the paper and the direction of the downward movement in writing, although these result in writing with a slope, nevertheless satisfy the conditions required for the hygienic posture of the pupil at the desk.

A further question arises as to whether the upward and downward strokes of letters should be executed by finger movements, as is almost exclusively the case in Britain, by arm movement, as in common in America, or by a combination of finger and arm movements.

We are fortunately enabled, by the adoption of a simple contrivance devised by Judd,[3] to isolate the movements of the hand from those of the fingers, and to obtain records of the former. Thus for any style of writing we can register how much finger movement is involved.

The tracing obtained from the hand-and-arm movement is readily distinguishable from that got from the finger move-

[1] Frank N. Freeman, " Some Issues in the Teaching of Handwriting " (*The Elementary School Teacher*, vol. xii. pp. 1–7, 52–59).

[2] *Ibid.*, p. 4.

[3] For description and illustration of tracer see Judd, *Genetic Psychology for Teachers*, pp. 170–171.

ment. The former appears practically as a reduplication of the original writing; the latter presents the appearance of a straight line indicating merely the movement of the hand across the page. Tracings taken of children's writing reveal the fact that there is a movement of the hand for long letters and in the passage from letter to letter; for medium-length letters there is no movement of the hand. Adults who have much writing to do, however, relinquish the finger movement and adopt the hand-and-arm movement. The excessive use of the finger movement is probably the cause of writer's cramp, and to those who are thus afflicted, the use of the hand-and-arm movement should be recommended. Beginners should use the arm movement only. This is made without resting the forearm on the desk, and requires that the desk should be inclined 15° or 20°, and the front edge should be low enough to allow the child's elbow to clear it when the arm hangs from the shoulder.

Freeman comparing the merits of the arm movement in forming the letters with a combined movement of arm and fingers, suggests that whereas the larger components of letters may be executed with the arm movement, the fingers are well adapted to perform the parts in the production of the letters which require the more delicate adjustment. From his analysis of the writing movement his general conclusion is that the most favourable type of movement is one which combines the use of the arm, of the wrist, and of the fingers, in such a way that they perform the work for which they are respectively best adapted. "The arm is clearly adapted to carry the hand along the line. Rotation about the wrist may readily carry the fingers along during the course of the formation of a group of letters or of a word. The fingers may co-operate by producing the details of the letters. . . . The condition which is most favourable, then, to a rapid and easy movement is one of general flexibility and of harmonious co-operation of the different joints." [1]

The pressure exerted in writing is registered by means of instruments specially devised for this purpose. Meumann employed an aluminium plate covered with a strip of paper

[1] Frank N. Freeman, "Some Issues in the Teaching of Handwriting" (*The Elementary School Teacher*, vol. xii. p. 59).

and supported on three levers, the lower ends of which terminated at one point, through which the pressure exerted on the plate was transmitted to a pneumatic capsule. This was in turn connected with a Marey tambour, which controlled the movements of a recording pen on a slowly revolving smoked drum. A pressure curve was thus secured.[1]

The objection to this type of instrument is that variations in pressure on the plate may not be variations in writing pressure but variations in pressure at, or changes in the position of, the wrist. To obviate this difficulty Drever has devised a means of registering the pressure from the writing point.[2] A pen or pencil is inserted in a guiding tube, the top end of the pen or pencil being caught tightly in a short metal holding tube which is attached to a rubber membrane. Variations in pressure affect the membrane, and are transmitted to a tambour and registered on a smoked surface.

The pressure curves obtained by such means demonstrate that in the case of adults two types of writers are clearly distinguishable, characterised respectively as the masculine and the feminine type. The masculine type writes with more pressure than the feminine, somewhat more slowly, and the innervations are better co-ordinated into one complex movement. The pressure is rhythmically distributed over the word, so that generally the highest or maximal pressure lies at a definite point in each word; with some individuals this maximum is at the beginning, with others at the end of the word. It is a special characteristic of the masculine type that as the speed increases the pressure increases. The feminine type, to which, however, the writing of some men conforms, writes more quickly than the masculine, but with less pressure, and the innervations are not so well co-ordinated. The pressure curve has in most cases several maxima, and it is characteristic of this type that, with increased speed, pressure decreases.[3]

The writing of the child is quite different. Here, as with

[1] For illustration see *Vorlesungen*, vol. iii. p. 538, or Schulze's *Experimental Psychology and Pedagogy*, English trans., p. 309.

[2] For illustration see *Journal of Experimental Pedagogy*, vol. ii. p. 26.

[3] For reproductions of pressure curves see Meumann, *Vorlesungen*, vol. iii. pp. 542–543, or Schulze, pp. 310–312.

reading, the beginner has to be distinguished from the more practised pupil. The latter in his style of writing approximates more to the type of the adult: the writing of the beginner, on the contrary, presents radical differences from that of adults. With children of six and seven years a pressure maximum is never found in the word, but each single letter, and at the outset each single stroke, is written with equal pressure. With such children no rhythmical writing curves can be obtained, but only an extraordinary long-drawn-out curve, which remains about the same height for each stroke.

The comparative rates of writing are likewise different: the adult writes the single letters of the word according to a definite temporal rhythm, so that at one place in the word, and at definite places in the various letters, an increased rate of writing occurs, whereas the child generally writes more slowly and produces each stroke at approximately the same rate.

By means of a device similar to that employed for registering point pressure Drever has investigated grip pressure.[1] His general conclusion is that the grip-pressure curves considerably resemble the point-pressure curves, though with less irregularity.[2]

It has been suggested that the individual variations in distribution of pressure in writing are related to difference of emphasis in expression, the words which are accented in speaking being written with the greatest pressure.[3]

The development of the child's writing takes in general the following course: the writing becomes more rapid; the independent impulses are co-ordinated into one complex impulse with rhythmical subordination of the separate expenditures of pressure to one main act of pressure, until the innervations of a word form a single unitary process in which by means of one resolution the whole word is executed.

By the success attending the application of the Montessori

[1] For illustration see "The Analytic Study of the Mechanism of Writing" (*Proceedings of the Royal Society of Edinburgh*, vol. xxxiv. p. 235).

[2] *Child-Study*, vol. vii. p. 63.

[3] *Cf.* Meumann, *Vorlesungen*, vol. iii. p. 547.

methods to handwriting, interest has been aroused in the mode of control exercised in retaining and reproducing the letter-forms in writing. The traditional practice has been for the pupil to observe the completed form of the letter, or to follow visually the formation of the letter by the teacher, the control being predominantly visual. In the Montessori system the pupil learns the form by tracing with his finger the outline of the letter cut in sand-paper; in this case the control is a motor control. On *a priori* grounds the advantage would seem to lie with the motor control, since this is the mode which must be employed in the reproduction. The success attending the Montessori method would corroborate this view.

From the results of an investigation into the "Rôle of the Muscular Sense and of Vision in Writing"[1] it has been maintained that it is wrong to train children to fix their eyes on what they are writing. It is a source of fatigue, and may contribute greatly to myopia. Experiments with the blind, with normal persons blindfolded, and with writing at arm's length, show that the speed is increased and the quality suffers very little when the rôle of vision is reduced to merely keeping on the line. In writing practice we should therefore encourage pupils to develop muscular control, and to depend on vision as little as possible.

The influence of the mental preparation on writing is considerable in the case of both children and adults. If we compare the operation of writing the figures 1 to 9 forwards with that of writing them backwards, the latter operation is found to be performed more slowly and more pressure is exerted. The less familiar association requires a greater concentration of attention, and this causes a greater pressure and a certain retardation in writing. This mental preparation in children comes especially into prominence when we consider whether children should write from a set copy, to dictation, or from memory. They write better from a set copy, at more regular speed, with greater uniformity of pressure, and form the characters better; but as soon as children become proficient, the copy has an inhibitive effect, and writing to dictation gives more favourable results. All

[1] J. Ioteyko and V. Kipiani, *Revue Psychologique*, vol. iv. pp. 357–361.

these circumstances naturally react on the appearance and form. Generally we may say that irregular distribution of pressure, retardation and irregularity in the relative times accompany a deterioration in the form of writing. As the psychological processes involved in the two forms of writing are quite different, it cannot be assumed that a child who writes well from a copy will also write well to dictation or from memory.

Investigations have been made with children to determine the effect of writing to the beat of a metronome.[1] Writing thus, children display fewer independent impulses than when writing without the beat. The compulsion to rhythmical writing thereby induced causes the child's writing artificially to approximate to that of the adult. Writing to a beat has on the whole a marked influence on handwriting; generally under the influence of the beat the child writes more rapidly, but the writing is not so uniform. It is consequently important that the *tempo* of writing to the beat should not be made too quick. The rate at which children can write well should be determined before the practice is introduced with a class. With young children this *tempo* is very much slower than with adults.

Into the exact psychological and pathological analysis of writing we cannot here enter,[2] but as writing, like speech, is a form of expression, disturbances or abnormalities in the one have generally their counterparts in the other. Thus a left-handed child who would naturally use his left hand for writing, when compelled to use his right hand for this purpose not infrequently stammers. The proportion of stammerers among normal children is probably not higher than two per cent., but with left-handed children who write with their right hands the percentage is seventeen. The act of writing, rather than any other act of skill, seems to be the interfering factor. Writing, then, should be practised with the superior hand, and with the superior hand only.[3]

[1] *Cf.* F. N. Freeman, *The Teaching of Handwriting*, pp. 104–106.

[2] *Cf.* James Kerr, "Nervous Mechanisms and Writing" (*Child-Study*, vol. vi. pp. 58–64). For effect on handwriting of tobacco smoking by school pupils see *London County Council Medical Officer's Educational Report*, 1906, p. 49.

[3] P. B. Ballard, "Sinistrality and Speech" (*Journal of Experimental Pedagogy*, vol. i. pp. 298–310).

The chief pedagogical question which arises in connection with handwriting is, as in the case of reading, whether analytic or synthetic methods should be adopted in the teaching of the subject. The analytic methods involve training the different processes simultaneously, the synthetic methods training different capacities one at a time; the opposition resolves itself in practice into the question as to which component in writing should be developed first, correct movement or form, the analytic methods aiming at the former, the synthetic at the latter.

Meumann maintains that the synthetic methods of teaching handwriting are of more didactic value than the analytic, since with the emphasis of the former upon the elements a more exact appropriation can be guaranteed: in the synthetic methods, too, the co-ordination of the individual and independent impulses into a unitary innervation is secured quite early enough by continuous practice.[1] Meumann attributes the success of the Montessori method largely to the thoroughness of the preparatory training; but whereas in this preparatory training the forms of the letters and the command of the writing instrument are acquired independently, when the pupil "explodes" into writing it is words that he writes, not mere components of letters.

Freeman advocates the adoption of analytic methods. Writing, he maintains,[2] should have meaning to the child from the beginning. The extreme synthetic method, that is, beginning with the so-called "elements of the letters," is fallacious, he argues,[3] in supposing that the elements into which the letters are analysed are the psychological elements of writing. The letter, he asserts, is the psychological unit, and defects in its form may be remedied by calling attention to them without the burden of the procedure of developing a series of elements. The question then resolves itself into the alternative between the use of letters and the use of words at the beginning of the writing practice. Freeman concludes that if words are used as the main basis of writing, then this procedure may be supplemented by the introduction of drill

[1] *Vorlesungen*, vol. iii. p. 558.
[2] *The Teaching of Handwriting*, p. 87.
[3] *Elementary School Teacher*, vol. xii. p. 54.

upon the letters whenever this seems to be necessary to remedy defects which may be found.

As the attainment of proficiency in writing is a form of the development of skill, the periods of practice should be determined in accordance with the principles governing the acquisition of a dexterity, discussed above.[1] As only successful practice counts, the periods should be short; for junior classes, Freeman recommends frequent periods of ten minutes, and in the primary school the practice periods should never exceed twenty minutes.[2]

In investigating the movements made in handwriting[3] McAllister considered the preliminary training which was advisable for the child to secure perfect control of the hand. Clay modelling in the kindergarten, he suggests, is useful for this purpose, and this should be accompanied by training in the use of the brush. Most children have the slate or lead pencil placed in their hands first. These require a firm grip and some pressure in order to produce sufficient friction to make visible the path of the point. The habit thus formed of gripping the pencil is difficult to eradicate. The broader path of the brush renders a small figure or character impossible for the little hands, and a large full-arm movement is readily acquired. By the continued use of the brush a higher degree of muscular sensitiveness is gained, and the child soon learns to make finer and more regular lines. No attempt should be made to form letters with the brush: care should, however, be taken that the forms of the letters are otherwise properly impressed upon the mind of the child. The two processes, it may be remarked, are treated independently in the Montessori method. The use of the pen will follow naturally upon this. The brush does not require a tight grip, and the pen will consequently be held lightly.

McAllister recommends that soft pens and light penholders should be used. Freeman likewise states[4] that for primary

[1] See Chapter XIII.
[2] *The Teaching of Handwriting*, p. 74.
[3] Cloyd N. McAllister, *Researches on Movements used in Writing* (Studies from the Yale Psychological Laboratory, vol. viii. pp. 21–63).
[4] *The Teaching of Handwriting*, chap. iii.

grades the penholder should be smaller than that used by older children. The general rule which he gives is that the holder should not be so small that it cannot easily be kept from turning in the fingers, nor so large that the fingers cannot easily be bent in a natural manner. It may be added that it should not be so long, nor so smooth, as to make gripping difficult. The quill pen doubtless possessed some advantages in these respects not reproduced in its modern equivalent. The ink, according to McAllister, should be a heavy black or dark blue, and the paper a light yellow. Freeman adds that the paper should not have a glazed surface; it should be rough enough to take a good mark, but hard enough to prevent the pen easily penetrating it.

McAllister also concludes that the letters should be considerably smaller than the large copies at present placed before beginners. He recommends that after the forms of the letters have been thoroughly mastered, each pupil should be allowed to adopt the size naturally agreeable to himself. The space between the lines should be sufficient to prevent any appearance of crowding, and to permit of the lines being disregarded. Freeman recommends[1] for beginners a ruling of lines $1\frac{1}{2}$ inches apart and writing of $\frac{1}{2}$ inch for one-space letters, for intermediate pupils a ruling of 1 inch and writing of $\frac{1}{4}$ inch, and only in upper grades should a ruling of $\frac{3}{8}$ inch and writing of $\frac{1}{8}$ inch ever be permitted. He advises the use of a base line,[2] which acts as a guide to the pupil's weakly controlled movements, and is not open to the objections urged against additional lines marking off the heights of the various letters; the latter impede the development of a free movement and impose an unnecessary strain upon the eyes. Kimmins has found that the absence of the base line militates against speed, especially in the lower part of the school.[3]

Although Freeman regards the style of alphabet used in handwriting as a relatively unimportant matter,[4] many advantages are claimed for a manuscript type of writing,

[1] *The Teaching of Handwriting*, p. 62.
[2] *The Elementary School Teacher*, vol. xii. p. 434.
[3] *Child-Study*, vol. ix. p. 63.
[4] *The Teaching of Handwriting*, p. 111.

and it has met with considerable success, especially with junior classes.[1]

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[1] See *Child-Study*, vol. ix. No. 5: "Handwriting: Methods and Tests," by C. W. Kimmins; "An Experiment in Handwriting," by K. L. Grainger; "The Introduction of a New Method in Handwriting," by Golds.

CHAPTER XVII

PSYCHOLOGY AND PEDAGOGY OF THE SCHOOL SUBJECTS

ORTHOGRAPHY

ORTHOGRAPHY presents on its theoretical side about as many difficulties as it does in its practical application. It is a subject which readily lends itself to statistical treatment and to superficial analysis, but in spite of this the causes of errors in spelling are as obscure as the faults are obvious. The ease with which the results of the teaching of orthography can be estimated has made the subject a popular index of the efficiency of teaching, and its educational value has consequently come to be much exaggerated.[1] It would be unprofitable here to discuss this usual misconception as to the relative importance of spelling among educational studies or to attempt an evaluation of the reforms projected to overcome the difficulties inherent in the subject; we must here content ourselves with indicating the results of investigations dealing with the presently accepted standard of spelling.

Two lines of research have been followed in investigating the subject of spelling; the one, we may call the statistical, the other, the psychological. The former attempts to determine from an enumeration of the errors made the degree of ability in spelling of pupils of various ages and of different sexes, the effect of practice in a given method or of "drill," the question of the transfer of words learned in isolation to the use of such words in connected writing, and similar general questions. The most important of the investigations of this

[1] *Cf.* Suzzallo, *The Teaching of Spelling.*

type are those of Rice,[1] Cornman,[2] and Wallace Wallin.[3] To the statistical type of investigation also belong the attempts of Buckingham,[4] Ayres,[5] and Starch[6] to devise scales for the measurement of ability in spelling. Investigations which we may term psychological seek to determine the mental processes involved in the retention and reproduction of words in spelling either by an analysis of the errors of pupils or by controlling the methods of learning and evaluating the results.

The investigations of Rice and Cornman were very similar in method, and their conclusions were in general agreement. From statistical surveys of the errors made by pupils of several different schools when required to write dictated lists of isolated words, of words in sentences, when writing compositions, and in lists of spontaneously written words, they concluded that the degree of general mental development, as measured by the school grade of the pupil, was the most important factor contributing to the accuracy of his spelling. The spelling result is dependent more on the alertness and efficiency of the teacher than on the time allotted to the teaching of the subject or on the method employed. Rice maintains that the spelling grind is futile, and Cornman advocates the incidental teaching of the subject.

Wallace Wallin employing, unlike Cornman, different sets of words for different grades, nevertheless found that, disregarding the retarded pupils in the various classes, spelling proficiency increased with age. He is also in agreement with Cornman that girls are more proficient spellers than boys, although there is not an exact correspondence as to the grade in which the superiority is most pronounced: with Wallace Wallin it is in the later years, with Cornman in the fourth and fifth years of school life. Wallace Wallin combats the suggestion that the method of teaching does not influence the result, maintaining that his tests amply demonstrate the superior

[1] J. M. Rice, "The Futility of the Spelling Grind" (*The Forum*, 1897).

[2] Oliver P. Cornman, *Spelling in the Elementary School.*

[3] J. E. Wallace Wallin, *Spelling Efficiency in Relation to Age, Grade, and Sex, and the Question of Transfer.*

[4] B. R. Buckingham, *Spelling Ability, Its Measurement and Distribution.*

[5] L. P. Ayres, *A Measuring Scale for Ability in Spelling.*

[6] D. Starch, *Educational Measurements*, chap. vi.

value of a skilful spelling-drill technique for developing orthographic excellence, such technique consisting of initial focalisation of attention on a limited number of words and attentive repetition. While he does not despise the effect of the motivation arising out of the felt need of the word by the pupil which constitutes the main factor of the incidental method, nothing can bring the form work to a state of facile control, he maintains, except focalised reiteration.[1] Winch also found that a "direct" method was for all purposes more profitable than an "indirect" method.[2]

In regard to the question of the transfer from lists of dictated words to the use of such words in dictated composition the results and conclusions of Cornman and Wallace Wallin are at variance. Cornman found a loss of ten per cent., and concluded that there was no transfer. Wallace Wallin found that, taking the gross results for all schools as a basis of comparison, the difference between the column and the composition tests amounted to only 1·44 per cent., and concluded that the average loss of efficiency through transfer was so slight as to be almost negligible.[3] In some cases there was found to be an actual transfer gain, so that column drills in spelling may produce a positive increment of spelling efficiency in dictated compositions or connected writing. Winch obtained the same result with London children.[4] The "transfer" takes place only when the same words are employed in both types of tests, it is not a transfer to all words whether they have been studied or not; it follows that the material of the training lists should consist of those words which are most likely to be used in the actual workaday experiences of the child and of the average adult, and the determination of this is a practical problem of some difficulty.

Before precise comparisons can be established in regard to the spelling abilities of pupils of different ages and for the settlement of similar questions in the pedagogy of orthography a scale of words of regularly increasing degrees of difficulty is necessary. To the construction of such scales Buckingham and Ayres have addressed themselves. Buckingham first

[1] *Op. cit.*, p. 71.
[2] *Journal of Educational Psychology*, vol. vii. pp. 93–110.
[3] *Op. cit.*, p. 65.
[4] *Journal of Educational Psychology*, vol. vii. p. 110.

set himself to select a series of words which would be easy enough in the third grade of the American school and hard enough in the eighth grade to afford a test in those, and therefore in intermediate, grades, and which showed regular percentage increases from grade to grade. Two lists each of twenty-five words satisfying these requirements were prepared, the words being incorporated in sentences for testing purposes. The fifty words which resulted were then scaled in order of difficulty as experienced by the pupils tested, ascending in order of difficulty from *only*, *even*, *smoke* to *grease*, *too*, as follows:—

only	even	smoke	chicken	front
another	lesson	bought	pretty	nails
butcher	Tuesday	sure	answer	nor
raise	cousin	beautiful	touch	freeze
forty	instead	wear	tailor	tying
minute	pear	towel	tobacco	whole
button	janitor	quarrel	against	circus
sword	whistle	stopping	carriage	guess
telephone	choose	telegram	saucer	saucy
already	pigeons	beginning	grease	too

It is impossible in view of the existence of this scale to assume, as is usual in school practice and as in the investigations above mentioned, that all words are of the same value. The objective scale of difficulty may also be profitable in assisting teachers to revise their estimates of the relative difficulty of words. The word "too," for example, was judged by more than one-fourth of a representative group of teachers to be the easiest, or the easiest but one, of the fifty words listed above instead of the most difficult, and as Buckingham adds,[1] "pupils misspell it because their teachers do not realise the need of teaching it."

From the material on which his fifty words were graded Buckingham was able to arrange equivalent series of words, a necessary step for many types of investigations. Thus the series

Tuesday, forty, towel, against, guess,

is equal in difficulty to

answer, instead, whole, janitor, carriage.

[1] *Op. cit.*, p. 112.

A scale whose words differ in difficulty by equal steps was also obtained: thus

only	smoke	another	pretty	answer
tailor	circus	telephone	saucy	beginning

As a preliminary step to the construction of a spelling scale Ayres sought to determine the writing vocabulary of adults, arranging the words in the order of frequency of use as they occur in written English, more especially in personal and business letters. One thousand words were finally selected and so arranged, the commonest, according to Ayres's calculations, being "the, and, of, to, I, a, in, that, you, for." With their repetitions these constitute, he says,[1] more than one-fourth of all the words we write.

The thousand words so selected were then made up into fifty lists of twenty words each, and these lists were employed as spelling tests. Altogether 1,400,000 spellings were secured from 70,000 children in eighty-four cities. The words were then arranged according to their location on a line representing the distance in spelling difficulty for each grade from the word so easy that just all could spell it correctly to the one at the other extreme so difficult that none could spell it correctly. The scales for the various grades were superimposed upon each other, the final resultant scale appearing in this form :—

	A	B	C	D	E	F	G	H	I	J, etc.
Second Grade →	99	98	96	94	92	88	84	79	73	66
Third Grade →			100	99	98	96	94	92	88	84
Fourth Grade →						100	99	98	96	94
Fifth Grade →								100	99	98
Sixth Grade →										100
	me	and	a	the	he	of	by	day	nine	seven
	do	go	it	in	you	be	have	eat	face	forget
		at	is	so	will	but	are	sit	miss	happy
		on	she	no	we	this	had	lot	ride	noon
			can	now	an	all	over	box	tree	think
			see	man	my	your	must	belong	sick	sister
			run	ten	up	out	make	door	got	cast
				etc.	etc.	etc.	etc.	etc.	etc.	etc.

[1] *A Measuring Scale for Ability in Spelling*, p. 9.

The scale consists of twenty-five such columns, and contains the thousand words which Ayres decided were the most frequently used in written English.[1]

The instructions for the use of the scale, which is reproduced for convenient class-room purposes on a sheet of paper 14 inches by 24 inches with the directions printed in the lower left-hand corner, run : " All the words in each column are of approximately equal spelling difficulty. The steps in spelling difficulty from each column to the next are approximately equal steps. The numbers at the top indicate about what per cent. of correct spellings may be expected among the children of the different grades. For example, if twenty words from column H are given as a spelling test, it may be expected that the average score for an entire second grade spelling them will be about 79 per cent. For a third grade it should be about 92 per cent., for a fourth grade about 98 per cent., and for a fifth grade about 100 per cent." It is also evident that by means of the scale a child's spelling ability can be assessed in terms of grades.

Norms of achievement in spelling ability for the various school grades have been arranged by Ayres and Starch.[2] Ayres's test is composed of a set of ten words for each grade from the second to the eighth, and seven out of ten children can spell correctly all the words assigned to each grade. The lists are :—

Second Grade.	Third Grade.	Fourth Grade.	Fifth Grade.	Sixth Grade.	Seventh Grade.	Eighth Grade.
foot	fill	forty	several	decide	district	petrified
get	point	rate	leaving	general	consideration	tariff
for	state	children	publish	manner	athletic	emergency
horse	ready	prison	o'clock	too	distinguish	corporation
cut	almost	title	running	automobile	evidence	convenience
well	high	getting	known	victim	conference	receipt
name	event	need	secure	hospital	amendment	cordially
room	done	throw	wait	neither	liquor	discussion
left	pass	feel	manner	toward	experience	appreciate
with	Tuesday	speak	flight	business	receive	decision

The objection to these lists is their shortness. Starch has overcome this difficulty by preparing six lists of a hundred

[1] The scale is published by the Russell Sage Foundation, New York (No. E, 139), at five cents.

[2] Starch, *Educational Measurements*, chap. vi.

words each, and he has been enabled to derive standard scores from employing these lists in testing over 2500 pupils.[1] The values of such norms for the comparison of the results of different methods of teaching is obvious.

The psychological aspect of spelling can be approached through a study of the errors made. In attempting to classify mistakes in orthography nothing is to be gained, it may be said at the outset, by adopting the procedure of referring errors to differences in types of imagery, for most adults, as we have seen, belong to mixed types, and no child has yet been found who can be regarded as representative of a pure type. The probability is that a special type of imagery is evolved for spelling.

Errors in orthography fall, it appears, into two main classes: (1) those due to defective capacity for expression; (2) those due to faulty apprehension.[2] In the former case the word has been properly apprehended, but from one cause or another—fatigue, excitement, etc.—the attempt to give it correct expression fails: it may even be expressed correctly in oral form, and nevertheless be reproduced wrongly when expressed graphically. The second class of mistakes is due to faulty apprehension or learning, caused by insufficient analysis of the word. The apprehension of a word which is presented auditorily may be wrong, and this for one of two reasons: either it may not be pronounced correctly by the person speaking, or it may be properly pronounced, but the phonetic analysis by the hearer may be imperfect. When the word comes to be reproduced, it is written as it is supposed to have been pronounced or heard. Clear and exact enunciation on the part both of teacher and taught would help to remove these errors. There is also a tendency to rely on phonetic analysis for words which are not regular. The percentage of such mistakes would be reduced if visual presentation were employed with such words. Visual presentation, however, does not necessarily secure exact appropriation, for the visual apprehension may be inadequate. To this cause may be attributed such mistakes as "ei" for "ie" or doubling the

[1] *Educational Measurements*, p. 97.

[2] *Cf.* R. R. Rusk, "Analysis of the Spelling Errors of Adults" (*Journal of Experimental Pedagogy*, vol. ii. pp. 119–122).

wrong letter as "paralell" for "parallel," where the visual articulation of the word remains practically unaltered by the substitution. To secure correct visual apprehension it is not sufficient merely to see the word, but exact analysis is usually guaranteed only by copying out the word.

On the basis of the above classification the errors of school pupils have been calculated[1] with the following results :—

			Faulty Capacity for Expression.			Faulty Apprehension.	
Average Age.	Number of Pupils.	Number of Mistakes.	Word Unknown.	Homonym Used.	Fatigue, etc.	Faulty Pronunciation.	Faulty Visual Analysis.
			per cent.	per cent.	per cent.	per cent.	per cent.
10	27	237	50·2	9·3	19	18·1	3·4
11	28	356	50·3	8·1	13·8	25·3	2·5

Physiological causes may account for some cases of chronic bad spelling. Thus Witmer states:[2] "My experience leads me always to examine the eyesight of a bad speller who is otherwise free from mental or physical defect and who has enjoyed satisfactory school training, even though such examination appears to be unnecessary and a mere matter of form. I have found in such cases that the chronic bad spelling is invariably associated with some form of defective vision. I am not convinced, however, that the bad spelling is necessarily caused by the eye defect."

Attempts have been made by controlling the methods of learning to determine the various processes involved in retaining and reproducing words in spelling. Lay initiated this type of investigation, and his researches were developed by Fuchs and Haggenmüller at Giessen, by Itschner at Jena, and Lobsien at Kiel.[3]

[1] Harry G. Stead, "Spelling Errors in Children" (*Journal of Experimental Pedagogy*, vol. ii. pp. 362–364).

[2] *The Psychological Clinic*, vol. i. p. 64.

[3] *Cf.* Meumann, *Vorlesungen*, vol. iii. pp. 565 *et seq.*

Lay proceeded to subject the various methods of teaching orthography employed in school practice to a comparative experimental test. His first task was to secure material of uniform difficulty in order that the comparative tests might be performed with words of similar articulation and visual form. This condition can be attained only approximately with intelligible material, the meanings of the words tending to influence the results. Lay consequently adopted unintelligible or nonsense material, so arranged that in each successive series the consonants remained the same, the vowels only being changed ; thus, for example :—

Libug, Bollis, Gohlin.
Labog, Bulles, Gihlin.

This method, nevertheless, favours visual presentation and prejudices auditory presentation.

The series were arranged as follows :—

I. Writing after merely hearing the words, that is, to dictation.
  (*a*) Hearing without vocalising : the children were required to keep the jaws closed, which is, however, but an imperfect means of suppressing vocalising.
  (*b*) Hearing with speaking in an undertone.
  (*c*) Hearing with speaking aloud.

II. Writing after seeing.
  (*a*) Seeing without vocalising.
  (*b*) Seeing with speaking in an undertone.
  (*c*) Seeing with speaking aloud.

III. Spelling the letters aloud.

IV. Transcription.

The main tests included 100 class experiments on each of thirty pupils from the first to the sixth school year, in all 3000 tests. They were further applied to students in training, yielding about 1800 single tests.

The number of errors was calculated and the value of the methods thereby determined.

The results showed that mistakes were distributed as follows :—

Hearing without vocalising	3·04	per scholar.
Hearing with speaking in an undertone	2·69	,, ,,
Hearing with speaking aloud	2·25	,, ,,
Seeing without vocalising	1·22	,, ,,
Seeing with speaking in an undertone	1·02	,, ,,
Seeing with speaking aloud	0·95	,, ,,
Spelling aloud	1·02	,, ,,
Transcription	0·54	,, ,,

Thus for the learning of orthography, transcription and seeing with speaking aloud give the best results. Then quite surprisingly comes the much maligned spelling of the letters aloud, and seeing with speaking in an undertone ; thereafter, seeing without vocalisation ; and, lastly, hearing without vocalising.

The tests of Fuchs and Haggenmüller were carried out in the third class of an elementary school and the corresponding class of the Gymnasium at Giessen. The material consisted of Latin words, the meanings of which were unknown to the scholars. To the exercises of Lay, Fuchs and Haggenmüller added writing in the air with seeing and with hearing. Fuchs, however, concludes from the results of their experiments that vocalising and imaginary writing are not valuable methods, since the errors are comparatively numerous. This ineffectiveness of imaginary writing demonstrates clearly that it is not the writing movements in themselves which aid correct spelling, but the combination of the writing movements with the visual apprehension of the word. The value of the writing movements consists merely in securing visual and mental analysis of the forms of the words, and in compelling the attention to linger on the different written characters ; they thereby effect a more fundamental analysis and ensure a more lengthened impressing of the word on the mind than is possible when the word is only fleetingly heard. The addition of the grapho-motor imagery to visual imagery is then of only secondary significance.

Itschner's tests at the Seminar school at Jena included intelligible and also non-intelligible words ; but, according to Meumann,[1] they are not numerous enough to lead to valid conclusions.

[1] *Vorlesungen*, vol. iii. p. 574.

The following objections have been urged against the methods indicated. In Lay's tests the number of repetitions with elementary school children varied between five and twelve, and with students in training between two and three; the averages cannot therefore be regarded as reliable. Fuchs and Haggenmüller, in presenting a group of words, kept the same number of repetitions for a given series, and the presentation time consequently varied, being necessarily longer for spelling by letters and transcription. With Itschner the presentation time was constant, and the number of repetitions accordingly varied.

Lay drew general conclusions on the teaching methods of orthography from the results of his experiments on unintelligible material, but memory experiments suggest that such an inference is not valid. Lay's material was so arranged that the sight and the sound of the word corresponded, but the difficulty of orthography in school practice is with words which do not so correspond. He also claimed that motor imagery—vocal and graphic—played a predominant part in orthography. But the time factor, which he ignores, accounts for the superiority of transcription and of spelling the letters aloud over the other methods. It is easy to see in this time factor, and the accompanying analytic work of attention, the real cause for the divergent results of the different methods. In the method of dictating words the time factor and the analysis of the word suffer. The word strikes the ear of the pupil in a fleeting fashion and he has no opportunity for analysis, whereas in transcription he is compelled to analyse. Even when, in dictating, the word is also repeated by the pupil, an analysis of the word is not secured. In spelling the letters a relatively effective analysis of, and a certain concentration on, the word occur. From this standpoint it is easy to account for the varied results obtained. The methods used do not sufficiently fulfil the conditions of psychological experiment to guarantee adequate analysis of the different factors involved and to render the results unequivocal.

From the point of view of method the investigations of Lobsien are sounder than those of Lay. Lobsien's tests were applied to the pupils of a given year in a boys' and a girls' school at Kiel numbering roughly a thousand. He suppressed vocalising by requiring the pupils to grip the tongue between the teeth. Intelligible material was included, and his tests thereby approximated to school practice more than Lay's. The difficulty in the selection of material of uniform difficulty Lobsien sought to overcome by collecting, after preparatory tests on the mechanical difficulty of reading written characters, intelligible words of relatively uniform difficulty for reading; from the letters forming these words he also arranged nonsense combinations. The difference in the orthography of intelligible words and the writing of the same characters in unintelligible combinations could thus be determined.

Lobsien's series comprised the following:—

1. Seeing the words with tongue fixed.
2. Hearing the words with tongue fixed.
3. Seeing and hearing the words with tongue fixed.
4. Seeing, hearing, and vocalising combined.

In estimating his averages Lobsien distinguished between errors of substitution and of omission.

The results of Lobsien differ from those of Lay in one particular, namely, that seeing gives generally the better results with unintelligible material, and hearing with intelligible material. He explains this by reference to the connection between thinking and speaking. Meumann, while agreeing with this explanation, suspects that something which favoured the dictating method must have been overlooked in the test: the children may, he suggests, have been unusually practised in phonetic analysis and thus inferred, with comparative ease, the visual orthographic form from the sound.

Winch without speculating and dogmatising as to the psychological processes involved, sought to compare the teaching value of a combined method with visual auditory and articulatory factors—the pupils' attention being throughout directed by the experimenter—with a silent visual method of learning to spell, each pupil working without the stimulus or interference of the teacher's direction. He found that in a poorly-situated boys' school the results were in favour of the combined method, whereas in a better-class girls' school, the silent visual method proved superior, except with the youngest pupils. The girls were the more advanced in mental development, and Winch concludes that the degree of mental development is roughly the determining factor.[1]

A fatal objection to all the above-mentioned investigations is the fact that, as we have seen in dealing with the part played by imagery in learning, the method of presentation does not determine the means of retention. No matter what care is taken in confining the presentation to one mode of apprehension, we have no guarantee that the pupil will not forthwith translate the given material into a type of imagery of a different modality from that in which the material was presented, and retain the words in this uncontrolled form. That this indeed is the usual procedure is confirmed by the investigation of Edwina E. Abbott.[2] Only four trained observers took part in Miss Abbott's research, and the investigation comprised the following five series :—

1. Comparison of visual and auditory presentation.
   (*a*) Successive visual presentation of the individual letters of a word at the rate of two letters per second, two seconds intervening between each group of ten words.
   (*b*) Successive auditory presentation of individual letters under the same conditions.
   Ten groups of ten words for each observer for the visual and for the auditory presentations were used.
2. The influence of vocalisation of the letters or of the syllables, the whole word being presented simultaneously.
3. The influence of syllabification and the use of diacritical marks of pronunciation.
4. Successive exposure of the words of a group compared with simultaneous exposure.
5. The influence in visual presentation of a few seconds' interval allowed for an immediate recall of an exposed word before exposure of the next word of a group.

[1] *Journal of Educational Psychology*, vol. v. p. 460.
[2] "On the Analysis of Memory Consciousness in Orthography" (*Psychological Review*, Monograph Supplement, vol. x. No. 1).

Miss Abbott [1] concludes that, irrespective of the method of presentation and the manner of learning, the *typical* mode of recall for all observers is through the visual imagery of the letters. The visual mode of recall is also a factor in determining the relative value of the visual and auditory methods of presentation. It seems to have been tacitly assumed by some writers, she observes, that the recall might be in terms of auditory imagery, as this would be more readily aroused when the perception had been auditory instead of visual. Her results show, first, that visual imagery is at once invariably substituted for the heard letters and, secondly, that the heard letters are never recalled in terms of auditory imagery. This fact alone makes the auditory method of presentation poorer than the successive visual presentation of the letters. The other results of this comparison of the two methods of presentation are, however, of more importance. It is found that the combining into syllables of the letters, as they are presented, is of prime significance, and that the successive presentation of the letters prevents this. The necessity for giving the letters successively in auditory presentation therefore prejudices this method in comparison with a method which admits of their simultaneous presentation.

The value of vocalisation seems from this investigation to depend, first, upon whether it is vocalisation of the syllables or of the individual letters; secondly, upon the relative predominance of the visual processes of the individual observer; thirdly, on the part played by the auditory imagery connected with the observer's incipient or actual vocalisation of the syllable—it is this vocal-auditory process in learning with which the visual imagery of the letters becomes associated. Thus the observer's vocalisation of the syllables is always an aid, but the vocalisation of the individual letters may be a hindrance. Other points in the analysis show how the latter may take place. The vocalisation of the letters is, in the first place, a slow process and prevents repetition of the word. In the second place, it may be a hindrance to combining the letters into syllables, especially for the observer who is predominantly visual. This may explain the results of Lay,

[1] "On the Analysis of Memory Consciousness in Orthography" (*Psychological Review*, Monograph Supplement, vol. x. No. 1, pp.153–155).

who found that, when the children were required to vocalise the letters, more errors were made in recall than when, as in transcription, such vocalisation was not required. It is to be further noted that we have here a process that is an aid in learning, but is not, as a rule, present as an aid in recall.

The conclusions of Miss Fairhurst in a report[1] to the Educational Science Section of the British Association on "Psychological Analysis and Educational Method in Spelling," and in a paper entitled "Analysis of the Mental Processes involved in Spelling," are in general agreement with those of Miss Abbott. The unit of spelling, she states, is usually the syllable; articulation of letters is no direct aid to the spelling memory, and a wasteful method of learning. Articulation of the syllables simultaneously with the writing of the word is probably the best method of learning—it introduces every essential element, visual, auditory, and motor; by producing the visual elements in succession it aids the exact analysis of the speech-whole, it helps the synthesis of the visual elements in accordance with the articulatory units, and therefore the fusion of the written and spoken symbols. The writing-motor element, however, is less important than that of the speech-movement, and has not been found to act as the conscious medium of memory like the articulatory elements.

There is no direct relation, Miss Fairhurst maintains, between imaginal type and spelling efficiency. The determinant of efficiency is, she believes, some factor working within imaginal type, although she recognises that imageless spelling occurs both in the case in which a word is familiar and in the case of the imageless observer.

The importance of imagery in spelling, it will be noticeable from the above account of the investigations into the psychology of the subject, is gradually being discredited. If Bergson's division of memory into two types is established, spelling may be found to depend on the habit memory, rather than on the pure memory, in which case imagery will be irrelevant. Cornman's definition of spelling,[2] if accepted, would support this suggestion, as its terms are almost identical with those

[1] *British Association Reports*, 1913, pp. 302–304, 687.

[2] *Spelling in the Elementary School*, p. 5.

used by Bergson in speaking of the habit memory. Thus Cornman says: 'Spelling is a sensori-motor habit which expresses itself in every concrete instance of the spelling of a word as a synthetised motorial reaction following, at more or less remote temporal intervals, certain complicated sensory stimulations." Spelling will on this view be subject to the principles governing the acquisition of a habit, imagery will be irrelevant, and the methods of testing and of teaching the subject will have to undergo revision. The intimate dependence of school practice on general psychology is in such a case well illustrated.

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CHAPTER XVIII

PSYCHOLOGY AND PEDAGOGY OF THE SCHOOL SUBJECTS

ARITHMETIC

"AN experiment in educational psychology," it has been said,[1] "is generally directed to a particular issue, it is not usually susceptible of complete adoption as a method of teaching." This is especially true in the case of investigations and experiments in arithmetic; they have so far been generally directed to particular issues, and are not yet susceptible of adoption as methods. They may nevertheless indicate the lines which future inquiry in regard to teaching methods in this subject can follow with some hope of success.

The origin of number in the mind of the child is one of the issues which have been raised by psychologists. The idea of number, so far as our knowledge of child psychology at present extends, appears relatively late in the development of the child. The sensory activity of the child, his perception of spatial relations, his linguistic powers, and in part also his manipulative skill are often highly developed before he arrives at a comprehension of number. The ability to count or repeat numbers, say up to ten, only indicates that a series of closely associated terms has been learnt; it is no guarantee that the significance of the names of the numbers is known. Nor is the fact that a child recognises when one of his playthings has been removed a proof that he knows the number of them.

A number of visually presented objects can by means of the visual image be exactly reproduced, for example, by

[1] *Journal of Educational Psychology*, vol. iv. p. 535.

drawing, without the idea of their number being present in consciousness; and two groups of objects can be compared and a correct judgment made as to which contains the greater number without the number of objects in either group being definitely counted. Of children entering school, about 75 per cent. in Berlin understood the significance of the number four, and in America the same percentage could appreciate the significance of the number five. On the Binet scale children of a mental age of five are required to count only four objects. The child's knowledge of number is thus very limited, and compares most unfavourably with his other knowledge. As the child in his daily life, in his play, etc., has every inducement to count, and yet does not avail himself of his opportunities, we must conclude that number cannot depend on mental processes naturally easy to him.

Two explanations are offered as to the origin of number in the mind of the child. One maintains that it is based on temporal sequence, the other that it depends on a simultaneous representation of a multiplicity of objects. The former view is that assumed in the statement of Professor James: "Number seems to signify primarily the strokes of our attention in discriminating things. These strokes remain in the memory in groups, large or small, and the groups can be compared. . . . We amuse ourselves by the counting of *mere* strokes, to form rhythms, and these we compare and name. Little by little in our minds the number-series is formed."[1] On this view is based the "counting" method of teaching number. The other explanation offered is that for the idea of number to originate in the mind of the child the spatial representation of a number of objects simultaneously is necessary. On this view depends the number-picture method of teaching the elementary operations of arithmetic.

If we seek to determine the mental processes out of the development of which the comprehension of number arises, we must at the outset reject the comprehension of spatial relations, since the child possesses a very correct knowledge of these long before he acquires the conception of number. The nature of number appears rather to be connected with two processes which develop relatively late in the child's mind:

[1] *Principles of Psychology*, vol. ii. p. 653.

one, the temporal aspect of number, the other its abstract nature, which requires that it should be apprehended in isolation and freed from its embodiment in perceptual objects and processes. It is noteworthy that the child's conception of time is likewise of late development. As already mentioned,[1] a very defective comprehension of the time aspects of experience is possessed by children of six and seven years. The acquirement of ideas of time appears to occur in the same period as the first ideas of number. The factor of rhythmical or arhythmical repetition of the same impression seems to be of great significance in the acquisition of the first ideas of number.

It must be remembered that when a young child sees a number of similar objects lying together, only with the greatest difficulty, if at all, can he apprehend these simultaneously; this is due to his defective ability to concentrate attention and his undeveloped capacity for synthetic combination of objects. The child comes to comprehend a plurality of objects existing in space only successively, through a corresponding number of independent perceptual acts, and their manifold existence is for the child's mind at the outset a manifold repetition in time of the same impression or of similar impressions. Since, then, the simultaneous presentation of objects in space does not alone induce the idea of number in the mind of the child, it follows that a comprehension of time relations must also be necessary.

The origin of number thus evidently lies in counting. This is confirmed by the statements of competent observers of the child's mental development, who agree that the child begins by enumerating the objects in a series after this fashion—one, another one, etc., and by the fact that with feeble-minded children the counting method is successful when no progress can be made with the method of pictorial representation. For the development of number, however, some form of grouping of impressions presented simultaneously is doubtless necessary. Children can indeed arrive at such a simultaneous apprehension of number through experience alone; probably as a result of accompanying the counting of a series of objects perceived simultaneously with the successive sounds of counting, the number of the former comes to be immediately recognised.

[1] Chapter V.

Historically, the view that the idea of number arises from the apprehension simultaneously of a number of impressions presented visually, and that instruction in arithmetic should commence with the pictorial representation of the units, must be attributed mainly to Pestalozzi. All knowledge, according to Pestalozzi, is based on *Anschauung*, that is, the direct perception or immediate experience of things. *Anschauung* he resolved into three elements—name, form, number—the last of which acquaints us with the quantitative relations of objects of perception. Number is thus an aspect of observation or immediate experience of things, and, accordingly, the basis of arithmetical instruction must be purely perceptual. Pestalozzi thus became the precursor of the modern methods of teaching arithmetic through number-pictures.

Many devices to illustrate numbers visually have been suggested, and investigations have been undertaken to determine which form of element and which arrangement of the elements in a number-picture give the best results. Pestalozzi used lines to represent the elements, but investigation has proved that circles or points are superior.

Several investigations into the most easily apprehended arrangement of elements have been undertaken, but as the majority of investigators have not applied their tests with both children and adults, but have confined themselves to adult subjects, we shall here consider Freeman's results only.[1] In his tests Freeman used a pendulum tachistoscope with an exposure time of fifty thousandths of a second. Twelve arrangements of points were used in the experiments, and the majority of the series were applied both to adults and to children.

The characteristics which, according to Freeman, facilitate the apprehension of definite numbers of objects are the following: (1) a clear division of the objects into groups; (2) the group to consist of as great a number of elements as will lie within the range of attention; (3) the arrangement of the

[1] Frank N. Freeman, "Untersuchungen über den Aufmerksamkeitsumfang und die Zahlauffassung" (*Pädagogisch-psychologische Arbeiten*, vol. i. pp. 88–168). For summary see "Grouped Objects as a Concrete Basis for the Number Idea" (*The Elementary School Teacher*, vol. xii. pp. 306–314).

elements in such a way that an addition or subtraction of an object makes a striking difference in the spatial form of the group and in its relation to other groups ; (4) such an arrangement of the groups themselves that a change in the number of groups causes a pronounced difference in the spatial form of the whole figure.

The following were amongst the groupings employed :—

Series I. ● ● ● ● ● ● ● ● ● ●

" II. ● ● ●   ● ● ●   ● ● ●   ●

" III. ● ● ● ● ●
● ● ● ● ●

" IV. (unit = 6) ● ● ●   ● ●
● ● ●   ● ●

" V. (unit = 4) ● ●   ● ●   ●
● ●   ● ●   ●

" VI. (unit = 3, arranged vertically) ● ● ●
● ● ●
● ● ●
●

Series V., with a unit of four and the groups arranged horizontally, gave the best results with adults. With a unit of six, as in Series IV., the groups appear to be too large.

In his investigation Freeman found that single units arranged in a row up to five are judged with an average of 20 per cent. of mistakes : six objects are in 50 per cent. of the cases judged rightly. A double row is just as easily apprehended as a single row containing only half the total number. An even number of points is not so often rightly apprehended as an odd number of points. In groupings by twos the evenness or oddness is usually apprehended even when the number itself is not estimated.

Grouped objects are more correctly judged than ungrouped objects, and a horizontal division of groups increases still further the accuracy of apprehension. Of the groupings used in Freeman's tests the rectangular form was proved to be the most suitable with adults. To facilitate the correct apprehension of a large number of objects two methods of procedure may be employed: the one the conscious apprehension of each single group by itself and then the addition or multiplication of the groups, the other the simultaneous apprehension of total groups.

Applying similar tests to children, Freeman found that children are not so often correct in their estimation of the number of points, and this is the more pronounced the younger the pupils. The simpler forms of grouping are better apprehended than the complex; and complete groups, in comparison with the incomplete, are more correctly estimated by children than by adults. Children apprehend preponderatingly in horizontal rows. Simple vertical series, for example,

4 = •
•
•
• are somewhat worse apprehended than similar horizontal series, for example, 4 = • • • •; but double vertical series, for example, 7 = • •
• •
• •
• are quite as well apprehended as double horizontal, for example, 7 = • • • •
• • •. Groupings in fives give with children the best results: this arrangement will be understood from the following:—

5 6 7 8 9 10

The range of attention is with children one or two points less than with adults, and with an increasing number of points accuracy decreases more quickly than with adults. If we place the scope of attention of adults and older children (twelve to fourteen years of age) at about five, that of the younger children (ten to twelve years) would be not less than four.

That is, up to and including four objects, the younger children can judge the number as correctly as adults.

The main difference between the perception of the child and that of the adult, however, lies in the fact that the former lacks the ability to organise the represented impressions into groups. Even when impressions are not objectively grouped, the adult in apprehending them tends to introduce a scheme of grouping, whereas when a regular arrangement of objects is presented to the child he either fails entirely to grasp the arrangement or adopts a scheme of grouping of his own which does not accord with the objective grouping. The child's deficiency in the appreciation of number is doubtless due to his inability to co-ordinate his impressions into groups and to recognise the plan of a regular arrangement where such exists rather than to the limited scope of his attention, and Freeman has consequently suggested [1] that a formal training in organising objects into regular forms and in the recognition of such grouped objects would be one of the best means of giving the child a grasp of the simple number operations.

To the employment of such visual representations of number as those used by Pestalozzi and those suggested by Freeman and others various objections have been offered, and a controversy has arisen as to the relative values of the counting or successive method and the pictorial or simultaneous method of presentation.

The two methods base their instruction, the one on the spatial aspect of experience, the other on the temporal aspect of experience. As there is no doubt amongst psychologists that in the idea of number both factors, spatial and temporal, are involved, it follows that either method alone is incomplete, and that with each method the child is himself left to supply something. Generally with the spatially based systems, or with the methods of number-pictures, the child has to supply the temporal factor and the ordinal arrangement of number which is largely conditioned by this; the pure counting method, on the other hand, demands that the child should be able to represent to himself perceptually a multiplicity of objects in space and to apprehend these simultaneously in one visual act. It is thus evident that only by a method giving due

[1] *The Elementary School Teacher*, vol. xii. p. 310.

recognition to each factor can the child come to a perfect comprehension of number.

The individual endowment types of the pupils, it has been affirmed,[1] must play a large part in determining the method by which the idea of number is acquired. A pupil of the visual type of imagery will be favoured when, in teaching, the numbers are represented visually, but will be at a disadvantage when the counting method alone is used. As the counting method relies on successive, rather than on simultaneous, presentation of stimuli, it favours the audile, who is accustomed to work with series of successive associations, whereas the method of using visual representation alone will cause the audile difficulty. From our present knowledge of the distribution of imagery in children and of the part it plays in the acquisition of the other school subjects we should, however, infer that with young children the method of combined stimuli would be the superior method of presentation, with pupils of higher mental development the purely visual. As children are generally endowed with the mixed type of imagery, and readily learn to adapt their imagery to the mode of presentation, these forms of teaching would doubtless not be prejudicial to any individual child, as Meumann fears.

The objections urged against the pictorial method of representing numbers are as follows.[2] It conflicts with the psychological fact of the limited range of consciousness, for only three or four visual impressions can be simultaneously apprehended by the child. Whereas the adult under favourable conditions can apprehend eight to ten elements presented simultaneously, about fifteen presented successively can be apprehended by the ear. The advantage thus apparently lies with successive apprehension, consequently with the counting method. This objection is met by the grouping of impressions presented visually, and as the visual presentation lends itself more easily to grouping than does the method of successive presentation, the advantage really lies with the pictorial representation. Successive impressions can, however, be grouped by the adoption of a rhythmical order, but not with

[1] Meumann, *Vorlesungen*, vol. iii. p. 631.

[2] For comparison of the two methods see Meumann, *Vorlesungen*, vol. iii. pp. 658–665.

the same ease as visual impressions. Thus Meumann found [1] that although his imagery type had by training been constrained to the acoustic-motor form, he could nevertheless after some practice apprehend with certainty at one glance groups of impressions up to eighty in number.

Pictorial representation, it is maintained, cannot displace counting. This is undoubtedly so, for the idea of number cannot originate without counting, and the method of pictorial representation deludes itself if it assumes that it can proceed without the counting of its series. But in the further development of number the counting is dropped, and when once the picture-numbers come to be recognised, they tend to displace, and by reason of the weakness of the child's memory facilitate, counting.

On behalf of the counting method it is also advocated that the scholars who are instructed according to the method of pictorial representation must necessarily remain dependent on the number-pictures and fail to develop abstract counting. The counting method undoubtedly leads more easily to the abstract conception of number, but it is wrong to suppose that the pictorial method does not lead to the abstract idea of number. It should be remarked, too, that in the learning of the fundamental arithmetical operations, as in the early stages of most other school subjects, the child should work with concrete ideas, and experience proves that children become surer in their groundwork if their visual representations of number are sharply and clearly developed. Through practice and progress in arithmetic the redundant perceptual material and imagery will, as in other spheres, come to be disregarded.

It is further urged that all the fundamental operations of arithmetic cannot be made clear by means of pictorial representation. If, however, the elements are properly grouped and made divisible and movable, then all such operations are possible. Of course the visual representation is limited to a small range of numbers; it has nevertheless significance for the beginnings of arithmetic.

The advantages and disadvantages of the respective methods for teaching purposes can be readily inferred from the above

[1] *Vorlesungen*, vol. iii. p. 660.

consideration of the objections to the method of representing numbers visually, and consequently they need not be elaborated here. It ought to be mentioned, however, as it is a popular fallacy, that the counting method does not avoid the use of perceptual material; it employs only a different form from that employed in pictorial representation, namely, auditory or motor or a combination of these. In conclusion, we may add that there is no necessity for the teacher to confine himself to the use of one method exclusively; a combination of the two, as in the case of the analytic and synthetic methods of reading and writing, will doubtless give the most satisfactory results.

The psychology of the arithmetical processes has been investigated by various psychologists, but in the majority of cases with adults only, the consequence being that the pedagogical significance of the results is somewhat ambiguous, as the mental processes involved are generally in the case of the practised adult more mechanical and more purely associative than is the case with the child. As typical of this type of research we may select Browne's experimental study of the psychology of the simple arithmetical processes.[1]

In Browne's investigation the processes of addition, subtraction, multiplication, and division were studied as they take place in the minds of subjects representing that large class of people whose dealings with numbers in the ordinary affairs of life do not involve a high degree of practice. The study is, therefore, an inquiry into the psychology of the processes as practically unchanged products of primary education.

In adding series of digits the simplest case is the count by 1's. Even numbers appear easier to combine than odd numbers, or than odd and even. The smaller digit is usually added to the larger; $9+2$ is found to be much easier than $2+9$. Browne suggests [2] as explanation Ebbinghaus's law of association, derived from memory experiments with nonsense

[1] C. E. Browne, "The Psychology of the Simple Arithmetical Processes: A Study of Certain Habits of Attention and Association" (*The American Journal of Psychology*, vol. xvii. pp. 1–38).

[2] *Ibid.*, pp. 9, 12.

syllables, whereby the strength of the associative bond between two members of a series is inversely proportional to the distance between them in the series; thus the associative bond between 9 and 11 is comparatively strong, but between 2 and 11 it is very weak. It is possible, however, that the fact can be explained more directly. In adding 2 to 9 the subject possibly orients from the 9 times table and has only to proceed two steps, $9+1$, $9+2$, whereas in adding 9 to 2 he takes as his standpoint the 2 times table and has to proceed through nine steps before he arrives at the result. By reason of the greater facility of the process, and independent of its cause, pupils should be encouraged to add where possible the smaller to the larger digit. The introspection of the subjects taking part in the investigation disclosed that the imagery employed was largely motor, or motor-auditory, and that difficulty in adding greatly increased the tendency to motor expression. In the addition process accidental relations of numbers and results sometimes obtrude upon consciousness as direct distractions or as causes of errors; for example, in $63+7=70$ the thought that 7 makes 70 was confusing, and in $26+7$ because 7 and $6=13$ the thought of the 1 in 13 made the subject say 31.[1]

Multiplication being regarded as an abbreviated form of addition is treated by Browne as the second of the fundamental operations. "The child," he affirms,[2] "should not study addition and multiplication as two distinct subjects, but understand the latter as a special case of the former, that he may make as large a use as practicable of the reinforcement which the multiple series ought, psychologically, to lend to the adding." Two types of tests in multiplication were set the subjects who took part in Browne's investigation: one, the oral multiplication of one digit by another, the other the written multiplication of all the digits differently arranged by each digit in turn 2 to 9 inclusive.

In the former type of multiplication many traces of the tabular verbalism were reported by the less practised individuals, and these traces were more prominent with the larger multipliers. With such multipliers any difficulty or halting of the association invariably threw the subject back upon the

[1] C. E. Browne, *ibid.*, p. 5. [2] *Ibid.*, p. 21.

full motor expression, as, six 8's are 48. Any distraction of the attention did the same, as also did general fatigue.[1] In the written multiplication the imagery is predominantly motor and auditory. Visual imagery also is present, but apparently plays a subsidiary rôle. The great predominance of motor-auditory imagery is due apparently to the difficulties of carrying, which is the most vulnerable part of written multiplication. In adding, the figure to be carried is retained motorially and combined directly with a visualised, or a perceived, digit without any other process intervening, since the writing down of the digit in the answer is practically automatic; a division of labour thus takes place between motor and visual imagery, with little or no rivalry between them. In multiplication, however, the figure to be carried has to be retained motorially while an intervening motorial process, the multiplying, is being performed; then the carried figure and the product of the multiplying have to be added motorially. There is rivalry of the worst type here among the images; for motor images cannot exist simultaneously, they must succeed one another, and if the attention turns back for the first, this can only be reinstated as the other image is displaced. Browne distinguishes two types of difficulty arising from carrying: (*a*) that of the multiplier who adds in the usual way and is in constant danger of losing the ten (digit to be added); (*b*) that of the multiplier who realising this danger tries to retain the ten by making it more conscious, thus drafting away the attention from the digit of the result, and consequently experiencing great difficulty in adding. In type (*a*) adding is relatively easy, carrying difficult. In type (*b*) carrying is relatively easy, adding difficult.[2]

Browne considers that from the introspective data of his subjects three pedagogical inferences seem warranted:[3] (1) "The difficulties superimposed upon the relatively easy process of multiplying by carrying would be entirely obviated by the method of writing the entire products at each step (multiplier placed at the left, the writing progressing in the natural way toward the right and adding at the end of

[1] C. E. Browne, *ibid.*, pp. 15–16.
[2] Cf. *ibid.*, p. 20. [3] *Ibid.*, pp. 20–22.

the process)." The following, we assume, would illustrate the suggested method:

$$\begin{array}{l}
8\ 7\ 5\ 9\ 4\ 6 \\
7 \\
\hline
5\ {}^{6}4\ {}^{9}3\ {}^{5}6\ {}^{3}2\ {}^{8}4\ \ {}^{2} \\
\hline
6\ 1\ 3\ 1\ 6\ 2\ 2
\end{array}$$

(2) "In the multiplication tables the verbal formula should be of as few words and as suggestive of immediate associations as possible." (3) "Since it is the office of the multiplier to suggest strongly, or switch the mental processes into, the particular set of associations (table) called for, it should stand first in the verbal formula. The multiplier should always be smaller than the digit multiplied. To think in terms of the smaller digit times the larger offers no necessarily greater difficulty than the immediate recognition: $9 \times 3 = 3 \times 9$. Such a method would reduce the multiplication tables about half. The larger tables would almost disappear, that is, the twelve-table would go entirely; $\frac{11}{12}$ of the eleven-table; $\frac{5}{6}$ of ten-table; $\frac{3}{4}$ of the nine-table; $\frac{2}{3}$ of the eight-table; $\frac{7}{12}$ of the seven-table; $\frac{1}{2}$ of the six-table, etc. The cases in which both factors are the same should probably be learned as a separate table, because they form a unique series, the square and square-root system."

Subtraction and division are treated by Browne together and independently of addition and multiplication, since in the latter the associative bonds operate forward, in the former they operate backward. Subtraction is found to be more difficult than addition, the reason being that counting is naturally forward, whereas in subtraction the associative bonds work backward, and consequently operate more weakly in the reverse than in the direct order. Browne consequently suggests that for this reason children should learn to count backwards as well as forwards.

From the introspective material at his disposal he also concludes that the modern method of subtracting, illustrated thus,

$$\begin{array}{ccccc} 8 & \cancel{7}_6 & \cancel{4}_{+1} & \cancel{3}_2 & 6_{+2} \\ 6 & 2 & 9^{-10} & 1 & 8^{-10} \\ \hline 2 & 4 & 5 & 1 & 8 \end{array}$$

presents the difficulty that, for example, in the tens subtraction the 3 is perceptually present, while the figure which must be operated with and consequently retained as a visual or motor image is 2. The conflict between the perceptually present figure and the mere image of a figure, which for the correct result is nevertheless the more important, frequently goes in favour of the former. The chances of error are increased by the fact that the substitution of the 2 for the 3 has to be retained in memory during a period when four intervening mental processes are performed, namely, the subtraction of 8 from 10, the addition of 2 to 6, the writing down of 8 in the answer, and the determination of the relation between the next pair of figures.

In the older method, illustrated thus,

$$\begin{array}{ccccc} 8 & 7 & {}^{1}4 & 3 & {}^{1}6 \\ 6 & 2_3 & 9 & 1_2 & 8 \\ \hline 2 & 4 & 5 & 1 & 8 \end{array}$$

when the upper digit is visualised as the "teens," only one intermediate step intervenes between such visualisation and the actual increasing of the digit in the subtrahend as against four in the modern method. Psychologically the old method appears to be superior to the modern method; it suffers from the disadvantages that logically it is difficult to justify the use of such terminology as "borrowing" and "carrying," or as, for example, with the third pair of figures 9 from 14=5 when the pupil has been taught that the 4 signifies 400: it also involves dealing with numbers up to 19, whereas in the modern method the highest digit from which a subtraction has to be made is 10. Browne maintains[1] that a combination

[1] C. E. Browne, *ibid.*, p. 29.

of the two methods, in which subtracting from the "teens" in the old method and reducing the minuend digit in the modern method are eliminated, would seem, from the psychological point of view, a distinct advantage. The decomposition method which Browne would retain has been found by Ballard[1] to be slower and less exact than the equal addition method. In the former, two steps are taken where only one is necessary. In the latter, it would be difficult to explain to a child who has 34 apples and has to give away 19 to a friend why he must add 10 apples to the original store and give away 10 more than the 19. The "complementary addition" method[2] seems to be freest from psychological objections while being logical and simple enough to be easily made automatic by pupils ; it is illustrated thus :

$$\begin{array}{r} 63 \\ 24 \\ \hline \end{array}$$

4 and *9* are 13. Carry 1. (This 1 that is carried is the 1 of 13, not a "borrowed" or "equally added" 1.) 3 and *3* are 6. Answer 39.

Division is a derived process based upon multiplication. Unlike subtraction, which continues to be largely influenced by the point of view of addition, division, according to Browne,[3] tends to free itself from the point of view of multiplication and to develop a special type of immediate association. The difficulty of the division process as a whole increases proportionately with the size of the divisor, because of the increased range of possibilities as to the dividend numbers falling above the multiple.

Browne's investigation has been considered worthy of treatment in some detail, since it affords a suitable introduction to the psychology of the arithmetical processes, describes experiments that can be easily repeated, records inferences that can be put to a practical test, and suggests applications of didactic value.

Investigations on the psychological analysis of the arith-

[1] *Journal of Experimental Pedagogy*, vol. iii. pp. 9–13.
[2] Cf. *The Oxford Elementary Arithmetics*, book i. pp. 17–18.
[3] *The Psychology of the Simple Arithmetical Processes*, p. 37.

metical processes with children as subjects have been few in number, but their results are of special value for experimental pedagogy.

Eckhardt[1] investigated the part played by visual images in arithmetic. Fifty-two school pupils from eight to ten years of age were tested; of these twenty-eight were endowed with strong visual imagery, nineteen were of the mixed type, which included visual imagery, and thirteen were non-visiles. It was found that the utilisation of points to represent number mentally was employed only up to the end of the first school year. The arrangement of balls on the counting machine was not adopted by a single pupil. In the second year of school life the visual representations of figures were employed as the equivalents of number concepts; these were either of isolated figures or of a series of figures. The latter, which occur regularly only in the case of children of the predominantly visual type of imagery, are of more value for mental arithmetic than the former, since they envisage the value of the number according to its position in the number series. This form of imagery should be developed in children by training and by the use of appropriate illustrative devices in the presentation of the elementary number operations. Many individuals are found to have concomitant visual images of spaces whose extent represents symbolically the value of the numbers; thus 1–36 is imaged as a larger space than 1–27. Concrete images reinforce the visual representations of figures, especially in the case of children who are poorly endowed with visual imagery; one pupil may see the figures on the desk, another on the blackboard. Some pupils employ quite fanciful imagery enhancements, but these accompaniments tend to persist and prejudice the memory for numbers; the favourite practice of some teachers of investing all the simple objects of learning with fanciful trappings is thus an offence against the economy of memorising. Children who do not belong to the visual type, image the figures in acoustic-motor fashion.

These results are of significance, as they show that the illustrative devices for representing numbers are very rapidly discarded by consciousness in favour of the images of figures: the former serve as mnemotechnical supports, which conscious-

[1] *Cf.* Meumann, *Vorlesungen,* vol. iii. pp. 672–677.

ness soon dispenses with as inhibitive and supererogatory. Only the visually endowed scholars image and can utilise the number series, so that it is wrong to assume that this is general. This also tells against a long delay over concrete representations of numbers.

Eckhardt summarises his results thus : The visual memory-images of the pupils who belong to the visual type or who mainly employ visual imagery have a pedagogical significance. The number of these scholars is relatively great, so that attention to them is desirable. The visual memory-images serve as valuable reinforcements of the number memory. The first arithmetical operations can be lightened by means of visual memory-images. Without guidance in the management and use of this type of imagery pupils appear uncertain and helpless. The number of the visual memory images can be increased through training, their nature can be modified, and the pupil can be guided in their use.

A report of experiments on the Ideational Types in Arithmetic[1] affirms that nearly all school children belong to a mixed type in respect to imagery. The auditory type predominates in the first and second grades ; the visual or the visual-motor in all the other grades. 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, while 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. Dull pupils do not seem to belong to any pronounced visual or auditory type.

The errors made by school pupils in the elementary arithmetical operations have been subjected to analysis with a view to finding means of remedying them.[2] The three main types are inversion, attraction, and carrying. In inversion the pupil either reads the figures in reverse order or writes

[1] Isidore Springer, *Journal of Educational Psychology*, vol. v. pp. 418–422.

[2] W. Scott, "Errors in Arithmetic" (*Journal of Experimental Pedagogy*, vol. iii. pp. 296–307).

them in reverse order; thus in $4143 \div 6 = 240$ the 41.. is read as 14..; or in addition the answer is given as 7227 instead of 2727. An imperfect grip of notation, it is suggested,[1] may account for these errors in some cases, but plainly not in all. In the errors due to attraction the factor known in association tests as "perseveration" is doubtless operative. When a digit occurs, and more especially when it is repeated, it tends to remain in consciousness and to obtrude itself unappropriately in a new context. Thus 359×3 results in 3077. This type of error is more common in multiplication than in addition, and this might be expected from the fact that in multiplication the imagery is mainly acoustic-motor, and the resonance of such imagery and the consequent perseveration would be greater than in the case of operations in which visual imagery predominated. The "carrying" difficulty has been considered above in connection with Browne's investigation.

More extended analysis on the same lines will undoubtedly prove fruitful in determining the relative value of teaching methods in arithmetic.

The accurate timing of the various arithmetical processes has been extensively applied with adults. With school pupils Ranschburg found[2] that multiplication takes the shortest time, addition somewhat longer, division still longer, and subtraction the longest time of all. It may be questioned, however, whether timing measures the difficulty of the operations; it is more probable that the times indicate the extent to which the automatisation of the processes has progressed, as it is generally agreed that with adults multiplication is the first of the processes to become automatic, and it is likewise the process that takes the least time.

Adding upward has been found to be more rapid but less accurate than adding downwards in the case of subjects who habitually add upwards, the increased time in adding downward doubtless allowing for more sustained attention than is possible in the more rapid adding upwards.[3]

[1] W. Scott, "Errors in Arithmetic" (*Journal of Experimental Pedagogy*, vol. iii. p. 305).

[2] *Cf.* Meumann, *Vorlesungen*, vol. iii. pp. 681–682.

[3] Lawrence W. Cole, "Adding Upward and Downward" (*Journal of Educational Psychology*, vol. iii. pp. 83–94).

The individual, however, who is quick in adding is more accurate also than the one who is slow; this seems to be a permanent characteristic, since with practice the difference is fully maintained.[1]

Problems in the experimental pedagogy of arithmetic of a more general nature than those we have dealt with in connection with the psychology of number and of the arithmetical processes have been subjected to experimental treatment, and the results of the most important we shall now record.

In no subject have the doctrines of formal discipline and transfer of training been so persistently maintained and retained on *a priori* grounds as in arithmetic. Those who profess to have abandoned the view that mathematics provides a general training of intelligence which is applicable to any other branch of knowledge or in any department of life are nevertheless easily beguiled into declaring that "accuracy" is transferred from one arithmetical process to another. It is to the credit of Winch[2] that he has sought to determine quantitatively, in a given case, whether this contention is justified.

The procedure adopted was to use parallel groups of pupils,[3] arranged according to tests in problematic arithmetic; one group was trained in rule sums, while the other did work other than arithmetic, and thereafter both were tested by problems involving arithmetical reasoning. In marking the tests in arithmetical reasoning no account was taken of the accuracy of numerical computations, marks being assigned solely for the steps in reasoning involved; while in a later investigation the pupils were required only to write down how they would solve the problems. Winch concludes that although there is a high positive correlation between the two processes, great improvement in accuracy of arithmetical computation seems to produce no improvement whatever in the accuracy of arithmetical reasoning.

A similar investigation is reported by Starch.[4] The training

[1] E. L. Thorndike, *Journal of Educational Psychology*, vol. v. p. 537.

[2] "Accuracy in School Children: Does Improvement in Numerical Accuracy 'Transfer'?" (*Journal of Educational Psychology*, vol. i. pp. 557–589; vol. ii. pp. 262–271).

[3] For procedure see Chapter II., above.

[4] D. Starch, "Transfer of Training in Arithmetical Operations" (*Journal of Educational Psychology*, vol. ii. pp. 306–310).

series here consisted of multiplication tests, and the initial and concluding series consisted of problems in adding fractions, and adding, subtracting, multiplying, and dividing numbers of two, three, or four digits. He concludes from his results that training in one type of arithmetical operation improves very considerably the ability to perform other fundamental operations. The explanation given, based on the introspection of the subjects, is that improvement is due to the identical elements acquired in the training series being directly utilised in the other arithmetical operations. The two main factors are the increased ability to apprehend and retain the numbers, and the acquisition of the ability to visualise arithmetical operations.

The contradiction between the conclusions drawn from the results of the two investigations is apparent only. In Winch's experiment there is no transfer, because no relation between the processes tested exists, and there is consequently no possibility of evolving a generalised method. In Starch's, where the elements of the training series are involved in the testing series, there is transfer. These investigations then confirm the view, generally accepted at present, that transfer is possible where a generalised method of procedure is evolved and is common to the different series.

The value of " drill " periods upon the fundamental number operations was investigated by Brown.[1] Groups of approximately equal ability were trained, one with, the other without, the special drill, the total time for arithmetic for each group being the same. The " drill " group showed greater improvement than the undrilled, and this improvement was still in evidence after the lapse of twelve weeks' summer vacation. The benefit was not limited to improved mastery of the number-habits, but included increased efficiency in arithmetical reasoning. In order that too great significance should not be attached to these results, Brown warns us that "the investigation proves nothing, but it indicates some probable tendencies." [2]

[1] J. C. Brown, " An Investigation on the Value of Drill Work in the Fundamental Operations of Arithmetic" (*Journal of Educational Psychology*, vol. ii. pp. 81–88).

[2] *Ibid.*, p. 88.

Further investigations on the same lines were carried out by Brown, with the result that the data and the conclusions of the first study were in every essential particular corroborated.[1] The same problem was investigated by Phillips [2] with much the same results. Whereas Brown found that the influence of drill was the same for boys as for girls, Phillips concludes that the boys made a better gain during the time between the tests than did the girls.

An extensive investigation by Winch [3] on the question of the possibility of teaching arithmetical proportion earlier than has been customary in Britain has led him to conclude that the teaching of this process when the method of unity is adopted and small numbers employed might be worth while, judged by the improvability evinced in the tests with pupils of Standard III., equivalent to 4th Grade of American schools, and in some cases even earlier according to the social status of the pupils.

The subject of arithmetic naturally lends itself to the production of scales of measurement and norms of performance. The Courtis Standard Tests are the best known and most extensively applied; [4] in addition may be mentioned the norms of performance of London children in the four fundamental operations in arithmetic,[5] also Starch's scale to measure ability in arithmetical reasoning.[6]

Some idea of the amount of investigation in the psychology and pedagogy of arithmetic still remaining to be undertaken may be gathered from the list of questions enumerated in an article by Stone on the problems in the scientific study of the teaching of arithmetic.[7]

[1] *Journal of Educational Psychology*, vol. iii. pp. 485–492, 561–570.

[2] F. M. Phillips, "Value of Daily Drill in Arithmetic" (*Journal of Educational Psychology*, vol. iv. pp. 159–163).

[3] W. H. Winch, "Should Young Children be Taught Arithmetical Proportion?" (*Journal of Experimental Pedagogy*, vol. ii. pp. 79–88, 319–330, 406–420; vol. iii. pp. 89–95).

[4] S. A. Courtis, *Manual of Instructions for Giving and Scoring the Courtis Standard Tests.*

[5] P. B. Ballard, "Norms of Performance in the Fundamental Processes of Arithmetic, with Suggestions for their Improvement" (*Journal of Experimental Pedagogy*, vol. ii. pp. 396–405; vol. iii. pp. 9–20).

[6] D. Starch, "The Measurement of Ability in Arithmetic" (*Journal of Educational Psychology*, vol. vii. pp. 211–222); also *Educational Measurements*, chap. viii.

[7] C. W. Stone, "Problems in the Scientific Study of the Teaching of Arithmetic" (*Journal of Educational Psychology*, vol. iv. pp. 1–16).

CHAPTER XIX

PSYCHOLOGY AND PEDAGOGY OF THE OTHER SCHOOL SUBJECTS

THE methods which have proved fruitful in dealing with the school subjects treated in the foregoing chapters have been applied, not unsuccessfully, in the solution of questions affecting the other school subjects.[1] It is impossible here to review exhaustively or comprehensively the various investigations which have resulted from such application; all that space permits is to indicate the general lines which have been, and are likely to be, followed in the scientific analysis and treatment of these subjects.

The most active line of inquiry in Experimental Education at present is the devising of scales of measurement and norms of achievement. In addition to those mentioned in the preceding chapters, scales of measurement have been prepared in many other subjects, for example, in Drawing, English Composition, Latin, French, German, and Physics.[2] Norms for the various years of study for some of these subjects have also been proposed, but these can as yet only be regarded as provisional. Such scales and norms not only afford us objective standards of the pupil's progress, but they also serve as means for evaluating the results of different methods of instruction, the comparative merits of which are at present merely matters of opinion. The scales can likewise act as controls in verifying new lines of procedure which may be suggested as a result of studies of learning in the various departments of knowledge, when the methods illustrated in

[1] *Cf.* Meumann, *Vorlesungen*, vol. iii. pp. 776–832.

[2] These will be found collected in Starch's *Educational Measurements*.

the chapter on the Economy and Technique of Learning[1] are extended to the higher school subjects.

Such scales and norms provide in addition standards for use in comparing the results of the teaching in different school systems and in different countries, and will make possible "surveys," or scientific inspections, of secondary schools similar to those already undertaken with primary school systems. The teacher will then no longer be subject to criticisms passed on the results of the application of tests of unequal difficulty. As the validity of norms of achievement depends largely on the extent of the application of the tests on which they are based, by affording facilities for the application of such tests teachers of high-school subjects can render service to this branch of Experimental Education.

A second line of activity in regard to the school subjects not treated in this work is their psychological analyses. The futility of much educational discussion in the past has arisen from the fact that the questions in dispute were formulated in too general a fashion. Before investigation can proceed, and scientific and satisfactory answers become possible, the complex questions usually discussed must be resolved into their elements, expressed in accurate terms, and directed to definite issues amenable to experimentation.

A beginning has been made with the psychological analysis of the various school subjects. In the case of the high-school subjects Judd[2] has undertaken this task, and so successful have his efforts been that he alone has raised as many problems for investigation as might keep Experimental Education occupied for many years. Out of the psychological analysis of geometry, for example, such questions as the following arise:[3] "Why is it more difficult to imagine solid figures than to imagine plane? Is it true that one of the functions of geometry as taught in the schools is to cultivate the power of imagery? Why should we be more deficient in this matter than the Greeks or the Japanese?" In dealing with the teaching of Language and Literature, Judd states:[4] "Appreciation is a mental process,

[1] See Chapter XIII., above.
[2] C. H. Judd., *Psychology of High-School Subjects*.
[3] *Ibid.*, pp. 79–80. [4] *Ibid.*, p. 184.

and is capable of training under direct guidance, while to some extent it seems to mature without direct guidance. Our problem is to discover what is the mental and physical mechanism involved in appreciation, and thus to throw light on the methods of training." As there is a psychology of play, why not a psychology of the industrial arts? he asks [1]; and in science he suggests the further study of the child's scientific interests.[2] To raise such questions is not to answer them, but it is a necessary prerequisite to any profitable discussion of them, and the exact formulation of a hypothesis or of a problem is more than half the battle in its scientific solution.

A third line of approach to the psychology and pedagogy of the school subjects is through investigations which are purely psychological in nature. From the results of these investigations of psychical processes we can occasionally draw inferences which may be valid in the more complex teaching process; such inferences must, however, be applied with caution, and regarded rather as hypotheses than as proved principles. In discussing the direct method of teaching a language, for example, it may be in place to point out that auditory presentation of a stimulus does not usually secure such an exact intellectual appropriation as visual presentation, and that as a consequence, if we delay too long over the oral method in the teaching of, and prevent the pupil from reading, the language, we cannot require of him the same standard of exactness as when he has apprehended the words visually. At present our knowledge of the pedagogy of the high-school subjects is mainly of this inferential type, and with it we must be content till the study of educational problems by psychological methods has been carried further, and direct experimentation made possible.

The application of the correlation methods given above [3] may throw some light on the relation between the various aspects of the school subjects as well as on the relation between the subjects themselves. Arithmetic and mathematics, for example, do not appear to be highly correlated, and algebra and geometry imply quite different mental functions. The

[1] C. H. Judd., *Psychology of High-School Subjects*, p. 257.
[2] *Ibid.*, pp. 319–321.
[3] See Chapter II.

higher branches of mathematics, the constructive and creative aspects of the subject, likewise involve different mental abilities from those demanded by the reproductive aspects of the subject which play the greater part in school mathematics; "applied" science may also require a special training. The essential differences in the various parts even of the same subject will doubtless explain many of the anomalies in the work of pupils, and perhaps lead teachers to employ other than the usual means of correction. Further investigation will doubtless reveal similar complexities in the other subjects, and lead to a further individualisation of instruction in them.

REFERENCES FOR FURTHER READING.

STARCH, D., *Educational Measurements.*
JUDD, C. H., *Psychology of the High-School Subjects.*

CONCLUSION

"WE have now reached a point in educational enlightenment where opposition to the scientific method must be frankly pronounced a prejudice."[1] "The essential thing is for all the world to understand that empiricism has had its day, and that methods of scientific precision must be introduced into all educational work."[2]

The multiplication of quotations in this strain would not increase the force of the argument. The day is past when it is possible for teachers to accept unquestioned and act on generalisations derived from an unanalysed experience. The aspirations of Pestalozzi and others after a scientific method are now coming to be realised; and the instruments are being fashioned which, when applied, will place the science of Education on a sure basis.

In the review of Experimental Education which we are now concluding, new solutions to old problems have been suggested and new problems have been disclosed. The subject is, however, far from finality. The field is so extensive that one who seeks to survey it in its entirety is threatened with despair, and the problems awaiting solution are so numerous as almost to overwhelm the investigator. It is the hope of the writer that this work will afford students a convenient approach to the subject of Experimental Education, and that they will thereby be in a position more easily and earlier than they otherwise would, to contribute to the advancement of the scientific treatment of Education; for this new movement differs from previous reforms in the history of Education, which were mostly initiated by individuals, in that its success, like the success of most sciences, depends on the co-operative activity of an army of workers, many of whom will ever remain nameless.

[1] E. J. Swift, *Mind in the Making*, p. 243.

[2] A. Binet, *Mentally Defective Children*, English trans., p. 146.

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