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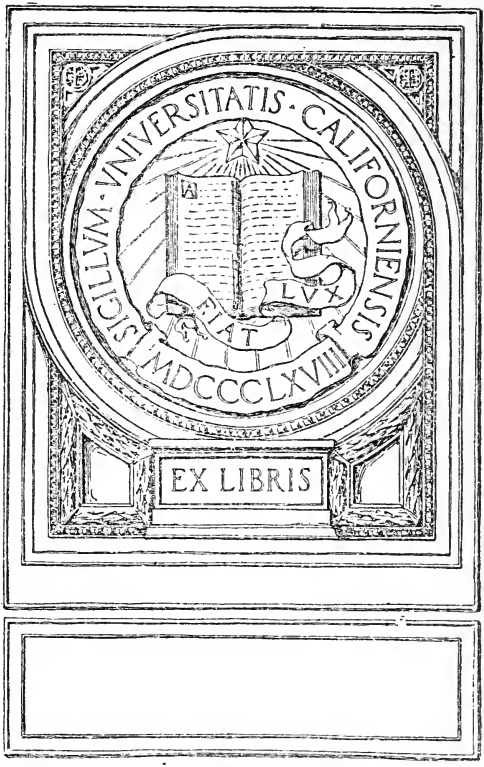
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An abridged sectional edition of "The Encyclopaedia and Dictionary of Education"

EXPERIMENTAL PSYCHOLOGY AND CHILD STUDY

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PUBLISHER'S FOREWORD

The New Educator's Library presents in a convenient form that is likely to appeal to many specialist teachers and others whose interest lies in a select few of the aspects of Education much of the subject matter of *The Encyclopaedia and Dictionary of Education* recently issued by the Publishers; in fact, the scheme is due in great measure to the suggestions of many readers of the latter work, pointing out the desirability of issuing in sectional form the authoritative contributions on the various subjects.

It is hoped that these little books embodying, as they do, the results of research and experience of educationists and others of high distinction in their subjects, will serve a really useful purpose to teachers, to students, and to many others connected with or interested in educational matters.

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EXPERIMENTAL PSYCHOLOGY AND CHILD STUDY

PART I

SECTION I

RESEARCH IN EDUCATION

EDUCATION has come to be regarded as an applied science, like medicine, engineering, or industrial chemistry. In each case, the change in standpoint has been due almost entirely to the application of the methods of research to problems of everyday practice. Training the mind requires a scientific study of the mind, just as healing the body requires a scientific study of the body. For long the teacher, like the earlier physician, was guided by little else than historical tradition, *a priori* speculation, and personal common sense. He now practises a technique almost as specialized as that of the modern surgeon or physician; and that technique, in turn, rests upon a large body of knowledge, almost as specialized as anatomy, physiology, or pathology.

Teaching, however, consists in much more than mere applied psychology. Starting with the application of psychological generalizations to the difficulties of the classroom, educational research has developed problems and methods of its own. Indeed, to education would now be conceded by almost universal consent the rank of a separate science, "applied"—that is, practical—in its nature, but as independent and as self-contained as engineering or medicine.

The methods of research are much the same in education as in other sciences: observation and description of individual children; questionnaires seeking *data* from large numbers; experimental investigation of specific problems, particularly by means of tests; genetic studies of growing children; pathological studies of abnormal children; and statistical analysis of the *data* collected.

The problems which have formed the chief subjects for research fall under one or other of two main heads: (1) the development and peculiarities of the individual minds to be educated; (2) the best methods to be adopted in educating them. The following are some of the more important of the results which have been yielded by the foregoing methods.

Developments of Individuals. The most active line of inquiry has consisted in applying to large groups of children *tests* of mental capacity or educational attainments, and calculating averages and standard deviations for each age. The age-averages yield a general picture of the normal course of mental development in the particular ability tested; and the standard deviations indicate the normal range of individual differences. "Norms" have thus been obtained for the chief subjects of the school curriculum. By the aid of such tests as those of Courtis and Ballard for arithmetic, Starch and Ballard for reading, Ayres and Buckingham for spelling, Ayres and Thorndike for handwriting, Thorndike and others for drawing, Thorndike and Hillegas for composition, the work of schools and school-systems can now be measured with fair accuracy. The majority of these studies have been carried out in America; but similar experiments have been commenced in this country by the research committees of the Child-Study Society and of the British Association. The latter have already published typical results obtained with standardized arithmetic tests applied to children of both sexes, and of average, superior, and inferior social status.

Similar researches have been carried out by means of tests in general intelligence, for example,

by the Binet and Simon scale. Manuals of mental tests give detailed instructions for examining other elementary psychological *data*—sense-perception, mental capacity, attention, memory, association, imagination, suggestibility, and so forth. Results stated, however, have been obtained from American children.

Statistical Concepts. Such as that of correlation and the normal curve have proved readily applicable to results obtained with such tests as the foregoing; and their application has suggested various fruitful generalizations. Two important conclusions have been drawn which have already begun to influence educational administration—

1. Mental and educational abilities appear to conform approximately to "normal" distribution: that is to say, grades of ability near the average are the most frequent; grades somewhat above or below the average are nearly as common; grades deviating considerably from the average are correspondingly rare; and there are, very roughly, about as many individuals belonging to the grades above the averages as to the grades below. This principle has been of considerable value in securing and testing uniformity in examinations conducted on a large scale; and promises to lead to great improvement in systems of marking. On this assumption it becomes possible, in dealing with large numbers, to predict the approximate number of children falling within or beyond the specific limits of ability with the same ease as we can foretell the ultimate proportions of heads in tossing coins, or the scattering of shots fired from a gun.

2. Mental performances appear to be the result of two kinds of capacities: first, a general factor common to all intellectual activities; secondly, specific factors, limited to certain activities or groups of activities only. This to some extent justifies the current choice of subjects for scholarship examinations, school promotion, and school classification. Composition and problem arithmetic, the subjects most commonly selected for such tests, apparently correlate very highly with the general

ability underlying all school work. At the same time, however, it is evident that examinations for specific purposes should themselves be made more specific. Tests for trade-schools, art-schools, particular occupations, and particular trade processes should involve performances as nearly as possible identical with the work the candidates will subsequently be required to undertake. It is clear, too, that children may be defective, not only in general intelligence, as is assumed by statutes relating to the mentally deficient, but also in particular or localized functions, as is shown by the occurrence of colour-blindness, word-blindness, number defect, and motor incoordination in children otherwise normal.

The method of CONTROL-GROUPS has been no less fruitful. The improvement resulting from teaching a sample group of children by some new educational method can be compared with the improvement shown by an equivalent paired group left to the ordinary educational routine. Such experiments have demonstrated, for example, that the practice acquired by exercise in one particular subject-matter affects ability to deal with other subjects to a very limited extent and under very special conditions. " Transfer of training " is the exception rather than the rule.

Problems of the Future. Researches have also been carried out upon the teaching methods most suitable for each subject of the school curriculum. Which method, for example, is the most effective in the teaching of reading or spelling—analytic, synthetic, alphabetic, phonic, or phonetic ? Is the method which proves most effective with the average child equally effective with the supernormal, or the backward ? What are the most effective methods of teaching arithmetic, spelling, writing, drawing, and so forth ? What are the particular psychological functions which enter into these several branches of school work and how may they best be trained ? Such problems are of obvious importance to the practical teacher.

A few investigations have been carried out upon the general technique and hygiene of mental work.

What is the most economical method of learning? What are the fatigue-effects of the several school subjects? How may effort and rest be best distributed so as to obtain a maximum result within a minimum time? Such problems have been answered tentatively by psychological investigators. But the conclusions are based more upon experiments with adults under laboratory conditions than upon experiments with children in the classroom under ordinary school conditions.

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SECTION II

EXPERIMENTAL PSYCHOLOGY

When G. T. Fechner published in 1860 his *Elements of Psychophysics*, he imagined that he was founding a general theory of the relation of mind to matter and propounding a new system of philosophy. His immediate purpose was to establish definite mathematical relations between physical sense-stimuli and the intensities of sensation following thereon, and so to build up a system of mental measurement which should be the psychical counterpart of the science of mathematical physics. His ultimate aim was to sketch out a new theory of the Universe, centred in the nature of the psycho-physical relation. In neither of these attempts has his work stood the test of time, and the ideals he pursued have been shown to be unrealizable. Yet his labours were not in vain, for in the course of his researches he developed a technique of experimentation, summed up in the so-called "psycho-physical methods," which formed the starting-point of a new science, the science of experimental psychology. In its earliest development it was the work of one other man, Wilhelm Wundt, who published his *Physiological Psychology* in 1874, and opened the first laboratory for experimental psychology, in Leipzig, in 1879. There is now hardly a university in Europe or America which does not possess a psychological laboratory, and the position of the science is so well assured that its methods and spirit are exerting a profound influence upon the course of development of kindred sciences such as Education, Psychological Medicine, Philology, Aesthetics, and other *Geisteswissenschaften*.

Starting out from the definition of Psychology as the science of the mind, with introspection as the fundamental method whereby it acquires its

data, we have in experimental psychology not so much a new science as rather an improved technique, in which introspection is carried out under prearranged conditions. In the performance of a psychological experiment, the co-operation of two persons, an experimenter and a subject, is generally necessary, although in certain special cases their work may be done by one and the same person. The experimenter arranges the external conditions of the experiment, manipulates apparatus, etc., whereby modifications are produced in the subject's consciousness. The subject then observes these mental changes in himself by careful introspection, and records them with as much detail as possible. In this way, both objective and subjective conditions of mental change can be accurately controlled, and the experiment can be repeated as often as is necessary, not only by the same two workers, but also by other workers in other laboratories, so that results can be compared with one another and general laws of mental reaction finally deduced.

The Psychophysical Methods. In the early days of the science, experiment was used mainly for the purpose of elucidating the relations between sensations and their corresponding physical stimuli. The attribute of sensation to which attention was chiefly devoted was that of intensity; and, working on the assumption that sensation intensities could be measured in terms of a unit of intensity, Fechner and his followers deduced the general law that, within any realm of sensation, sensation intensity varied as the logarithm of the stimulus. It is now universally agreed that sensation intensities are not in themselves measurable magnitudes, but that "contrasts" between one intensity and another, or "sense-distances" as they may be called, are measurable. If these sense-distances are taken as the measurable magnitudes on the psychical side, the logarithmic law still correctly expresses the relation between them and the stimulus values of the pairs of contrasted sensation-intensities. Just noticeable differences of intensity, which figured so prominently in the earlier work as the "difference

threshold," are merely a limiting case of such contrasted intensities.

It was in the course of experimental work on sensation intensities that the so-called psychophysical methods were developed, as we have already mentioned. These methods are three in number—

1. *The Method of Minimal Change*, or the method of limits, in which a standard sensation stimulus is compared with regularly increasing or decreasing values of a variable stimulus in the following ways. That value of the variable is chosen which gives an obviously more intense sensation than the standard stimulus gives, and is then reduced by successive small amounts until it ceases to elicit from the subject the answer "greater." It is diminished still more and then increased until it again just gives the answer "greater." The mean of these two values gives the upper difference threshold. By choosing values of the variable less than that of the standard, and proceeding in an analogous way, the lower difference threshold can be similarly determined. The order in which the standard and variable are presented is found to influence the result, and therefore separate determinations are made for the cases where the former or the latter is presented first. In this way, a quantitative measure of the influence of the time-order on the subject's judgment of difference is determined, and is known technically as the "time-error." In similar fashion, where the standard may be presented either to the right or to the left of the variable (as in the case of lifted weights) a "space-error" occurs and can be measured.

2. *The Method of Average Error*, or the method of production. Here the subject himself adjusts the size of the variable until it appears to him equal to the standard, and makes this adjustment a large number of times under varying conditions (*e.g.* in one series of measurements with the variable to the right of the standard, in another with the variable to the left). By averaging these measurements separately and comparing them, a "space-error"

can be quantitatively determined. There is no time-error in this method. One important measure that may be obtained by the use of the method is the "mean variation" of the different values of the variable which the subject has judged equal to the standard. This is obtained by first finding the average of all the values and then finding the average of all the deviations of the individual values from this average, counting all the deviations as positive. It is a general measure of the reliability of the subject's judgment, and although not identical with the difference threshold, varies directly with it.

3. *The Method of Right and Wrong Cases*, or the method of constant stimuli. In this method there is a graduated series of variables, with each of which, in quite irregular order unknown to himself, the subject compares the standard a large number of times. The standard is sometimes to the right, sometimes to the left of the variable; sometimes presented first, sometimes second; and the subject gives as his answers the judgments "greater," "equal" or "uncertain," and "less" with reference to the last-presented stimulus. In this way, a series of percentages of each of the three kinds of answers is obtained corresponding to the different variables used. The value of the variable corresponding to 50 per cent. of answers "greater" gives the size of the upper difference threshold. From the series of answers "less," the lower threshold can similarly be determined. The values are most accurately determined by the method of interpolation (*i.e.* by fitting smooth frequency-curves to the obtained values).

These methods admit of a more extended application than that for which they were originally devised. They have, for example, been employed in the investigation of optical illusions; and the different results obtained by varying the length, inclination, etc., of the lines forming the illusion-producing figures, and by observing the figures under conditions of momentary as well as prolonged exposure, throw much light upon the factors underlying such

illusions. Even in the realm of sensation-intensities, a more careful comparison of the subject's introspective record with the various numerical results obtained has in recent years added greatly to our knowledge of the psychological processes involved in the comparison of sense impressions. The effects of the experience of "absolute impression," "side comparison," and similar factors have been worked out, and furnish a valuable psychological supplementation of an otherwise merely quantitative result. Shorter methods of measurement are sometimes used, but in principle they are variations or abbreviations of the classic three. A thorough training in the use of the latter is an indispensable part of the mental equipment of every experimental psychologist.

Head's Experiments. In a short review like the present, it is impossible to do more than merely refer to a few selected topics, and to indicate in an impressionist way the type of problems with which experimental psychology attempts to deal. Passing over the enormous amount of detailed work that has been done on the sensation of vision and hearing, and the psycho-physiological theories that have been propounded to explain the large number of facts known about these forms of experience, we may with advantage mention some recent work on cutaneous sensations which is of considerable theoretical importance. An experimental investigation was made by Dr. Head, who cut through one of the cutaneous nerves of his own forearm and then observed the gradual recovery of cutaneous sensibility which occurred in the course of time. It was found that immediately after the operation there persisted sensibility to heavy pressure, and that the experience of deep-seated pain could also be elicited. If, however, the skin supplied by the severed nerve was lifted up in a fold and pressed between the fingers of the experimenter, no sensation was experienced. In course of time, cutaneous sensibility returned in two stages. The first comprised sensibility for heat and cold, localized in definite spots on the skin; and to pain. The temperature- and

pain-sensations aroused radiated widely, and showed no precise localizability. The two points of a pair of compasses, simultaneously placed on the skin, could not be discriminated as two, however widely apart they were separated. This condition of the skin was named by the investigators *protopathic* sensibility. At a much later stage, sensibility gradually returned for light touch, warmth and coolness (not localized in definite points of the skin), and the discrimination of two points simultaneously touched on the skin when at a sufficient distance from one another. This form of sensibility was named *epicritic* sensibility, and on its return the previous radiating and vaguely localizable character of the protopathic sensations disappeared, and was replaced by definiteness and restriction. It would seem as though the cutaneous sensations of the normal skin, which to introspection appear simple and ultimate, were the result of a complex physiological mechanism whereby a later form of sensibility is superimposed on a more primitive form; and that the simplicity and definiteness is a result of this synthesis. There is evidence that the areas of protopathic and epicritic sensibility do not completely correspond, the conclusion to be drawn being that they are supplied by different sets of nerve fibres. Sensations from the viscera, which give rise to "referred" pain, are probably to be classed with protopathic sensations.

Experiments dealing with Visual Experience. In the domain of perception, experiment has added greatly to our knowledge. By employing conditions of momentary as well as prolonged exposure in the case of visual perceptions, not only has a deeper insight been obtained into the nature of optical illusions, but also the processes of reading and of the apprehension of number have become better understood. The tachistoscope in its various forms, whereby visual stimuli such as dots, lines, words, and other visual objects can be presented to a subject for a brief interval of time (*e.g.* $\frac{1}{10}$ sec.) is an apparatus of great general usefulness in analysing the apperceptive processes that take place in all

acts of perception (*i.e.* the bringing to bear of past experiences, either in the form of memories or of unconscious dispositions, upon the given impression). By presenting a succession of momentary impressions of words or sentences, and observing the mistakes which the subject makes in apprehending them, inferences can be drawn as to the processes of apperception aroused, such inferences being confirmed or corrected by appeal to the introspection of the subject. In visual perception under conditions of prolonged exposure, the record of eye-movements, either by photography or by a system of levers joined up to one writing on a revolving smoked drum, gives interesting results. It is found that in the apprehension of optical illusions and aesthetic diagrams or objects, the eye-movements have no relation to the illusory or aesthetic character of the perception, and are therefore to be ruled out as possible factors in its production. On the other hand, in the process of reading the eyes move discontinuously from fixation point to fixation point along a line of print, the fixation points being only three or four in number, in the case of a line of about a dozen words, and the two terminal ones being some distance within the two ends of the line. This sequence of eye-movements is found to correspond with the processes of attention and apperception involved in the reading.

Long series of experiments have been carried out with children and adults to determine the character and accuracy of their observation processes. The psychology of testimony has become almost a science in itself, and many types of the observing process have been distinguished. The importance of all this work for the estimation of scientific and legal evidence is obvious.

Experiments dealing with Memory and Association. In the domain of memory and association of ideas, the possibilities of experiment are well-nigh unlimited. Single words may be presented to the subject and he may be asked to reply as quickly as possible with the first word that comes into his mind, the time elapsing between the stimulus and

the reply being measured correct to fifths of a second by means of a stop-watch. The replies may be classified according to the kind of association that has occurred, and full introspective records from the subject give valuable information as to his type of association process. The association-time, as the interval between stimulus and response is called, varies from association to association and from individual to individual; but, if it exceeds three or four seconds, as it sometimes does, it is regarded as significant of something abnormal in the association. In such a case, the reaction is usually of an emotional nature, a whole system of ideas and memories tinged with a particular emotion being aroused by the stimulus word. Where no conscious emotion accompanies a prolonged reaction time, it is sometimes assumed that the emotion is unconscious. But a state of fatigue or distraction may in some cases adequately explain the anomaly.

In experiments on memory, the material used has been for the most part nonsense syllables, each consisting of two consonants and an intervening vowel not making sense. These syllables have no preformed associations, and therefore the process of building up associations between them can be studied from the beginning. Lists of such syllables are learnt in definite ways and under definite conditions, and then relearnt after the lapse of definite intervals of time; or the memory for them is tested in other ways. There are many different memory methods, but the most reliable is the scoring method. In this method a series of nonsense syllables, say sixteen, are presented to the subject's view one by one at a definite rate of sequence through an aperture in a screen. The subject sees only one syllable at a time, and he learns the series in trochaic rhythm (*i.e.* accenting every odd member). This helps to divide the series up into associated pairs of syllables. The series is thus presented a definite number of times, a number insufficient to produce complete learning. The strengths of the individual associations are then tested, either

immediately after the learning or after definite intervals of time, by presenting through the aperture the odd members of the series in quite random order. The subject is asked to reply with the first nonsense syllable that occurs to his mind, and the time elapsing between stimulus and reply may be measured by a chronoscope connected up electrically with the apparatus. The percentage of correct replies and the lengths of the association times are approximate measures of the extent to which the syllables have been memorized.

Among the many results obtained by the use of this and other memory methods are the following:

1. The rate of forgetting is high immediately after the learning, but becomes less and less with further lapse of time.

2. The learning of a list of syllables immediately after a previous list has been committed to memory tends to weaken the association of the previously-learnt series—a phenomenon known as "retro-active inhibition."

3. A given number of repetitions are more effective the greater the number of days over which they are distributed.

4. Repetitions of a series from beginning to end are more effective than an equal number of repetitions of sub-sections of the series; in other words, the "whole" method is more efficient than the "part" method.

5. The strongest associations are formed between successive syllables in a series, acting in a forward direction; but associations are also formed between non-contiguous members of a series, and also between contiguous members acting in a backward direction.

6. Of associations of equal strength but unequal age, the younger associations suffer more at the hands of time than the older.

The learning of rational material, of course, takes place with greater ease than that of senseless material, but the laws above-mentioned are merely supplemented, not superseded, by the effects of rational connection.

It is found that as many as twenty sentences,

each expressing some definite thought and read slowly in pairs, can be reproduced correctly as regards their thought-contents, although not necessarily in their original verbal form, after a single reading; whereas the number of nonsense syllables that can be correctly reproduced after a single reading is usually not greater than seven or eight. This brings us to the question of the nature of thought as distinct from mere association, and the comparative experiment just mentioned illustrates the kind of experimental evidence upon which the existence of definite but imageless thought-elements is based. In other experiments a series of sentences are read out to the subject, and shortly afterwards a number of other sentences expressing analogous thoughts but arranged in a random order, and comprising also one or two irrelevant sentences as "catches," are read out, and the subject is asked to state the thoughts of the earlier sentences which correspond to each of the second series. The task is satisfactorily performed by most subjects, and introspection shows that there is awareness of the thoughts and of their relations to one another more or less independent of the verbal sensory material in which they are clothed.

Association experiments have also been devised which indicate the existence and throw light on the nature of definite volitional elements distinct from the sensory elements ("sensations of strain," etc.) of consciousness. A series of nonsense syllables is read a number of times in trochaic rhythm, as in the scoring method; but when the odd members are presented later, the subject is asked to reply not with the spontaneously-arising second syllables, but with syllables which contain the same letters of the presented syllables in the reverse order; or, in other experiments, with syllables rhyming with the presented syllables. An effort is needed in overcoming the mechanical tendency built up by the initial repetitions, and detailed introspective accounts of this effort have been obtained which prove definitely the existence of a non-sensory volitional element. The technique of all this experimentation on

processes of thought and volition is still somewhat crude and immature, but a great deal of work is being done along these lines which will undoubtedly produce results of far-reaching importance for the science of psychology, and possibly, too, for those of logic and ethics.

Pleasure and Pain Experiments. Experiments on feeling have till recently been almost entirely limited to a registration of the physiological changes accompanying experiences of pleasure and pain. The plethysmograph, sphygmograph, and pneumograph have been used to give tracings on a moving smoked surface of the alterations of volume of blood vessels, rate of pulse, and rhythm of breathing corresponding to variations in feeling tone. This general " method of expression " is now being supplemented more and more by the " method of impression," in which aesthetic preferences are observed under varying conditions of presentation of the stimuli, and fuller and fuller introspective accounts are demanded of the subject. The word-association test, to which we have already referred, is very useful in the exploration of emotionally-tinged systems of ideas—technically known as " complexes "—and is finding a wide sphere of application in psychiatry.

The Measurement of Fatigue. Methods of investigating mental efficiency and mental fatigue can be but barely referred to here. The ergograph and aesthesiometer have given reliable results in skilful hands, but great care is needed in drawing conclusions from them. Direct mental tests of efficiency and fatigue have been coming more into favour during the last few years. The addition or multiplication of figures, the erasing of certain letters in a page of print, the filling-in of blanks in an otherwise continuous piece of prose, all give quantitative results, and can be used either as continuous tasks producing mental fatigue and measuring its progress at the same time, or as interpolated tests applied at regular intervals in the course of mental work of another kind. Work-curves can be obtained by either of these methods, showing change of

mental efficiency with time. The various factors affecting the shape of the work-curve, such as practice, fatigue, incitement, and adaptation, have been investigated in great detail, as well as the effect of rest-pauses of varying lengths upon the total amount of work done.

The Science of Mental Variation. Finally, we can but touch the fringe of a field of psychological research in which exceptional activity is being displayed at the present time. This is the psychology of individual differences, better termed the science of mental variation. Individuals differ from one another in every form of mental ability, and a precise statement of these differences can, in many cases, only be obtained by quantitative determinations. In the various forms of mental tests, some of which we have already mentioned in connection with the problem of mental fatigue, we have means of getting a many-sided view of these variations. The psychophysical methods, adapted and simplified to meet the exigencies of the case, have a new value and furnish the basis of a more general scheme of mental measurement than that sketched out by Fechner. And when we go further and consider the question of correlative variations of mental capacity in groups of individuals, we find that the modern mathematical theory of probability admits of application in its fullest extent to the elucidation of the problems of the mind. The extent to which any two mental abilities show a tendency to vary concomitantly within groups of individuals is measurable by the so-called "correlation coefficient," if the concomitance is linear, or by the "correlation ratio," if it is non-linear. These values form the starting points of mathematical investigations which are at present still in the process of formulation, but which, when developed, will throw a flood of new light upon the dynamics of the mind, and will bring appreciably nearer that ideal towards which Fechner strove—the ideal of an all-inclusive science of mental measurement. Yet the qualitative differences of the mind will never be completely bridged, and objective measurement must always

remain dependent on, and subordinate to, subjective introspection, if the science of experimental psychology is to retain a character of its own, distinct from that of the other biological sciences.

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SECTION III

REACTION AND REACTION EXPERIMENTS

STRICTLY speaking, any response following a stimulus is a reaction; the contraction of the iris which follows the incidence of light on the retina, the withdrawal of the hand which comes into contact with a hot poker, the movements made by a hungry animal in sight of food: all these are reactions.

In psychology, however, the term is generally limited to a pre-determined movement made in response to a pre-determined stimulus. In a reaction-experiment, the subject (or reagent; *i.e.* the person whose movements are under examination) is instructed to react in a particular manner on perceiving a certain object (a sound, printed word, etc.). In its simplest form, he presses a Morse-key. By means of suitable apparatus and a chronoscope (a clock which reads to a thousandth of a second, and is automatically started and stopped by making and breaking an electric current), the interval that elapses between the exposure of the stimulus and the subject's reaction can be measured with great accuracy. This interval is called the *reaction-time.* This complicated apparatus is used only in experiments where the reaction-times are short; much useful work, especially in the higher mental processes, where reaction-times are long, can be done with a stop-watch and some simple device for exposing the stimulus instantaneously.

Reactions may be roughly classified as simple and composite. A simple reaction is a pre-arranged movement made directly on perceiving a pre-arranged stimulus; for example, the release of a reaction-key on hearing a certain sound. After a little practice, such a reaction approximates in its automaticity to a reflex action.

Reaction-times. The lengths of simple reaction-times vary with the nature of the stimulus, the

nature of the reaction, the direction of attention, and many other conditions. The average simple reaction-time of an experienced subject to sound stimuli lies between 125σ and 220σ (1σ = one thousandth of a second), to light stimuli between 175σ and 270σ, and to touch stimuli between 110σ and 210σ. These differences are undoubtedly due to differences in the times required for the production of physiological changes in the peripheral sense-organs and their central connections. Some movements are made more easily and more quickly than others ; *e.g.* a reaction-key can be more quickly released than pressed. The direction of attention has a pronounced effect on reaction-times. When it is directed on the stimulus, the reaction-time is longer, though less variable, than when it is directed on the movement. Reactions of the first kind have been called *sensory*, those of the latter *muscular*.

The average sensory reaction-times of a practised subject to sound, light, and touch are 220σ, 270σ, and 210σ respectively; whereas the corresponding muscular reaction-times are 125σ, 175σ, and 110σ. These differences are to be explained by the effect of the reagent's attitude on the preparation of the motor apparatus. Variations in the power of maintaining a favourable attitude probably explain other features of reaction-times; *e.g.* that they are shorter when the stimuli are presented regularly and preceded by a warning signal; that they are shortened by practice and lengthened by fatigue; that children and the aged give long reaction-times; and that individuals and races show characteristic differences in rapidity of motor response. Intense stimuli give shorter reaction-times than faint stimuli.

Composite Reactions. Composite reactions may be recognitive, discriminative, choice, associative, etc. They are preceded by more complex mental processes than simple reactions. In recognitive reactions the subject is instructed to react as soon as he recognizes the stimulus; in choice reactions he reacts only when a certain stimulus appears, or in one way to one stimulus and in another to

another; in associative reactions he calls out the name of some object associated with the object, the name of which is shown. The reaction-times here are much longer than in the case of simple reactions.

Their Significance. In the early days of the reaction-experiment, attempts were made to deduce the time required for the performance of typical mental operations: *e.g.* recognition-time was supposed to be given by subtracting simple reaction-time from recognition reaction-time, and choice-time by subtracting discriminative reaction-time from choice reaction-time. This procedure, however, is indefensible, for mental processes are not added together in time; mental complexity is a result of differentiation rather than of addition. Further, simple, recognitive, discriminative, and choice reactions are not so different as their names imply: even in simple reactions, there is a certain amount of recognition, and in choice reactions there is no real choice, for decision is made before the stimulus is exposed. It is equally unsatisfactory to attempt to determine the duration of cerebral processes by subtracting from simple reaction-time the time required for the production of changes in the sense-organs and in the afferent and efferent nerves, since our knowledge of the duration of these processes is not very reliable.

Modern Reaction Experiments. Reaction experiments have recently gained a new lease of life on account of a change in the use to which they have been put. In the experimental study of the thought-processes, the method of the reaction-experiment has been used for the purpose of delimiting the segment of consciousness under investigation. A task has been set (*e.g.* to find the name of the class to which the stimulus-word belongs), the interval elapsing between the exposure of the stimulus and the reaction has been measured, and full accounts have been given of the contents of consciousness during this interval. Reaction-times here have been used merely as a control of the subject's introspection.

SECTION IV

PSYCHOMETRY AND PSYCHOPHYSICS

THE term *psychophysics* is usually applied to a rather narrow domain of experimental psychology, namely, that concerned with the appreciation of sense differences, such as the differences between lifted weights, or various shades of colours, and allied matters. But, had the ambitious aims of its founder Fechner been realized, this science would have had a much wider, indeed an all embracing territory to explore: for it was then hoped that measurement of the relationships between the psychical and physical would lead to a strictly quantitative psychology and to a new and clearer philosophy. These hopes, however, have not been realized, and many think them unrealizable.

The term *psychometry* is less commonly used, and may perhaps be taken at its face value as covering all forms of mental measurement, free from the narrower implications which have come to be associated with *psychophysics*.

The purpose of the present article is, therefore, to consider from a central point of view all forms of mental measurement, and to discuss their aims, methods and success in relation to the central idea of a *quantitative* psychology.

Mental Measurement. The possibility of the true measurement of mental entities has been debated hotly for half a century and would probably be negatived by a majority of psychologists at the present time. There is, however, a fairly general agreement that mental states of the same class can be "ranked" in order of their intensities, and that the differences between mental states (such as two feelings of *warmth*, or two experiences of *anger*) are themselves mental states and can also be ranked: as when I might say, "I was angry on Monday, a little less angry on Tuesday, and much more angry on Wednesday."

The point of difference between magnitudes which can thus be ranked in order, and quantities which can be measured, is commonly said to be that in the latter case a *unit* is employed but not in the former. In the writer's opinion this contrast is one of degree only, and not essential. If differences, and the differences of these, and so on, can all be ranked, the result is measurement if the magnitudes available are infinite in number, and almost as good if they are merely numerous though not innumerable. Indeed, it may be doubted whether all measurement is not really mental measurement. Psychophysics in its attempt to establish mental units may have failed, without the impossibility of mental measurement in a wider, and perhaps truer, sense being thereby demonstrated.

Fechner's Mental Units. It was G. T. Fechner who some sixty years ago began the most thoroughgoing attempt to establish a system of mental units. He wished to measure a mental state as one measures a length of calico, by taking a yard stick, laying it along the calico, making a mark, and transferring the yard stick to its new position; and so on. In this form of measurement the idea of a movable unit is most pronounced, and probably Fechner's failure was largely due to his not having taken for comparison some "physical" measurement where the unit is less directly applied, as in measurement, say, of weight. The units which he adopted in the mental domain were "just noticeable differences." For example, suppose I want to measure the difference in the feeling of weight produced by masses A and B when supported in a certain way on my hand. On Fechner's system this would be done (1) by adding masses to A till I could *just* detect the addition (under certain experimental conditions). This would be called in mental units *one*. (2) The new weight $A + a$ would then be compared with slightly heavier weights and one found which could just be detected as heavier. This is *two*, in mental units. This process would be repeated until the weight

B was reached, when a number would have been found expressing the distance mentally from A to B.

The chief assumption in this is that those just noticeable differences are mentally equal. This has been strongly denied and strongly asserted. But, since larger differences which contain equal numbers of these units are commonly found to be approximately equal in introspection, there is some justification for the assumption. Whether theoretically justifiable or not, however, there can be no doubt that Fechner's system is, at present at least, practically unworkable.

Fechner's Logarithmic Law. Weber had previously found that, in order to be just noticeable, the increment to any stimulus had to bear a constant ratio to that stimulus. If a 103 gram weight is just noticeably heavier than a 100 gram weight, then the weight just noticeably heavier than a 200 gram weight will be 206 grams. This ratio of 3 per cent. (approximately) only holds for lifted weights. A different ratio holds for visual comparisons, yet another for acoustical, and so on. Moreover, the law is only approximately true. Based on this experimental series of facts, the *fundamental formula for mental measurement* formulated by Fechner was—

$$d\,(\text{sensation}) = c\,\frac{d\,(\text{stimulus})}{\text{stimulus}}.$$

Integrating, this becomes

$$\text{sensation} = c\,\log_e\ \text{stimulus} + \text{C}.$$

Putting the stimulus in this equation equal to the threshold T for which the sensation is just below the threshold of consciousness, *i.e.* = zero, we have

$$\text{O} = c\,\log_e\ \text{T} + \text{C},$$

and subtracting,

$$\text{sensation} = c\,\log_e\ \frac{\text{stimulus.}}{\text{T}}$$

Putting T = 1 and transferring to the ordinary logarithm system, we get—

$$\text{sensation} = k\ \log\ \text{stimulus.}$$

The Psychophysical Methods. In the mass of detailed experimenting which followed Fechner's bold pioneer researches, there were worked out certain methods of experiment which have a wider applicability than the field in which they were designed. These methods are described at some length in another article from the experimental point of view. (See EXPERIMENTAL PSYCHOLOGY.) A few lines may be devoted here, however, to the mathematical aspect of the data accumulated. It is found necessary, except in the crudest experiments, to view the data in the light of the mathematical theory of probability. This is because in experiments upon human beings it is impossible to keep the conditions of experiment constant, as can approximately be done in a physical or chemical experiment. A repetition of what is apparently the same experiment gives a different result, just as in dicing (a form of game of chance which originally led to the development of the theory of probability) the throw of ten dice will give results varying from 10 to 60. These dice throws, however, will *average* 35, and their curve of *scatter* can be calculated. Similarly an average result can be found from psychological experiments, and from the scatter of the data something can be learned of the factors at work. In more complicated forms, this idea leads to fitting elaborate curves to psychophysical data, and to devices intended to gauge the homogeneity of the data accumulated, and to disentangle from one another such matters as practice effect, fatigue, diurnal variations in efficiency, and the like. The statistical chapter in Myers' text-book (see References at end) is probably the best introduction for a beginner to this part of the subject, and Brown's *Essentials of Mental Measurement* gives further work and many references.

The psychophysical methods are found in use in many places beyond the narrower domain of psychophysics. Indeed in one sense all human experimenting is based on them. For example, the successful Binet-Simon tests use a group form

of the method of minimal changes. These same tests give, too, an excellent example of the forms which mental measurement can take when the strict use of a truly mental unit is no longer insisted on.

Mental Ages and Intelligence Quotients. In the Stanford Revision of the Binet Tests, there are six tests for each year. Beginning with a year of which the subject can pass all the tests, the experimenter proceeds step by step to a year for which none of the tests can be passed. For example, suppose a boy passes all the tests for year VI, three for year VII, one for year VIII and none thereafter. His "mental age" is then calculated as six years *plus* two months for each higher test passed, that is six years eight months. If his real age is five years three months, then his intelligence quotient is—

$$\text{I.Q} = \frac{80 \text{ months}}{63 \text{ months}} = 1{\cdot}27$$

Now it is to be noted that there is here no attempt to use a mental unit. The average increase in intelligence of children per annum is, in a certain sense, used as a unit. But there is no guarantee whatever that the increase in intelligence which children on the average make in passing from their sixth to their seventh birthday is equal to the increase, say, from their tenth to their eleventh birthdays. We have a set of milestones, but no guarantee that they are equal distances apart. Nor, for the practical purposes to which the scale is put, does this matter one iota.

A priori there would seem to be no reason for expecting the "mental years" to be equal. Indeed it is conceivable that at certain ages children might slip back a little in their intelligence. But it is interesting and important to notice that, as far as experiments have gone, there is some reason to believe that an individual's I.Q. remains fairly constant as he grows older. The above boy, if tested four years later, might be expected to have a mental age still 27 per cent. ahead of his real age. Though this *proves* nothing about the mental steps which are being treated as units, it certainly

seems to *suggest* that they really are equal, and that the Binet measurement is more strictly *measurement* than might at first be imagined.

Somewhat similar remarks apply to other systems of mental tests, such as the Yerkes Point-Scale.

The Correlation of Abilities. In Section XIV of the volume in this series entitled *Ideals, Aims and Methods in Education* formulae are given which enable the degree of concomitant variation shown in two different performances to be calculated. Suppose, for example, that the two performances in question are a form examination in Latin and one in arithmetic. It must be strongly emphasized that calculation of the "correlation" between the marks obtained in these examinations can have no meaning if the number of boys in the form is small. At least thirty should take part if chance correlations are to be reasonably avoided, and even thirty is far too small. Secondly, the Bravais-Pearson formula, or formulae strictly based upon it, are the only absolutely reliable ones. But for many purposes an approximate formula, such as Spearman's "Footrule," is sufficient: and for an illustration of the method we may take perhaps a form of only ten boys (instead of the much larger number really required). Let the order of merit in the two examinations be—

	Latin.	Arithmetic.
Jones	1	3
Smith	$2\frac{1}{2}$	4
Robinson	$2\frac{1}{2}$	1
Anderson	4	7
Grey	5	2
Charlton	6	5
Emerson	7	9
Tennyson	8	6
Forster	9	10
Robson	10	8

Then the degree of correlation or resemblance between these lists is by Spearman's Footrule formula dependent on the gains in rank from either to the other.

Robinson ($1\frac{1}{2}$), Grey (3), Charlton (1), Tennyson (2), Robson (2), have gained in rank in arithmetic as compared with Latin, and the sum of their gains will be found to be $9\frac{1}{2}$. This sum of the gains is divided by $n^2 - 1$, where in this case $n = 10$ (boys in the examination) and subtracted from unity.

$$1 - \frac{6\ S\ (\text{gains})}{n^2-1} = 1 - \frac{[6 \times 9\frac{1}{2}}{99} = 0{\cdot}42$$

The fraction 0·42 is not yet a measure of the correlation. It has to undergo a correction which is practically equivalent to increasing it by 50 per cent. We thus get the correlation—

$$r = 0{\cdot}63$$

for the resemblance between the lists. $r = 1$ would have meant that the order of merit was identical. It must again be emphasized that this calculation is illustrative only, that larger numbers are needed, and that Spearman's formula, though useful, is only approximate.

The method gives a convenient check on examiners' reliability. If two teachers will *independently* mark the same essays and find the correlation between their marks they will be shocked to find how low it sometimes is.

The Theory of General and Specific Ability. The chief result of the application of the methods of correlation to mental tests and school subjects has been the above theory, which has been advanced by Professor Spearman and supported by mathematical and other arguments. In the writer's opinion these arguments are invalid and the theory unproven, but many well qualified to judge think otherwise.

This theory is that in performing any test we make use of two factors: one our General Ability(g) which can be applied indiscriminately in any direction whatever and is uneducable, the other a

Specific Ability which is usable only in that particular task or in *very closely* allied tasks, and has no connection with tasks dissimilar in what would commonly be thought to be only a slight degree.

This theory is based mainly on the fact that when the correlation coefficients between a number of different performances are calculated, they are found to fall into a certain order or progression, which Professor Spearman has termed *hierarchical order*. A formula for measuring the perfection with which they do this has been devised, and the perfection found to be very complete. This complete perfection of hierarchical order can be shown to be explicable by the theory in question.

The writer and others who oppose this view do not admit the validity of this argument. The mathematical accuracy of the measure of hierarchical order is questioned and denied, and it is claimed that such hierarchical order as is actually found is the natural thing to expect on any theory whatever.

Following Professor Spearman's methods and accepting without question his formulae, Dr. Webb and Mr. Maxwell Garnett have asserted the presence of two other general factors, which they term Persistence of Motives (*w*) and Cleverness (*c*) respectively. These of course stand or fall with the validity of the original argument.

It is difficult to reconcile these new general factors with Spearman's original assertion that all correlations between dissimilar performances are due only to one general common factor. And it would seem that there is grave danger of the exponents of this theory returning to a crude form of faculty theory, in which *g*, *w*, and *c* play the parts of personified faculties of intellect, will, and feeling. That the human mind has these aspects everyone will admit, but that entities which can be expressed by algebraical symbols stand behind them is less certain, though many appear to consider it possible.

The suggested alternative view is that of a closely integrated system of numerous units:

and, as analogies, the integration of the units of the physical body by means of the nervous system and the products of glands, and the idea of unit characters so fruitful as Mendelism, are appealed to.

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SECTION V

STATISTICS AND EDUCATIONAL EXPERIMENTS

THE last twenty years have witnessed the introduction and increasing employment of accurate statistical methods in the experimental and observational study of educational problems. Wissler, Urban, Spearman, and Thorndike, to mention only a few prominent investigators, have applied the methods with which Karl Pearson and the Biometric School achieved brilliant results in the study of heredity and evolution to experimental psychology and education. The theory of correlation enables the investigator to supersede the vague generalities of Herbert Spencer by precise statements of association, which facilitate accurate comparisons of the results of experiments.

Nature of a Frequency Distribution. Let us consider for a moment the statement frequently made with regard to the homework in a particular form. We tell the parents that the homework in Form A should take "about two hours," and request them to inform the school authorities when that limit is seriously exceeded. Imagine a return made with regard to every boy in the Form, stating the average time spent by the boy on his homework. We can, from the return, make out a table showing that, out of the N boys in the form, there are n_1 who spend under half-an-hour, n_2 between half-an-hour and one hour, and so on, winding up with, say, n_8 boys who habitually spend from three and a half to four hours on their homework. We may represent the frequencies $n_1, n_2, \ldots n_8$ by rectangles on equal bases, and shall in general obtain a figure like Fig. 1, with the greatest (or *modal*) frequency in the neighbourhood of two hours. If this diagram be constructed with similar *data* on different occasions, the general features of its appearance will be retained, but there will be

random variations in the heights of the individual rectangles. The theory of probability suggests a series of frequency curves, characteristic of the different types of distributions that occur in nature. Each such curve is determined by means of a small number of constants, a knowledge of which provides a satisfactory description of the distribution.

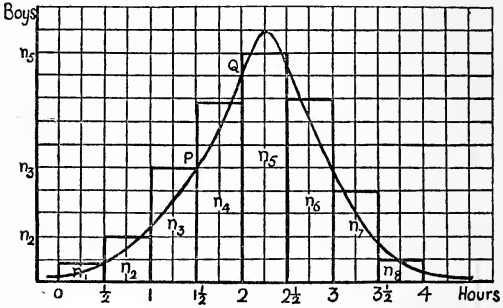

FIG. 1

The best known of these is the so-called *normal curve* or curve of error, whose equation is

$$y = \frac{N}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\frac{(x-\bar{x})^2}{\sigma^2}} \quad \ldots\ldots (1)$$

The chief properties of the frequency curve are: (1) the total area under the curve is equal to the sum of the areas of the rectangles, *i.e.* $N = n_1 + n_2 + n_3 + \ldots$; (2) the area included between two ordinates MP_1NQ measures the theoretical frequency with which values of the character we are measuring fall between OM and ON. We shall not discuss here frequency curves in general, but it is necessary for what follows to describe how the constants of the normal curve are determined and to state the conditions satisfied by a normal distribution. Let $x_1, x_2, x_3, \ldots$ be the values of the

measured character at the middle points of the bases of the rectangles. In our example, $x_1 = \frac{1}{4}$ $x_2 = \frac{3}{4}$, . . . measured in hours. Then $\bar{x}$ (the mean) is given by

$$N\bar{x} = n_1x_1 + n_2x_2 + n_3x_3 + \ . \ . \ .$$

the so-called *standard deviation* σ is given by

$$N\sigma^2 = N\mu_2 = \Sigma n_1(x_1 - \bar{x})^2,$$

and is analogous to the radius of gyration in dynamics. The constant μ_2 is called the second moment coefficient about the mean, and the third and fourth moment coefficients are similarly defined by the equations

$$N\mu_3 = \Sigma n_1(x_1 - \bar{x})^3 \text{ and } N\mu_4 = \Sigma n_1(x_1 - \bar{x})^4.$$

The conditions to be satisfied for a normal distribution are $\beta_1 = 0$ and $\beta_2 = 3$, where $\beta_1 = \mu_3^2/\mu_2^3$ and $\beta_2 = \mu_4/\mu_2^2$. Much reasoning based on the assumption of normality of distribution is invalidated by the failure to calculate the constants β_1 and β_2; unless these have approximately their normal values, zero and three, the distribution is not normal.

Correlation. So far, we have been dealing with a single variable character. When we have to deal with two characters which admit of concomitant variation, we meet with a conception of the utmost importance in the statistical study of school experiments. This is the notion of *correlation*.

Where phenomena are connected by a physical law, as in the relation between the pressure and volume of a perfect gas at constant temperature, to each value of the pressure there corresponds one value of the volume. In statistics we find a dependence of a different character. We know that, in a sense, it is true that the heights of schoolboys increase with age; nevertheless, if the boys in a school are classified according to age, we find much variation of height among boys of the same age. The *correlation ratio* η and the *correlation coefficient* r

TABLE I

A	x	B	y	n_x	$\bar{y}_x$	A	x	B	y	n_x	$\bar{y}_x$	A	x	B	y	n_x	$\bar{y}_x$
1	549	10	243			21	399	18	231			40	348	13	239		
2	529	1	270			22	397	2	262			41	342	30	214		
3	525	37	205			22	397	42	197			42	340	30	214		
4	516	5	250	6	242	24	394	30	214			43	337	22	226		
5	514	2	262			25	392	22	226			44	320	33	211		
6	501	25	223			26	390	15	234			45	319	4	254	12.5	212
						27	382	35	208			46	318	53	173		
7	455	35	208			28	381	52	174			47	317	21	228		
8	453	11	240	3	229	29	376	26	222			48	315	44	193		
9	451	11	240			29	376	7	246	18.5	213	49	309	24	224		
						29	376	27	218			50	304	47	188		
10	449	28	217			32	372	14	238			51	303	46	190		
11	435	28	217			33	371	17	232								
11	435	40	200			34	369	54	170			52	292	40	200		
13	434	39	203			35	362	20	229			53	291	19	230	4	202
14	429	34	210			36	361	55	164			54	275	49	185		
15	425	7	246			37	356	38	204			55	263	44	193		
15	425	43	194	11	217	38	353	49	185								
17	418	9	244			39	350	47	188			56	217	56	149		
18	413	51	178									57	181	57	138	4	122
19	410	6	247									58	104	58	102		
20	403	16	233									59	0	59	100		

[The entries 18.5 and 12.5 in the n_x columns should be noted. There were 11 boys whose x was *between* 450 and 400. There were 68 for whom the mark was between 400 and 350, and one whose mark was *exactly* 350. We credit .5 to the 400–350 group and .5 to the 350–300 group.]

are numerical measures of dependence or concomitant variation. Of these, the first is a positive constant, ranging from zero in the case of complete independence to unity in the case of functional dependence. The second has a range from -1 to $+1$, being negative when an increase in one variable is on the whole accompanied by a decrease in the other. This constant r is of use only when the distribution satisfies a condition we shall describe later known as *linear regression*. The definition and calculation of these constants will be made clear by a numerical example.

Calculation of Correlation Ratio and Coefficient. In Table I, the columns headed x and y contain the marks received by each of fifty-nine candidates in a certain examination, x being the marks awarded for "school subjects" and y for "workshop subjects."

The mean mark for "workshop subjects" is $\bar{y} = 12423/59 = 210{\cdot}56$, or, say, 211 to the nearest integer; similarly the mean "school subjects" mark is 370. The standard deviation of the workshop mark is given by

$$\begin{aligned}\sigma_y^2 &= \{(243-211)^2+(270-211)^2+\ldots \\ &\quad +(102-211)^2+(100-211)^2\} \div 59 \\ &= 1195{\cdot}4; \quad \therefore \ \sigma_y = 34{\cdot}6.\end{aligned}$$

The candidates are arranged in order of merit as regards the "school" mark, and at first sight their "workshop" order appears to be haphazard. But the column headed $\bar{y}_x$ gives the mean "workshop" marks for the boys arrayed in groups, commencing with a group of six boys whose school mark was between 550 and 500, and ending with a group of four for whom it was below 250. The regularity of these means of y in what are called the "x arrays" is sufficiently striking. The *correlation ratio* η is defined by the equation

$$\eta^2 = \Sigma n_x(\bar{y}_x - \bar{y})^2 / N\sigma_y^2,$$

where n_x is the population of an "x array," $\bar{y}$ the

mean of y for the whole population, $\bar{y}_x$ the mean for the array, and σ_y the standard deviation for the whole population N.

In our example,

$$\eta^2 = \{6(242-211)^2 + 3(229-211)^2 + 11(217-211)^2 + 18{\cdot}5(213-211)^2 + 12{\cdot}5(212-211)^2 + 4(202-211)^2 + 4(122-211)^2\} \div 59 \times 1195{\cdot}4 = {\cdot}5562.$$

So that $\eta = {\cdot}75$ nearly.

A consideration of Table I and the definition of η will show that if there were no dependence, there would be no reason why there should be any (but small random) differences between the means $\bar{y}_x$ and the general mean $\bar{y}$ (*i.e.* theoretically η^2 would be zero). On the other hand, in a case of functional dependence, the numerator of η^2 would become $N\sigma_y{}^2$ and η^2 would $= 1$.

The middle points of the x groups are at 525, 475, and so on. If we erect ordinates $\bar{y}_x = 242$, 229 and so on, at these values of x, we get the *Regression Curve* of y on x. In a very important class of cases this regression curve is approximately a straight line. In such cases, the correlation ratio η (which is essentially positive) is numerically equal to the *correlation coefficient* r (which is positive when x and y on the whole increase together and negative when y decreases as x increases).

This correlation coefficient is defined by the equation

$$r_{xy} = \frac{\Sigma(x-\bar{x})\,(y-\bar{y})}{N\sigma_x\sigma_y}$$

$\bar{y}$ and σ_y have already been found. Similarly we find $\bar{x} = 370$, $\sigma_x = 94{\cdot}7$, while

$$p_{xy} = \frac{\Sigma(x-\bar{x})\,(y-\bar{y})}{N} =$$

$$\frac{(549-370)(243-211)+\ldots+(104-370)(102-211)+(0-370)(100-211)}{59}$$

$$= 2334{\cdot}22;$$

so that $r = \dfrac{2334{\cdot}22}{94{\cdot}7 \times 34{\cdot}6} = {\cdot}71$*

[*η is always greater than r. The difference $\eta^2 - r^2$ is used as a measure of the departure from linear regression. Here $\eta^2 - r^2 = {\cdot}5562 - {\cdot}5041 = {\cdot}052$.]

Psychologists have calculated r more frequently than η, but it is important to note that the value of η is always significant, while that of r may be very misleading if the regression is not linear.

Spearman has proposed a method for calculating the correlation when only the ranks (or order of merit) in the two characters are given. His proposal is to calculate the correlation between the entries in our columns A and B.

This leads to the formula $\rho = 1 - \dfrac{6S(d^2)}{N(N^2-1)}$,

where $S(d^2)$ is the sum of the squares of the differences in rank. Pearson has shown that this formula is always incorrect, but that in the case of *normal distributions* the correct value of r can be deduced from

$$r = 2 \sin\left(\frac{\pi\rho}{6}\right)$$

In our example, β_1 and β_2 for the x's are ·966 and 5·557 respectively: while β_1, β_2 for the y's are 1·408 and 3·654, as compared with the normal values, $\beta_1 = 0$, $\beta_2 = 3$. Thus the distributions are very far from normal.

As a matter of fact, Spearman's formula gives

$$\rho = 1 - \frac{6(17069)}{59(59^2 - 1)} = \cdot 5012.$$

So that Pearson's Formula yields $r = \cdot 5189$, or, say, ·52, which is a very poor approximation to the correct value, which we have already shown to be ·71. L. I.

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SECTION VI

THE PSYCHOLOGY OF THE CLASS

THE older psychologists devoted themselves to the study of the individual, and to the mature individual at that. Recent developments have led to an investigation of the effects produced upon the individual by his intercourse with his fellows. Among the many "selves" recognized by modern psychologists is the "social self," and by the very use of this term they admit the need for a special study of the interaction among egos. From this study has arisen what is sometimes called collective psychology, a science that treats of the nature of man as it is manifested in his relations with his fellows. Its subject is human nature dealt with in bulk.

Experience shows that man's conduct varies according to the person or persons in whose presence he is acting. His nature appears to change according to his social environment. He varies according as we find him at home or abroad, in church or in the market-place. Carrying the matter farther, we are not surprised to find that a man in a crowd will often act in a way that astonishes those who have known him only in his ordinary social reactions. Consequently, the study of crowd activity becomes of importance to all of us, but particularly to those of us who have to deal with humanity in the mass, as is the case with the teacher.

The beginnings of collective psychology are not to be found in the direct study of the crowd. Plato and Aristotle touched the fringe of the subject in their treatment of the relations between the individual and the State. But it is probable that to Walter Bagehot belongs the credit of initiating an investigation into the direct mechanism of the interaction between the individual and the social group in which he finds himself. His *Physics and Politics* marks the beginning of the detailed analysis

that lies at the bottom of collective psychology. In his monumental *Les Lois de l' Imitation*, G. Tarde elaborates the principles that underlie the interactions of social units. Mark Baldwin carries the analysis still further; and in his popular little book, *The Psychology of the Crowd*, Gustave le Bon supplies a presentation that is particularly useful to the teacher, since it definitely introduces a collective unit.

We have to realize that this unit, whether we call it the crowd, the mob, or the class, is something quite different from the elements that make it up. It is very natural to regard the crowd as a mere sum of its constituents. We are apt to think, for example, that we can get a knowledge of the nature of a crowd by the simple process of summing up the qualities of the members of the crowd, and then finding the average. Teachers are, perhaps, specially liable to this fallacy of the average. They have a way of talking about the average pupil as being the sort of person they must keep in view in preparing a lesson; and so long as we confine ourselves to matters of mere instruction, no great harm is done. But as soon as we begin to deal with a group as a psychological unit, we must give up all idea of working by averages. Such a unit differs qualitatively from the elements of which it is made up, and therefore cannot be treated by merely quantitative methods. A group of people gathered together is not necessarily a crowd in the sense of forming a psychological unit. There is no better way of making the point clear than by a comparison between a mechanical mixture and a chemical compound. In the mixture, the individual elements always remain distinct from, and independent of, each other; in the chemical compound, they are so united as to become a new whole. A mixture of pepper, salt, and sand becomes a greyish powder in which each of the constituents remains distinct and unchanged, and can be separated out. A chemical compound of a colourless gas (oxygen) and a silvery metal (mercury) becomes not a silvery gas or a colourless metal, but something totally

unlike both constituents—a bright red powder. The crowd as a psychological unit is something quite different from the mere group of persons of which it is formed. There must be a common interest before a group of persons, however numerous it may be, can be welded into a whole. All the elements of human nature necessary to produce a strong collective activity are no doubt present, but there is need of some force to set them in motion.

The Influence of Imitation. If it is asked why it is that in a crowd individuals will act in a way they would never dream of doing if they were alone or among their ordinary associates, the answer usually given is that the driving force is imitation, which is universally recognized as one of our fundamental instincts. But this explanation is not in itself sufficient. The respectable elderly gentleman on his way home from business can watch with impunity an excited individual shouting and throwing his hat in the air. Here there is a model, but the imitative instinct remains dormant. Yet in a crowd the respectable gentleman has been known to yield to imitation, and send his hat flying with the rest. The model apparently must be supplied on a sufficiently wide scale to produce an effective response. The truth is that the mere effect of numbers, when dominated by a common interest, exercises a positive influence which the individual cannot resist, even though the action imitated is against all his usual habits and prejudices. It does not make matters much clearer to speak of this compelling force as *herd instinct.* We want to know how it is that the members of a collective psychological unit are reduced to a common level. It probably comes about in some such way as this.

In a crowd, all the psychological elements that are present in every individual react upon each other in such a way as to strengthen their force. In collective activity, the universal elements of human nature, as found in each person, fuse with those found in all the others. On the other hand,

all the peculiarities of each individual are opposed by the peculiarities of the other members of the crowd. The result is a process of struggle which ends in the arrest of the activities that might be originated by those peculiarities. By this process of fusion and arrest, individual idiosyncrasies, whether natural or acquired, lose their effectiveness, while the great elemental forces are intensified.

The Application of Crowd Psychology to Teaching. From the crowd, the teacher has much to learn. It is true that crowd reactions are usually much more vehement than anything that occurs in school. But the same influences are at work in the class, and in what is called a crowd or mob. Crowds are sometimes divided into the two kinds, homogeneous and heterogeneous; and it is quite reasonable to describe a school class as a homogeneous crowd. Indeed, it would be difficult to find a better example of this kind of collective unit. The pupils are of approximately the same age; they belong to the same class of the community; they live in the same district; they are subject to the same social and political influences: from the very nature of the case, their academic attainments are practically identical. A school class may, therefore, be reasonably regarded as a special kind of crowd and treated accordingly.

This matter of treatment does, however, differentiate the class from the crowd as ordinarily conceived. As a rule, a crowd is regarded as autonomous. It is not something to be managed from without. No doubt, history supplies cases in which crowds have been deliberately manipulated by political adventurers; but, generally speaking, the crowd is regarded rather in the light of one of the manifestations of Nature—a sort of blind force. It is true that there is always some sort of leadership in crowd activity: but the leadership generally comes from within, not from without. In the class, it is the other way about. Mob leaders are of the crowd as well as in it. The teacher, on the contrary, always stands outside the class, and regards himself as something apart from it. He plays upon the

class as upon an instrument. It has to be noted that in the class, as in the heterogeneous crowd, there are usually class leaders, and of these the teacher must take account. But they are instruments by means of which the teacher manipulates the class, rather than independent forces directing the class on their own account. It occasionally comes to pass that certain of the pupils do come to regard themselves as specifically class leaders, but wherever this takes place we have something abnormal. Such leaders become, by the very fact of their awareness of their rôle, rivals to the teacher. The difficulty does not, as a rule, arise except in dealing with advanced classes, and in their case a safety valve is offered by the system of prefects or monitors. These officials hold an intermediate position between internal and external class-leaders. They are of the class, and on certain occasions are merged into it.

Just as it is dangerous to allow members of the class to exercise conscious control over their fellows without the express delegation of authority by the teacher, so it is undesirable that the teacher should, except on rare occasions, abdicate his external authority and become a mere class leader from within. Some teachers rather like the idea of "losing themselves in their class," but all that they aim at can be attained by avoiding laying emphasis on the fact of external authority. If the teacher could really lose himself in his class, it would become a genuine crowd and forfeit its distinctive features as a class.

If imitation be the driving power of crowd activity, suggestion is the force that guides imitation. A psychological crowd is always in a highly suggestible state. It is for this reason that it is so much in the hands of its more or less deliberate leaders. It is, further, by the use of suggestion that the teacher can manipulate his class with the minimum display of authority.

The Nature of the Class. In order to get at the real nature of the school class, it is well to remember that it owes its origin to economic

considerations. It is an obvious way of communicating knowledge at the least cost. In the first instance, the class existed for the sake of enabling society to spread information. Its aim was instruction rather than training. While the wealthy were able to provide private tutors for their children, ordinary people had to combine in order to get for theirs the advantage of instruction from competent teachers. The gathering of crowds of students at the feet of the professors at the ancient universities strengthened the system of class teaching. But underlying all this was the idea that the class was a compromise between personal instruction by a highly-qualified private coach and no instruction at all. The justifications offered for the huge classes of the monitorial system emphasize this point of view. It was all a matter of how many pupils a master could *teach*. It is not often realized that when we consider education in its wider aspect, as apart from, and yet including, mere instruction, the class may have a positive value in itself. The training the pupils get by the interaction with their fellow-pupils in class counts for much. Class control can be so exercised as either to repress or to develop the individuality of the pupils. Some of the teachers who during the last century elaborated the class system in elementary schools quite realized the value of the collective or class feeling and its effects on the pupils. When they spoke of that mysterious force that they called "the sympathy of numbers," they indicated their recognition of the possibilities of collective psychology. David Stow, in the development of his Training System, laid great stress on this collective sympathy, though he left its analysis to those who were to follow him.

Mr. William Macdougall, in his *Social Psychology*, has set forth a scheme which provides a very promising basis for further investigation into the interaction of individuals in a social group. Basing on the fundamental instincts and their corresponding emotions, and using A. F. Shand's theory of the sentiments, he provides a sort of atomic table

which may be used in the building up of binary and ternary compounds which future writers will no doubt so manipulate as to produce a working guide to the class teacher. In the meantime, we have only the rudiments of a science that has yet to be developed.

Many teachers do not realize that in ordinary school work it is not possible to keep a class continuously at the level of a psychological unit. Before a lesson begins, a class is not usually a collective unit at all: it is a mere group of individuals at the mechanical mixture stage. At the end of the lesson it drops back to the same state, and too frequently at various points during the lesson there is a falling away from the collective unity that real class teaching demands. To be sure, the interest of the lesson is not the only force that can maintain the class as a collective unit. A rebellious class may maintain its unity by the force of the hostile reaction against the teacher. In unwholesome conditions of discipline, the class may have given up all intellectual work and yet be so intensely alive as a corporate body that it deserves to be described as being " in an electrical state."

But in normal healthy class work there are periods when the collective feeling is deliberately dispelled. There is such a thing as a useful, and, indeed, necessary, breach in the collective unity. Occasions frequently arise when the teacher deliberately breaks up the psychological unity and reduces his class to a mere group of individuals, each doing a separate piece of work. A problem is set, for example. In the stating of the terms to the class, the teacher is dealing with his pupils as a unity. So soon as they are set to work out the problem, the class as a unit has disappeared, and has resolved itself into a group of individual investigators. When the teacher by-and-by goes to the blackboard to gather up the results of the work done, and to explain difficulties that have arisen, he has to treat the class again as a whole. This alternation between disintegration and

redintegration ought to mark the class work of every school, but the alternation ought always to follow the will of the teacher. It is the business of every teacher to prevent the class ever, except at his desire, slipping out of the status of a collective unit. Even the best of teachers will find now and again that disintegration has set in without his will, but every such case he must regard as one of his failures.

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SECTION VII

VISUALIZATION

THE investigation of the nature of mental images —and of visual images in particular—began with the researches of Francis Galton. And it would be but slight exaggeration to say that it also ended there; for the account of the variety, intensity, and distribution of visual imagery which he published in his *Inquiries into Human Faculty* in 1883 is still the best and fullest we possess. He gives abundant evidence of the fact that, while some people can imagine a scene almost as clearly and vividly as though they were actually looking at it, others have such dim and vague mental pictures that they even deny that they have any at all.

Visualization and Verbalization. To visualize is to see with the mind's eye—to imagine things seen. In considering its educational significance, we should distinguish between the value of the image as a picture of reality and its value as an instrument of thought. To the painter the pure image is important; to the thinker the symbol. No visual image is really free from symbolism; it always means more than is pictorially presented. Even when it seems a faithful and complete reproduction of a visual experience, an attempt to draw from the image will convince one of its inadequacy. A part has to stand for the whole—to symbolize the whole. In thinking of a ship one man will visualize roughly the whole structure, another merely a sail or a mast, another the sea or a sailor, or something else closely associated in his mind with a ship, another the word "ship" either written or printed. Moreover, there are many who would not visualize at all, but would imagine themselves hearing or speaking the word "ship." Indeed, the same person may experience all these and other varieties according to the context of the

word and the train of thought into which it enters. Thus we have in the image a part symbolizing the whole: one thing symbolizing another with which it is essentially connected, and one thing symbolizing another with which it is only conventionally connected. There is a gradation of imagery between two extremes, with the full picture at one end and the bare word at the other; and all influences that change mental imagery tend in the direction of pictures or in the direction of words. Is it the duty of the educator to encourage one of these tendencies at the expense of the other, or is it his duty to foster both? The ideal mind would be so richly endowed that it could use each of these powers for its own particular purpose; and there is little doubt that the ordinary mind often varies the two functions; but there is reason for thinking that to feed the one is, to a certain extent, to starve the other. One of Galton's most startling discoveries was that eminent men of science do not visualize, they verbalize. It is true that the meanings of the two words are not mutually exclusive, for we can visualize a printed page or a manuscript; but, generally speaking, when we think in words the images are either auditory or motor. Verbalization is here used as complete symbolism, the opposite extreme to the full reproduction of a primary expression.

It would be of great educational advantage if further investigations were made on the same lines as Galton's, with the object of discovering what type of mind, what modes of thought, what special aptitudes and interests, went along with the powers of vivid visualization of the reproductive kind. It is well-known that Macaulay's remarkable memory was largely visual, but we have no evidence that it was other than a visualization of the printed page: we do not know that he thought in pictures. It is said that the volubility with which he delivered his parliamentary speeches hitched and halted where his original manuscript was indistinct. He was really reading his speech from a mental image. A capacity of this kind is extremely rare,

and is a natural gift, not a cultivated faculty. Some years ago I made notes of the imagery of some of my friends, and arrived tentatively at certain conclusions. Booky people, quick-witted people, shrewd people, had visual imagery which was very scanty and schematic. Those who claimed to have abundant and vivid pictorial images seemed to be of a different intellectual type. They lacked a sense of humour, they were not " quick in the up-take," and their style of literary composition was inclined to be florid and lacking in logical coherency. These generalizations are based on a small number of instances and merely indicate lines of possible inquiry. If more extensive research bore out these provisional theories, it would discourage indiscriminate attempts to cultivate a purely pictorial imagination. Not that a pictorial imagination is of no value (it most certainly is; and as a source of intellectual pleasure it is difficult to over-estimate it), but it is probably desirable to counterbalance this form of mental process by a more severe form of conceptual thinking.

Cultivation of the Faculty of Visualization Questionable. These are two pertinent questions; first, is it possible to improve a person's natural powers of visualization? Secondly, if it is possible, is it desirable ? And in reply to neither of these questions can an unqualified " Yes " be given.

As to the possibility of cultivating the faculty, Galton believed in it and cited instances; certain drawing masters believe in it and make it a direct aim in their teaching; the plain man believes in it as a matter of course: to doubt it seems to him sheer folly. And yet doubt it we must. For when the matter has been put to the test of rigid experiment the result has been negative. It is not a question of habitually slowing down one's thinking so as to give what usual images we are capable of time to develop: it is not a question of dwelling upon a topic until all its pictorial adjuncts have had time to emerge in the mind. That such mental habits can be acquired will readily be conceded. The real point at issue is whether the utmost one can

do in visualizing to-day can be so improved upon by practice that we can, as a result of such practice, visualize at some future time more easily, more vividly, and more faithfully. That drawing from memory can be cultivated has been abundantly demonstrated. M. Lecoq de Boisbaudran, perhaps the greatest drawing master of modern times, based his success mainly upon the practice he gave his students in drawing from memory a picture or scene which they had previously studied. Mr. R. Catterson Smith, late Director of the Birmingham Art School, achieved much success in training his students to design by getting them to draw with their eyes shut—to draw from an image definitely visualized. Much improvement in drawing took place in the experiment made by Mr. W. S. Foster on the effect of practice on visualization and the reproduction of visual impressions. In this case the three observers were trained psychologists; and, after forty hours' practice distributed over ten weeks, while all three improved in the power to draw from memory, none could discover the slightest improvement in visualization. Progress seemed to be accompanied by greater reliance upon verbal cues—upon mentally describing the thing observed, its colour, proportions, and the relations of its parts. Here we have an experiment in memory drawing, an experiment which seemed to make a special demand on visualizing powers; and yet the outcome is an increased use of verbalization and a diminished use of visualization. Does it not raise a suspicion that all mental training, whatever its nature, makes for verbalization? There seems to be little doubt that ordinary teaching devices tend to foster symbolic rather than pictorial imagination; for the teacher endeavours to make his pupils think—to get their minds to work most efficiently. And for rapid and efficient thinking an abundance of imagery of any kind seems to be an encumbrance. The scantiest and the most schematic and symbolic images serve its purpose best. Galton has pointed out that visual imagery may be almost

entirely lacking in painters of the rank of Royal Academicians.

There is yet another way in which the mind economizes its energy in thinking; it uses the type of imagery (visual, auditory, kinaesthetic, etc.) most characteristic of the thinker and most natural to the topic. To try to induce a man of the auditory type to visualize things which he would naturally "auditorize" would be injudicious; to try to induce anybody to visualize an air from an opera would be more injudicious still.

It seems difficult to avoid the conclusion that in training the mind to think purposively, or—which is the same thing—to solve a problem, we cannot wisely interfere with the mechanism by which it does its work. In developing mental skill, the attention should be fixed on the goal to be attained: the mind itself will spontaneously supply the most speedy and economical means of reaching the goal.

The Desirability of Exercising the Faculty. This, however, is not the whole of the matter. For there are types of mental activity besides those which come under the head of thinking proper, In reverie or day-dreaming, and in the contemplation of a work of art, in listening to music or reading poetry, there is little or no purposive thinking; and it is here that mental pictures are obviously useful. Much of our enjoyment of poetry depends upon our being able to repicture in our minds the poet's imagery. It is, perhaps, possible to foster an appreciation of poetry in pupils by inculcating a habit of reading slowly—of looking for mental pictures and giving them time to form themselves before the mind's eye.

It will be seen that it is impossible in the present state of our knowledge to adjudge the precise value of visual imagery in one's mental make-up and one's mental processes; and to say how it is possible to improve one's natural powers of visualization. It seems certain that the current methods of education—no less than the education afforded by practical life and scientific pursuits—tend to impair the faculty; and it is at any rate

worthy of consideration whether the interests of artistic production and appreciation do not demand pedagogical devices directed towards fostering a visualizing habit in at least some fields of mental activity. Much experimental work must, however, be done before we can arrive at any authoritative body of doctrine in this matter.

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SECTION VIII

THE DEVELOPMENT OF REASONING IN CHILDREN

REASONING may be defined as the process whereby the mind passes from one or more judgments (called the premises) to a new judgment (called the conclusion), which the former are seen to imply. The psychological nature of this implication is obscure. The mind may be regarded as controlled throughout its procedure by what may be described, according to the epistemological standpoint adopted, either as *a priori* logical principles ("laws of thought"), or as empirical conventions and habits assumed to be conducive to true knowledge. Except in its most primitive forms, reasoning is impossible without symbols—such as words, figures, diagrams, etc.—which represent objects of thought and their relations, and which enable attention to be focused upon highly abstract or highly complex aspects of experience. The classical example of reasoning is usually cited in the following so-called syllogistic form: "All men are mortal; I am a man; therefore I am mortal." The instance, though time-honoured, is misleading. Reasoning, as a psychological process, seldom commences with a major premise. Indeed, major premises, even where logically implied or assumed, are as a rule suppressed. Reasoning is instigated by a problem, commonly formulated as a question. The conclusion forms the answer to this question. And the whole process, so far from being purely cognitive (or intellectual), has a strongly conative (or purposive) element running throughout. A specific interest starts and sustains every train of reasoning. Further, in the initial discovery of the problem there is a marked emotional element, mildly unpleasant or unsatisfying; and the emotional element is equally marked in the discovery

of the solution, being then somewhat of an aesthetic character, mildly pleasant and satisfying. The whole process may perhaps be regarded as an acquired reaction to a mental conflict, largely developed from, and motivated by, an inherited instinct—such as the hunting instinct, with its correlative emotions of curiosity and wonder, operating in a highly modified and sublimated form.

The Nature of the Reasoning Process. In the reasoning of the child these purposive and emotional aspects, due to instinct and interest, are vividly accentuated. The realization of this fact has recently begun to tinge with a practical and concrete colour the teaching of abstract subjects, such as algebra and trigonometry. Before expecting a child to reason, we now require that he should see the difficulty which demands the exercise of reason; and express that difficulty clearly in the form of a question. He should watch that his final conclusion really answers the question with which he set out, and so solves the difficulty which first aroused his interest.

Reasoning, then, like every mental process, is a reaction to a stimulus, a response to a situation. It proceeds by association; and may be regarded as characterized by associations of a particular type, peculiar to man as distinct from other animals. In the first place, the successive thoughts or images are not recalled haphazard through free association (as in reverie or day-dreaming); their reproduction is controlled by the "determining tendency" (*Aufgabe* or "task") which initiates the whole process. Further, in the most explicit forms of reasoning, we seem immediately to apprehend, not only the ideas or objects associated, but the relations between them—the manner in which they are associated. In judging "A is to the right of B" (or "is similar to B"), I can in succession attend to and perceive not only A and B, but also the relations between them; similarly, in judging "B is to the right of C." From two such propositions, I proceed to infer—"A is, therefore, to the right

of C." In so doing, I apprehend the whole relevant system of space-relations of which A – B and B – C form part; and "see" (as we say) that the first two relations, falling within this system, necessitate the third and last. It is the inability to perceive relations, and the consequent confinement to chance associations due to contiguity in time, or to partial identity between percepts, that render animals incapable of reasoning. In the child, the growth of reasoning consists essentially in the development of the former capacity out of the latter.

The more primitive forms of reasoning are based upon association by similarity. This does not mean, in the simplest cases, that the immature reasoner is aware of the similarity, or attends to similarity, as above suggested; but simply that the second object perceived, in virtue of its partial identity with, or resemblance to, the first excites, as a whole, the same neural system as was previously excited by the first object. The inference is thus implicit, not conscious. A child of 2 or 3 who has been ill-treated by a person characterized by some striking peculiarity (for example, short stature) will turn away in dislike from all other similar persons. Later, at the age of 4, he may, like the child in the Worcester collection (*see* below), explain that he expected C D would be cross, because she was short like his cross nurse A B. The child here argues, not from the particular to the general, nor from the general to the particular, but from the particular to the particular. Such " reasoning by analogy " is perhaps the commonest feature of the child's first intellectual efforts, as it is of the intellectual efforts of the savage. This is one of the results that emerge most clearly from the early collections of children's reasonings. The process leads to unexpected deductions, such as that drawn by the little boy who said that he was 6 when he stood on his feet, but would be 9 if he stood on his head, because 6 upside-down makes 9; or that implied by Sir John Lubbock's little girl, who said to her brother: " If you eat so much goose, you will get silly "—an inference which might be

closely paralleled by many a savage custom. Many of these analogies consist in little more than ignorant play upon words. Stanley Hall's inquiries found children who believed butter came from butterflies, grass from grasshoppers, and kittens from pussy-willows. It was this analogical character of children's reasoning that suggested the test now known as the "Analogies" test, where a relation discerned between two given terms (*e.g.* black–white) has to be applied to a third term (*e.g.* bad) to deduce a fourth term which is not given.

The earliest studies of reasoning processes in children consisted in collecting observations either from large numbers of children of different ages (for example, the 500 records gathered in the Worcester State Normal School, Massachusetts), or from one or two children closely observed during their early development (for example, Professor Sully's *Studies of Childhood*). Later investigators, beginning in this country with an inquiry of Professor Holman and the Child Study Society, employed tests involving problems either in arithmetic or in everyday matters.

Experimental Investigations. The interest in tests of general intelligence gave a new impetus to reasoning-tests. An investigation attempted by the writer, for example, showed that tests of reasoning —such as finding opposites, working out analogies ("rule of three" in words), criticizing absurdities, inserting missing words in a mutilated argument (*e.g.* the opening paragraph of Bacon's *Essay on Revenge*), drawing conclusions from premises stated in syllogistic form—gave a far higher correlation with general ability than the older tests of simple sense-perception or simple motor activities.

Experimental investigations, however, carried out by means of tests such as those specified, are still urgently needed. The following are perhaps the more important of the conclusions so far reached.

All investigators are agreed that the reasoning efficiency of children develops progressively with increase of *age*. There have been, however, scarcely any inquiries carried out with a large number of

problems upon a large number of children representing a large range of ages, in order to determine in what precisely this development consists. The samples appended to this article illustrate the type of problem an average child may be expected to solve at each age. It will be noticed that the difference is quantitative rather than qualitative. The development of reason does not consist in the successive comprehension of one type of inference after another. The appreciation of a given logical form does not emerge at one definite age or stage. Rather the development consists in the power to co-ordinate an ever-increasing multiplicity of data in a single systematic whole. A problem appropriate to age 7 may be made appropriate to age 14, not so much by altering its form, as by increasing its complexity. An analysis of children's compositions and essays yields a similar result. They pass from simple disconnected sentences to sentences joined by " and "; later, temporal conjunctions are introduced (" when," " while "); then casual (" because "); later, still conditional (" if," " although "). Interest passes from motive (" what for ? ") to cause (" why ? ")—at first, anthropomorphically conceived (" what makes it do so-and-so ? ")—then to mechanism (" how ? ") and, finally—if at all—to predisposing and exciting factors duly distinguished. This, however, is not because the child is incapable of appreciating causes or conditions at an earlier stage; but rather because he has difficulty in attending to such a complexity of relations as causal and (even more) conditional conjunctions imply. Almost all the mental mechanisms essential for reasoning appear to be present before the child leaves the infants' school (*i.e.* at the mental age of 6 or 7, if not earlier). Development consists chiefly in an increasing interest, extension, refinement, and control in their employment.

Many observers state that the development of reasoning is spasmodic rather than uniform. Hancock, for example, found errors in arithmetical reasoning decrease most rapidly at 9, 13, and 15.

Between these stages he often detected an actual loss of power. The approach of puberty is marked by an accelerated development of spontaneous intellectual activity, manifested in the increased interest in puzzles—mechanical, geometrical, and linguistic—and in other forms of intellectual play. About the age of 12, too—somewhat earlier in girls, somewhat later in boys—the critical spirit enlarges. The curve of doubt, disbelief, and argumentation begins a very rapid rise. At first this spirit insists only upon a single test of validity; even as far as the seventeenth year, a single coincidence is readily accepted as a proof among well-educated adolescents. Many never pass beyond this stage. Mathematical tests in secondary schools suggest that an increase in logical activity at the stage of mid-puberty is accompanied by a decrease in mechanical accuracy. Older writers connected this enlargement with the accelerated development of the " association-fibres," particularly in the frontal and parietal areas of the brain-cortex. Wernicke, for example, noted a marked increase in the medullation of the systems of " nerve-fibres " at the age of 12. Very little, however, is known of the physiological basis of intellectual activities. The true cause of the development is probably to be sought, not in the sudden ripening of a new faculty, but in the heightened interest in and extended use of a pre-existing capacity, suppressed hitherto by the authority of school and home, and now called into play by increased freedom and independence.

Individual Differences. All investigators have been struck by the wide range of individual differences. In a random sample of a thousand London elementary school children aged 10, the brightest proves able to solve problems which can only be answered by the average child of 14; the dullest is unable to answer those which can ordinarily be solved at the age of 6 or 7. Since the tests employed are constructed so as to depend as little as possible upon any special fund of learning or form of skill, acquired at school or at home, the differences may be regarded as for the most part innate. Education

still tends very largely to ignore these peculiarities. It leaves them untrained, unexploited, unexplored. Dull children are confronted with problems and methods of reasoning that are well above their intellectual level, often above any level they can ever achieve. Bright children do not receive material sufficiently hard, complex, varied, or progressive, for them to advance at the speed of which they are capable. Several writers attribute the temporary decline of reasoning powers to premature forcing of immature individuals, and to insufficient exploration and utilization of the powers of the more mature. Of all practical corollaries drawn by different investigators, this criticism is perhaps the most important and the most constant.

Sex Differences in reasoning are small. This conclusion is reached by nearly all investigators who have applied tests of reasoning to children of both sexes. "There is no general superiority on the part of the male sex, as is often asserted. Rather, specific instances of masculine superiority are counterbalanced by specific instances of feminine superiority" (Cohn and Dieffenbacher). "On the whole, the resemblances between the sexes are far greater than the differences" (Bonser). Practically all inquiries have disclosed a superiority on the part of the boys in mathematical work, especially in mathematical reasoning. In scholarship examinations where mathematical papers are included, it is found that female scholarship winners gain fewer marks in arithmetic than male, but more in literary papers. A recent analysis of replies sent in by members of the inspectorate in Scotland, where mixed schools are more general, indicates that the difference depends largely upon extrinsic factors—differences in interest, in teaching efficiency, in standard of work required, in the time devoted to the subject, and in the curriculum generally: but that it is, nevertheless, to a small though discernible extent, due to inborn peculiarities, which reveal themselves increasingly with increase of age. According to several of the

correspondents, the arithmetical inferiority of the girls is more marked in problem work, in adopting new methods of analysis, in intellectual initiative and enterprise, in reasoning by progressive logical steps; but in other respects (in accuracy, memory-work, mechanical routine) they are equal to the boys, if not superior. An extensive survey with psychological tests shows that these peculiarities very largely characterize the reasoning of the two sexes in non-scholastic work generally. The differences fluctuate somewhat with age. Before the age of 7, no differences in reasoning power are discernible, except such as may be directly due to the girls' superiority in the appreciation and use of words. From 7 to 11 the boys are slightly superior. Towards the age of 13, girls are temporarily superior. As adolescence is completed, the male sex again becomes superior. The differences, however, are very largely due to differences in the traditions and experience of the two sexes. Further, in different aspects or elements of reasoning, the sex-divergences are differently manifested. Where the solution of a problem depends upon grasping the meaning of words or expressing meaning in words, girls are favourably handicapped, though their solutions are apt to be wordy and diffuse. Where the problem is presented in mechanical form (*e.g.* in reasoning out the working of a piece of apparatus), the boys surpass the girls. Girls excel in the imaginary construction of situations or concrete hypotheses, in jumping to presumptive conclusions, in patient and persevering analysis, in attention to minutiae and detail. Boys tend to be more methodical in thought and more critical in their inferences. (An examination of the differences in reasoning power between the two sexes, as compared with the differences manifested in other mental functions, will be found in the *Journal of Experimental Psychology* Vol. I, Nos. 4 and 5, especially pp. 375–378.)

The Influence of Education upon reasoning is difficult to determine. One of the earliest investigators concluded from his tests that "education

improves this faculty, grammatical and mathematical studies both telling their tale." The doctrine of the limitation in the transference of improvement due to practice—a doctrine now generally received—stands in strong antagonism to such a view. Reason is not a simple faculty to be trained by repeated exercise in the special gymnasium of mathematics or grammar. It is a highly complex function of the mind working as a whole, quite as much as through special capacities. Very largely it depends for valid results upon a definite technique—a habit of methodically forming and testing conclusions, and avoiding common fallacies—a technique or habit which admits of formulation just so much as the principles of literary composition, and which is doubtless teachable to much the same extent and by much the same means. The invalid reasoning of the young child is due not as much to the immaturity of a slowly developing faculty, as to the limitations in its knowledge, in its experience, in its environment, in its familiarity with language as an instrument of conceptual analysis and synthesis, in its power to organize or integrate a multiplicity of percepts and ideas into a complex systematic whole, and finally in the practical needs which force mental constructions to conform to objective fact rather than to subjective fancy. Present systems of instruction endeavour to teach reasoning through but one or two kinds of subject-matter, which are highly abstract, and remote from the concrete daily experiences and interests of the child himself. An inquisitive and independent child will learn more of reasoning from reading well-written detective stories, investigating machinery, reproducing conjuring tricks, arguing with another companion or debating in class—especially if the topics be widely varied—than from all the mathematical lessons of his whole school career.

Graded Tests exemplify the type of material that may be used for testing reasoning, and probably for training it; and at the same time, illustrate the average level to which the reasoning powers attain

at the ages specified. Each problem is taken from a set of five, which, in turn, are selected as answered by approximately 50 per cent. of ordinary town elementary school children at the several ages—

"7 *years.* Kate is cleverer than Mary; Mary is cleverer than Jane; who is the cleverest—Kate, Jane, or Mary?

"8 *years.* I don't like sea voyages; and I don't like the seaside; I must spend Easter either in France, or among the Scottish Hills, or on the South Coast. Which shall it be?

"9 *years.* Three boys are sitting in a row; Harry is to the left of Willie; George is to the left of Harry. Which boy is in the middle?

"10 *years.* There are four roads here. I have come from the South and want to go to Melton; the road to the right leads somewhere else; straight ahead it leads only to a farm. In which direction is Melton—North, South, East, or West?

"11 *years.* Where the climate is hot, aloes and rubber will grow; heather and grass will only grow where it is cold. Heather and rubber require plenty of moisture; grass and aloes will grow only in fairly dry regions. Near the river Amazon it is very hot and damp. Which of the above grows there?

"12 *years.* Field mice devour the honey stored by the humble-bees the honey is the chief food of the humble-bees. Near towns there are far more cats than in the open country; cats kill all kinds of mice. Where, then, do you think there are most humble-bees, near towns or in the open country?

"13 *years.* 'Iron nails will not float in a pool. A cup of pure gold dust weighs nearly twenty times as much as a cup of water of the same size. If you drop a silver sixpence or a copper coin into a puddle, it will sink to the bottom. A cubic inch (about a tablespoon) of water weighs less than half an ounce. A cubic inch of brass weighs over two ounces. A leaden

weight will drop to the bottom of the ocean.' Sum up all these observations in one short statement of the following form: 'Most . . . are . . . . . .'

"14 *years.* John said: 'I heard my bedroom clock strike yesterday ten minutes before the first gun fired. I did not count the strokes; but I am sure it struck more than once, and I think it struck an odd number.' John was out all the morning; and his clock stopped at 5 to 5 the same afternoon. When do you think the first gun fired?"

Additional tests will be found in the articles cited below from the *Journal of Experimental Pedagogy* and the *British Journal of Psychology.*

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PART II

SECTION IX

CHILD STUDY

Child Study as a separate and also an important branch of education was first organized and developed under the direction of Dr. G. Stanley Hall, President of Clark University, U.S.A. In connection with the World's Fair, which was held at Chicago in 1893, an important Education Congress was held, and a number of British teacher-delegates attended. The section which dealt with child study was presided over by Dr. Hall, and three of the British women-teachers here came under the inspiring influence of Dr. Hall, and of Professor Earl Barnes, who, later, materially helped the growth of the child study movement in Britain. They returned home thoroughly imbued with the need for, and usefulness of, such study, and, with the help of influential educational and medical friends, they founded the "British Child Study Association" in Edinburgh at the University Extension Summer Meeting of 1894. Branches were afterwards opened in Cheltenham and London. From the first, the medical profession has been keenly interested and influentially helpful; while teachers, parents, doctors, school managers, inspectors, and social workers form the bulk of the members. In 1898, through the efforts of the late Mr. H. Holman and Mrs. Langdon Down, the Association was placed on a sound constitutional basis, and the branches affiliated. The affairs of the Association are now managed through a Central Council, composed of delegates from each branch, or "Constituent Society." Thus unity of aim and centralization of results were secured, without interfering with the adaptation of diverse interests consequent upon the special environment of each

separate branch. Branches were later formed at Derby, Newcastle, Manchester, Birmingham, Liverpool, Dundee, Halifax, Tunbridge Wells, and the Hartlepools. The Annual Conference of the Association, attended by the delegates from the constituent societies, is usually held in May, at the different centres in turn. The present title is "The Child Study Society," and the headquarters are at 90 Buckingham Palace Road, London, S.W.1, where the lectures and discussions arranged by the London Society take place.

In 1905 the Child Study Association began to work in co-operation with the Childhood Society As both societies had similar aims, and in many respects covered the same ground, it was felt a waste of energy and organization to continue two sets of lectures, when both societies would be strengthened by co-operation. Accordingly, a joint committee was appointed to draw up a programme of arrangements. Through the efforts of a President of the London Society, an active and generous co-operation with the London University Extension Board was brought about, and a three-years' continuous course of lectures on "The Evolution of Mankind, as seen in the Child and the Race," was arranged and successfully carried out.

Aims. These were originally stated to be : "To interest parents, teachers, and others in the systematic observation of children and young people, with a view to gaining greater insight into child nature, and securing more sympathetic and scientific methods of training the young."

In 1902 this was further expanded so as to read as follows : "The Association seeks to interest parents, teachers, and medical men in the study of children, in the belief that it is only by a more precise knowledge of the natural process of unfolding of the human mind, and of the way in which this can be modified by the environment, that further advance can be made in elucidation of the principles of a natural and sound education."

The different opportunities of these three classes of interested persons suggest different modes of

approaching the problem, and all methods of exact and intelligent research are welcomed, provided they do not conflict with the well-being of the child. The studies hitherto made, besides throwing light on the mutual relations of bodily and mental growth, and the moral development of childhood and adolescence, serve to provide material for a science of genetic psychology, and are found to have an important bearing upon many social questions.

Dr. Hall has well summed up some of the benefits of child study in the following extract: "It has brought together higher and lower grades of education, and tends to mark the unity of educational systems. It has distinctly helped to bring the teacher *en rapport* with individual pupils and has helped towards the discovery of nascent periods, when the individual subjects can be most effectively taught. It has brought together parents and schools in many interesting ways; it has increased the love of children, has lessened the number of misunderstood children, and has taught us to recognize the superior law of the nature and needs of childhood."

Methods. Various studies and special pieces of investigation have been undertaken by members of the Society and reported from time to time in the magazine *Child Study*, and elsewhere. Others were taken up under the direction of Professor Barnes, and published fully in his *Studies in Education*. The chief work of the Society is the organization of courses of lectures by men and women who are authorities on child study and general education. These lectures are usually followed by interesting and suggestive discussions. Further investigations of a given problem—by the aid of *questionnaires*—are undertaken and reported upon, and Circles are held for reading, study, and investigation. Studies are made of individual children, or of groups of children or young people, and the results given. Visits are organized to places of special interest in connection with the particular problem being studied; while occasional social gatherings give opportunity for members to become acquainted, and to exchange views and

experiences. Pamphlets dealing with special phases of the work are, from time to time, published by the Society (*e.g.* "How to Conduct Study Circles "). Since 1899 the Society has published its own magazine, at first entitled *The Paidologist*, but latterly *Child Study*. The Society possesses a valuable library, which contains many books, papers, and magazine-literature dealing with child study; it is free to members.

A useful bibliography of books and articles bearing upon child study is published annually by Dr. L. N. Wilson, the Librarian of Clark Library, Worcester, Mass.

SECTION X

OBSERVATION OF CHILDREN

THE present day insistence on direct observation of the conduct of children as the source of the *data* for a child-psychology and a theory of training is the consequence of dissatisfaction with a theory based on the analysis of adult states of mind and formal static theory. Till comparatively recent years, the child was regarded as an adult in miniature, and growth as a regular and proportionate development of parts and faculties until maturity is reached. But the physiologist found that the child is by no means an edition in small of the adult, with all his organs complete, and in size and function bearing the same relation to one another as they do in the adult. Moreover, the theory of recapitulation came to be applied beyond the strict limits of the physical embryo. Hence was made possible a science of mental embryology, which provides the observer with a firm theory whereby the life of the child can be mapped out into a number of well-marked stages. Yet this theory must not be used arbitrarily. Child-study is objective, and its *data* are found in the conduct of children—of normal, free, and happy children, as well as of exceptional ones.

The Methods of Observation may be arranged in two groups: the first, physiological and anthropometric observations, being directed to the physical organism—stature, weight, and build—and the outward signs of abnormal development, both physical and mental. From the results, norms of growth and development are being established, so that the comparison of the measurements of any child with the norm may lead to useful suggestions for dieting or remedial treatment.

The second group of methods consists of attempts to discover the laws of growth of the mental nature of the child. The broad aim of the study is to

build up a series of mental types which will illustrate the main interests of a child at any stage of growth, the order in which the instincts and emotions break through into life, the incidents and things to which these become attached, the sentiments under which they become organized, and the ideals belonging to those sentiments. If we know these, the effective determinants of the child's conduct, we have some light on the meaning of his behaviour. We can find them out by setting children to express themselves in response to definite suggestions under notable circumstances; and again by unobtrusive observation of them in a state of freedom from direct control or suggestion of parent, teacher, or school conditions. This analysis of concrete instances of response and invention will be tested by comparison with what the observer can recall of his own early interests, moods, and desires. Autobiography will help and suggest, as, in a lesser degree, will fiction and the artistic interpretation of childhood. So also will, to some extent, biography. Methods of observation which aim at the establishment of standards of achievement, either in general mental ability or in subjects of instruction, are included here. The Binet-Simon tests may be taken as typical of the former kind of inquiry; the attempts to secure norms of performance in arithmetic, reading, and spelling—of the latter. This second example requires the application of known statistical laws to a large number of individual responses. Students of child-life are not agreed as to the value of the child's own introspective accounts of his mental operations, though these are of use to the observer as evidence of susceptibility to ideas and personality.

SECTION XI

THE VOCABULARY OF A CHILD

A CHILD possesses at birth the physiological mechanism of speech, and a tendency to use his vocal organs, but language is the product of development, in the individual as in the race. The infant's cry speedily becomes differentiated into sounds that express such primitive emotions and wants as hunger, pain, anger. At three or four months begins the period of babbling or vocal play. These vocal gymnastics serve as raw material for the later evolution of articulate speech. During the second six months of life, developing consciousness of his environment and the emergence of the imitative impulse lead the child to attend to the sounds uttered in speech by those around him, and to strive to reproduce them. Imitation is an enormously important factor in the child's acquisition of words, as is also his discovery that words are an effective means of obtaining satisfaction of his desires.

By the end of the first year, the vocabulary of the average child is limited to less than a dozen words. Names of the articles of his food and dress, of actions that he performs, of things and animals that especially attract him, terms expressing primitive social relationships, are the constituents of infant vocabulary. Since the muscles concerned in voice production only gradually attain coordination, a young child's pronunciation of words is very defective.

An important limiting factor in a young child's vocabulary is the small span of his consciousness. Space for him is confined to the " here " and time to the " now." Hence at first words serve merely to direct attention to objects and occurrences that are actually present. The development of the

power of forming images enables him to begin to realize the absent, the past, and the future, though, of course, within small range in the first two or three years of life. With the growth of memory and imagination, words become of increasing value to the child in social intercourse, and, as a result, his small store is rapidly enriched.

Lines of Growth. The limitations of a young child's vocabulary drive him to eke out his verbal poverty by the plentiful use of gesture, intonation, and facial expression. For the same reason he makes a single word do duty for an adult's entire sentence. *Up*, to the attendant adult, accompanied by significant gestures, means "Take me up"; *Ball*, cried in angry tones to the rival possessor, signifies "Give me the ball."

Again, the limitations of a child's vocabulary are apparent in his application of words to objects or experiences to which they are inapplicable. *Pussy*, to one child, indicates the domestic cat and also his mother's fur coat; *daisy*, to another child, means all flowers, while *dada* is commonly, at first, the general term for all men. Darwin's grandchild applied the word *quack* to a duck; then extended the term to the water in which the creature swam; then to all birds, insects, and liquids. Other examples will readily occur to all observers of young children. Generally it is objects associated together in the child's experience, or between which he discerns some likeness, that receive the same name. Increased experience and growth in analytical power impel him to attend more closely to differences and distinctions in the things around him. More words are necessary to express these distinctions, and so his vocabulary is enlarged.

Social pressure aids largely in the process. People laugh at his blunders, correct him, direct his attention to unnoticed features in the object, give him the right word, and the native tendency to social conformity assists in the widening and shaping of his vocabulary in accordance with conventional standards.

As has been previously pointed out, it is concrete terms, names of things and their more interesting qualities and actions, that form the preponderating elements in a young child's speech. *Hot, cold, sweet, nice, big, little, eat, drink, walk, dance,* occur before terms like *yesterday, heat, colour, size,* and similar expressions. Adverbial expressions, except simple terms for time and place, are relatively late in appearing, as also are prepositions and other relational words. The place of such words is taken by gesture. Expressions like *up, down, on, under, and,* occur before such as *except, unless, toward.* Early speech has no pronouns. *I* and *mine, you* and *yours, he* and *his,* etc., do not occur normally till about the beginning of the third year. Pressure on the adult's part and conscious imitation on the child's gradually extend his vocabulary to the pronouns and the correct inflected forms of the verb.

Individual Differences. Records of children's vocabularies have been made, and they indicate rapid acquisition of words in the latter part of the second year, and during the third year. A child of two may not use more than twenty or thirty words, but it is more probable that he will employ 200 or 300 or more, and the vocabulary of a child of three in an educated home may contain over 1,000 words.

School activities, and especially reading, bring new elements into a child's vocabulary. But mechanical teaching and the use of uninteresting reading-books militate against language growth in the pupil. The close connection of practical experience and concrete objects with their verbal symbols is continually necessary in the early years of school life, as is also the practice of oral and written verbal expression on the part of the child. In all stages of education, the growth of ideas involves extension of vocabulary, while an enriched store of words tends to the classifying and stimulating of thought.

SECTION XII

THE SIGNIFICANCE OF INFANCY IN EDUCATION

THE pre-eminent importance of early life as a formative period is universally accepted. That it is important psychologically in inverse ratio to the age appears increasingly probable, but is by no means as obvious; indeed, the common belief would appear to be to the contrary if one may judge by the usual practices of those in whose hands lies the arbitrament of the first years. Less training and skill are demanded of the first educators of babyhood than of their successors. Less care is exercised in controlling the indirect influences which bear upon the somnolent, unobserving infant than is deemed necessary in the case of older children. Before the unconverging gaze of baby eyes, and within the hearing of unheeding baby ears, are said and done many things that few of us would venture in the presence of an inquisitive child of 8. Yet it is not improbable that the sensory impressions then recorded in the nervous system both reinforce by summation the "core," and also provide material for the "fringe" of later perceptual images, thus determining which elements in the environment (of all those competing) shall claim and hold the attention; and consequently which of the manifold possible reactions shall, through repetition, acquire ascendancy in the future.

The contention that the earliest years, indeed the earliest months of life, are of supreme importance from the educationist's point of view is found to gain support from several sources, including some of the most recent fields of modern research. To begin with, the most evident tradition and observation emphasize the importance of impressions made on the plasticity of the immature. This point of view is expressed in the familiar idea that, as the twig is bent, so the tree grows. The pleasure or

unpleasure which given experiences will produce in the young child, the type of behaviour which will consequently become habitual to it, are not these initiated in the cradle?

On *à priori* grounds, too, the hypothesis that ontogeny repeats phylogeny being granted, is it not to be expected that during those short years, into which are compressed untold ages of phylogenetic experience, the elements of the personality-to-be being so labile, as well as so numerous and so diverse, there would be every chance of modifying profoundly the combinations of those multitudinous elements, which shall result—did we know more of the laws of mental growth and functioning.

What is Infancy? The length of the period designated by the term "infancy" varies considerably. Taken in its widest sense, the arbitrarily determined limit of legal minority terminates it abruptly. Regarded from a biological angle of vision, it may be taken to cover the period of the first dentition. Acute observers of human nature have long claimed the first seven years of life as the essentially formative ones, during which are laid the entire foundation of the *possible* future superstructure. Certain other authorities, again, define infancy in a narrower sense, severally preferring five years, four years, two years. For the purposes of the present consideration, the narrowest of these limits is intended, namely, that of about two years. This must, however, be regarded as a rough approximation. It should be taken to cover a period varying somewhat in duration in different individuals, and not delimited from the succeeding one by any sudden change, yet marked by characteristics both physical and psychological which distinguish it from the period immediately succeeding it. Wherein precisely these changes reside and what are their causes are among the problems awaiting investigation.

The Evidence of Psycho-Analysis. In pursuance of the thesis that the psychological care of infancy is of paramount importance for the future of the

individual, we now pass from general and *à priori* considerations to evidence contributed by researches which may claim to be regarded as scientific in method. Although this description may be disallowed by some in the case of a recent development in psychology, a promising method of investigating the subconscious infantile material stored in the mind is nevertheless afforded by the exact technique known as psycho-analysis. Through the application of this method, early percepts, early concepts, early emotions, and early conative trends are brought up into consciousness, laid bare for the introspection of the one who originally experienced what is now fragmentarily reproduced. With an overwhelming insistence, the mass of psycho-analytic *data* speaks for the determining force of the earliest situations—those situations, for example, concerned with the often painful process of infantile efforts at motor self-control, whether of sphincters, the muscles of locomotion, or of facial or vocal expression, to say nothing of the social pressure during the short but urgent recapitulation of the long and tedious phylogenetic stages of "coercion to domesticity!"

Similarly, ineffaceable traces are left by the earliest experiences of the "not-I," of the properties of inanimate objects (strangely reminiscent of the animistic beliefs and magical practices of the races of the lower culture!), of the qualities of the Woman, the Man, the other Child, and the Animal, which by association laid the foundations of all future loves and hates, and yielded standards of behaviour valid for the emerging intelligence.

But, however far back the process penetrates, it reveals the sensation-filled life of the infant and the importance of cutaneous sensibility—sensations due to visceral activity, intense special-sense memory-images, etc.

The Evidence of Direct Investigations. The evidence afforded by the psycho-analytic method is, however, convincing to few who have not been either subject or analyst; and, were the evidence forthcoming confined to this largely subjective

sphere of investigation alone, the popular opinion regarding the inaccessibility of infancy to the more subtle and indirect influences of the environment might remain almost unaffected. But confirmatory evidence is far from being exhausted. Methods of research, hall-marked by controlled experiment and the precise technique associated with the laboratory equipment of modern science, provide fresh corroboration. Much, it is true, remains to be done in the direction of interpretation, but the *data* furnished are full of suggestion for the educationist.

Modern histological researches on the development of the mammalian cortex cerebri or neopallium, both from the ontogenetic and phylogenetic aspects, tend to confirm the importance of infancy. Meynert, Bevan Lewis, Henry Clarke, and Flechsig among the earlier investigators; Bolton, Brodmann, Campbell, Elliott Smith, Mott, and others more recently, have contributed a mass of *data* to what is nevertheless a science still in its initial stage. Stated in the briefest way, the facts are as follows. The structure of the neopallium or cortex cerebri is found to consist of cells and cell fibres arranged in laminae, which have been variously classified by different neurologists. Bolton (see References) describes five which are constant for the entire cortex, though severally varying in depth and complexity of structure in different areas. These are: (1) The superficial layer of nerve fibres (outer fibre laminae); (2) the layer of pyramidal cells (outer cell laminae); (3) the layer of granules (middle cell laminae); (4) the inner layer of fibres (inner fibre laminae); (5) the layer of polymorphic cells (inner cell laminae).

To compare the above as regards function. The inner layer of polymorphic cells, together with the fourth, or superincumbent, layer, subserves the lower voluntary and instinctive activities of the animal economy. Of these laminae, Watson (quoted by Bolton), who has investigated the cortex of various vertebrates, says: " They are concerned with associations necessary for the performance of the instinctive activities; that is, all that are innate

and require for their fulfilment no experience or education. They form the basis of many complex actions necessary for the preservation of the individual and the species. Next above these laminae is the middle cell layer (Bolton's third). The main function of this is the "reception or immediate transformation of afferent impulses arising direct from the lower sensory neurones, or from other regions of the cerebrum." In the mammalians this layer is remarkably developed in the visuo-sensory area, particularly so in the primates and in man.

Finally, we see in the outer pyramidal cell layer (Bolton's second) the latest developed, ontogenetically and phylogenetically, of the neopallic laminae. Speaking of this layer in the vertebrates, Watson says: "It has to do with all those activities which it is obvious the animal has acquired (or perfected) by individual experience, and with all the possible modifications of behaviour which may arise in relation to some novel situation; hence with what is usually described as indicating intelligent, as apart from instinctive, acts, the former being not merely accompanied but controlled by consciousness." Again, we must compare the three-cell laminae of the cortex in respect to the degree of development at birth. No. 5, the inner polymorphic layer, associated with instinctive functioning, presents at this period a depth nearly 80 per cent. of the adult. No. 3, the middle granular layer, associated with the reception of sensory stimuli, has attained at birth 75 per cent. of the adult depth. No. 2, the outer pyramidal layer, associated with the highest psychic functioning, has attained about 50 per cent. of the adult depth.

The inverse degree of development at birth of the physical bases of the instinctive, sensory, and psychic activities respectively, is to be specially noted.

Inferences from Evidence. Thus we see the human infant already endowed at birth with a cerebral equipment as complete on the instinctive level as that of any lower adult mammal. Over and above this, he possesses a higher endowment than theirs,

providing for a more ample reception of sensory stimuli. On the other hand, that part of the cortex which subserves "voluntary attention, inhibition, and selective co-ordination" is still only half evolved at birth. There appears, therefore, every reason to conclude that the stimuli pouring in on the infant cerebrum initiate therein appropriate instinctive impulses; which, however, on account of the lack of capacity to co-ordinate motor responses, are unable to be discharged in intelligent and intelligible action. None the less, it may be inferred that time-related, sensorial memories cannot fail to add their quota to the sum total of formative experiences. All the foregoing evidence, gathered from various sources, emphasizes the dynamic aspect of mind. Mind develops in immediate response to environment—the environment, therefore, is the chief factor to be taken into account by the educator. This is already a well established fact, but what has yet to be conceded is that the special control of the environment which is of the essence of education cannot be exercised at too early a period of life.

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SECTION XIII

PHYSIOLOGICAL ASPECTS OF CHILD PSYCHOLOGY

"THE race marches forward on the feet of little children," and each child in its development tends to recapitulate the history of the race. Growth is the conspicuous characteristic of childhood. The main purpose of education is to secure the most abundant and effective equipment for the service of life. A study of the race, and an understanding of the evolution of the individual, afford the surest basis for the culture of the child.

The physiology of childhood reveals the nature and purposes of vital forces governing bodily development; the psychology of childhood provides a scientific account of mental processes in the unfolding life; and the pathology of childhood indicates the character, causation, and consequences of innate and acquired defects, disorders, and diseases.

The study of childhood demands a scientific spirit, a comprehensive outlook, and boundless sympathy with individual needs. Child-study is the most highly elaborated department of biology, and in its numerous branches touches practically all sections of human interests.

The individual child climbs up its own genealogical tree, hence in the revelations of heredity are afforded helpful records for the ordering of life's day. And each child is but one link in the living human chain, and therefore must be viewed and dealt with as a determining factor in eugenics.

In the investigation of childhood, and in the care and control of the developing child, the wise teacher must ever remember the paramount importance of looking before and after, while giving of the best in the preparation for the duties and discipline of the present.

The child in all its stages of development must be considered and dealt with as a whole. For purposes of convenience, we divide; but such division is detrimental unless it enables us to approach more nearly to an effective development and control of the unity of body, mind, and spirit. For the purposes of the present section, we are compelled to confine attention to what may be most conveniently designated physiological aspects.

Stages and Ages. Birth is a mere incident in the development of the child; it marks a change of environment, and the establishment of important bodily readjustments and new physiological activities. The act of birth divides pre-natal life from post-natal life.

The periods of childhood can be conveniently divided into (1) infancy, extending from birth to the end of the first year; (2) early childhood, up to the seventh year; (3) childhood, from the seventh year to puberty; and (4) the period of adolescence. These are more or less arbitrary divisions. Some have advocated a more physiological grouping, such as (1) the period of maternal nursing, or the age of suckling; (2) from the appearance of the first teeth to the completion of the temporary set; (3) from the appearance of the first permanent teeth to the onset of puberty.

An attempt has been made to divide development into periods according to the various stages in the ossification of the bones, as can now be conveniently ascertained by X-ray examination. Some find it convenient to divide adolescence into early youth and late adolescence. Full maturity in bodily development and physiological powers are often not reached until considerably after the legal "coming of age"; some say 25 years or even later.

For the purposes of psychological studies of childhood, it is convenient to recognize in each child the following periods: the *chronological* age is that determined in years, months, and days, dating from birth; the *physiological* age is indicated by ascertained standards of physical growth, as regards height, weight, and the like indications of degrees

of bodily development; the *mental* or *psychological* age significant of intellectual ability, capacity, and progress; the *pedagogical* age, or school standing denoted by the relative position in educational group grading; and the *moral* or *religious* age.

During recent years, many observations and numerous experiments have been carried out in order to discover accurate means for the discrimination, differentiation, and classification of children, and the regulation of educational work in relation to psycho-physiological development. Various forms of intelligence tests are now available.

Standards of Growth. In studying the upspringing of the body, and providing for the blossoming of mental powers, it is essential to secure some convenient and readily applied standards of growth. In such examinations as can be carried out in schools under our system of medical inspection, some few easily determined points provide data which serve as useful guides. *Weight* affords a particularly valuable index as to the health and proper development of a child. From the end of the second year to the age of 7 years, a child should gain about 4 lb. a year; and from the seventh to the thirteenth year, 6 lb. should be added annually. As to increase in *height*, this is most rapid during the first five years of life. At the conclusion of the first year, a child should be 27 in., and 3½ in. should be gained every year up to 5 years, and then 2 in. annually up to 15 years. Much useful information is obtained from an examination of the number and character of the teeth, the size and shape of the head, the development of the chest, the state of the muscles, and the configuration of the limbs. The influence of racial, sexual, seasonal, and other modifying agents must be remembered. Periodical variations occur in the growth of all children. Boys of from 5 to 10 years develop more rapidly than girls; girls of from 10 to 15 grow quicker than boys. Girls at from 11½ to 14½ years are taller, and from 12½ to 15½ are heavier than boys. From 15 to 20, boys develop more speedily than girls, and

continue to progress longer than is usually the case with girls. Growth is generally most marked in the spring, and least during the winter. As is well known, residence abroad in such a country as India frequently proves detrimental to the fullest development of a British child.

The Physiology of Childhood. The general well-being of a child, his intellectual powers, moral forces, and spiritual aptitudes are all dependent in great measure on the effectiveness or otherwise of physiological processes. To play aright the part of a parent, or rise to the responsibilities of the teacher, or render effective leadership of adolescents, a working knowledge of the psycho-physiology of childhood is essential. Pedagogical and ethical instruction, provision for recreation and guidance in vocational and civic training, must recognize the importance of a foundation in the principles of child physiology and child psychology. Many text-books dealing with these subjects are now available, and it will only be necessary here to refer to certain general points. Throughout the periods of development, the human machine is characterized by activity; growth is at its maximum. Nutritional processes require constant consideration. Much sleep and proper periods of rest are essential for recuperation. It is necessary that hygienic habits control all functions. The bowels and bladder must be regularly relieved. Personal cleanliness is to be insisted on, and means provided for proper baths, attention to mouth and teeth, care of the hair and nails; self-regulation and self-control should be encouraged as far as may be possible. It is well to remember that the clinical thermometer is an instrument of much service when wisely used, but in early life the temperature is readily raised by slight and temporary influences. The normal temperature of the healthy child, when taken in the arm-pit, is about 98·4 F.

Sexual differences are discernible from earliest days. The importance of the sexual instinct, even in early life, has of recent years been forcibly insisted on by Freud and his disciples. At puberty

and during adolescence, the sex factor exercises profound influence on mental and moral states. It is well that parents and teachers should give heed to the physiological distinctions and anatomical characteristics which mark the development of active sexual life and the establishment of secondary sexual characters. The importance of individual instruction in racial or sex hygiene is now generally recognized.

Psycho-Physiological Considerations. Each portion of the developmental period may be said to have more or less special and, to some extent, distinctive psychological and physiological characteristics, and no attempt will successfully dissociate them. Their presence, development, manifestations and effectiveness for individual and community service depend on racial, family, and individual inheritance, the action of environment, and the special processes of education.

The nervous system provides the material basis of mind. The brain is the organ of mental powers; and whatever is prejudicial to the development and active functioning of the nervous elements, must hinder and hamper mental processes. Prior to birth, the brain, spinal cord, nerves, and sense organs have reached a highly elaborated degree of development; and although, during the early period of infancy, there is little or no evidence of the activities of mind as we understand them, yet a rapid mental evolution is in process, and, should damage be done to the nervous tissues, irreparable mental disorder or disaster will probably result. Very early in the life of the child, evidences appear of the dawn of mind. The senses undergo progressive development and training, powers of perception are established, memory begins to store her treasury, reasoning powers evolve, human instincts gather force, and the intellect and will become established. The order, nature, meaning, and manifestations of this wonderful evolution will be explained elsewhere in this volume, but it is our desire here to insist on the importance of providing effective care and control for the developing

organic basis. The nutrition of the nervous tissues must be insured by the provision of adequate and suitable food, rest, and exercise. Agents exerting mechanical injury or infective, chemical, thermal, or other causes of disease must be prevented from damaging or attacking the delicate organic cases of the mind. Considerable attention has been devoted to the study of early mental development, and we now know much regarding the order and form of the appearance of mental faculties. The channels for the inrush of stimuli to the brain are the sense organs, particularly those of vision and hearing; and, if these are imperfectly formed or suffer impairment or are lost, arrest in mental progress is likely to result. Profound influence is exercised by the inflowing to the brain of stimuli through sensory and afferent nerves, and by the initiation, co-ordination, and inhibition of muscular movements the higher centres are trained in some of the habits most essential for well-being. By apathy or ignorance in regard to the care and training of the material elements, permanent deterioration of the whole individual may result.

During recent years, attention has been directed to the importance of a study of the child's unconscious mind. The work of Freud and other students of Psycho-analysis have demonstrated its value in the investigation of certain educational problems. The teaching of Montessori and other progressive educationists is exercising profound influence on educational principles and practice.

Child Pathology. The consideration of the pathology of childhood and youth scarcely comes within the scope of this work. But the educationist has now to provide ways and means for the care and control of many handicapped lives. Some are restricted in their bodily powers by inborn or acquired physical defects, while others are the subjects of mental defects. However limited and restricted the capacity of the individual may be, it is our duty to provide agencies which will enable the fullest degree of development to be reached. In dealing with all classes of defective children,

physiological principles must be applied, and practices and methods should be amplified or modified as may be rendered necessary by a recognition of pathological considerations. The great aim in dealing with all classes of morbid children is to enable them to approximate as far as may be possible to normal standards.

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SECTION XIV

THE PSYCHOLOGY OF INFANCY

CHILDHOOD differs from later periods of human life in that in the earliest years all is in rapid flux, and this movement is quickened or slackened, confused or harmonized, directed or misdirected not merely by formal lessons in school, but by everything that affects the great mass of varied elements out of which the nervous system is built up.

In the first years, there can be no formal lessons —no formal attitudes even—and yet, in these months and years, education goes on more rapidly than at any later period. Not heredity alone, but every detail of circumstance and place, habit and experience is playing a part in this natural education; and, by the time a child is 7 years old, so much is done or undone, that the teacher enters at last to look not (as was long supposed) on a beginning, but on a little person who is far advanced along the road of life. She is not dealing with a beginner when she takes in hand even a 2-year-old child.

Birth itself is, of course, not a beginning, though it is a new starting-point. So well advanced are things even at this period, that the character of the education which the new-born child has received is not hidden from the seeing eye. He reveals almost with his first breath the nature of the life he derived even when he had no brain, no spinal cord; and was formed as in a mould through the influence of the life currents of another being. For months before birth, the foetus is far more sensitive than the mother. It re-acts to any and every kind of stimulus. A loud noise, a strong odour—things that appear to have very little effect on her—will have a great effect on *him*. Every slight emotion also of the mother's—surprise, pleasure, or sorrow—he re-acts to, showing, in some cases, the terrible and permanent results of what was to her only a passing event or feeling.

The Development of Sensation. We see the well-born, who is in some cases a child from a mean street, start on his journey. We see the less fortunate (often from the same street). We see, also, the "war baby," whose mother's life, while he was still unborn, was filled with shocks and trouble. The chances of life have overtaken them ere they began an independent existence; and these happenings, whatever their nature, play a part in the shaping of a nervous system. It is the fate of a nervous system which is, after birth and before it, in the balance. It develops fast in the early years, though not nearly so fast as was assumed in older systems of education. During the first four years at least, the Grand Sympathetic nerve plays, as Séguin declared so long ago, "the part of a great tramway in the midst of the life citadel." To the organic sensations which form the base of consciousness, and where in the first years consciousness itself flits like a light in a cellar, belong, for example, sensations of breathing, of circulation and nutrition, and also sensations of the muscles and nerves in exercise. To these belong also what is often called "the muscular sense," the sense of resistance, of weight or pressure, with all its attendant pains and pleasures. The sensation of heat and cold are probably far less vivid in the young child than in the adult, though he has very little power of resisting extremes of heat and cold in the earliest months and years. It is certain that the consciousness of a young child is filled very largely with sensations that accompany acts and movements which for older people have become entirely automatic.

In this world of effort and labour, where he is tempted to try every one of his powers in succession, the child's instinct of play has, of course, a great *rôle*. It is preceded, however, by a kind of appetite for sensation. The child touches and feels everything it can lay its hands on. But it does not deal only with solids. It appreciates odours at the age of a year or more, greedily holding out its hand and pressing to its face one herb after another. It listens with delight to loud noises and sounds,

tapping its spoon on the table, ringing bells, and smiling on its shouting or laughing brothers and sisters. It delights in gay, bright colours; in shining objects; and bright flowers. Not only every sense, but every nerve and muscle is brought into activity as soon as its centre arrives at any degree of organization. At first, the child uses its senses and muscles for the pleasure of the sensation; but soon a new instinct unfolds itself and urges him to carry his self-education much further. He begins to play.

The Development of the Play Instinct. The first games in which the toddlers of 2 and 3 appear to be greatly animated are those of pursuit and escape —"Robbers," "Hide-and-seek," "Giant running after little people"—all running-away games. The little ones keep in a large troop or horde, and thus supporting one another derive great joy from the game. All, save one or two of the boldest, dislike to be separated from the troop. Even when the game is over, they group themselves; and in lying, standing, or sitting together, appear, as Séguin declared, to fall into the same formation as the blood-globules. From such natural groupings they emerge, to test their individual powers and, above all, their new-found muscular powers.

It is necessary to have hillocks, platforms, and big tree-stumps, or raised mounds in the gardens. They climb these like lambs or young goats. (At a certain age they resemble goats even more than lambs.) They also show a great desire to use the large muscles, and to handle tools that are too large for them. Thus I have often seen a little child struggle to lift an elder boy's spade, and to get hold of his hammer and file. On fine days, the covered way in front of the toddlers' shelters is full of little ones who try to trundle hoops, push toy perambulators and even low carts for children. A small wheelbarrow is eagerly pushed, and it is clear that even dull children, *if not prevented,* will quickly learn to use their limbs and handle things. These experiences have a great educational value that can be traced later on in a great variety of ways.

Play as a Factor in Education. The years between 4 and 7 are the " play-epoch " *par excellence.* Hearing and vision games are not very numerous in the little child of to-day. They are probably artificially restricted, for " silence lessons " are popular, not only in class, but sometimes even in the playground. Among vision games, ball-catching in all its varied forms is no sooner known than it is warmly appreciated. The child of 4 will spend hours trying to throw and catch. The little ones, when at all excited, use their feet instinctively. In children whose opportunities in life are small, the games are mostly of a fighting and teasing character, and the play often ceases to be mere play and degenerates into real fighting.

At every point in his development, the child assists himself through the instinct of play, his inventiveness and industry in play being the measure of his advance. For example, neglected children are slow to speak. They invent little and even avoid speech altogether. But the baby no sooner manages to utter even a vowel-sound, than he repeats it again and again, in varying keys and with an industry and energy that distresses his institution-trained nurse. If forcibly silenced, he will fall into an inert state, and will remain for hours seated at a table or on the floor.

About the age of 3 a child enters on a new play-epoch. From this time forward, he begins to attempt memory plays—plays with visual and aural memories—and new orders of imitative play—going on, it maybe, to will-test plays, and even a kind of drama. It is the epoch when the child himself aids his instructors by self-imposed tests of attentive power and will-training, which are certainly not the less valuable because they are spontaneous. Attention is, in its earliest manifestations, a means of furtherance in the struggle for life. Warned of the meaning of danger, the child braces himself to look, to listen, to keep his muscles tense, and also to keep his own powers in check. And the instinct to live through all these experiences, even in the toddler, is intensified and refined in the older

child. He not only uses his superfluous physical energy in running, throwing, and climbing; but directs his attention to the things and persons that appeal to new aims and desires. "Let us keep shop," cries an older girl. And forthwith the group finds ways and means which the teacher certainly never dreamed of. They make a counter of an old plank, fix a balance by putting one piece of wood on an upright stone, gather the crumbled fruit of one grass to sell as tea, and sand to sell as sugar. They put stones for weights, and proceed to sell and buy, imitating the words, voices, gestures, and manners of grown-up people. It is more realistic than any grown-up invention of such play can be, and involves the exercise of attention of varied orders. The same is true of the play of other children making tunnels and waterways in the sand, or building houses, and placing cranes near the stopping-places on the "river."

The constructive play of children in war-time was remarkable, and showed, in its ingenuity and daring, the stimulus to creative energy given by the greater emotion which children, in common with their elders, experienced. Instinct is usually defined as a hereditary and clearly defined motor reaction to a given stimulus. No fixed hereditary bias can be claimed as the origin of all the motor 'buses, bi-planes, water-planes, bomb-projectors, and electrical apparatus with which children now cover tables at exhibitions. Nor are these toys mere imitations of things seen, though in every instance, adults have, of course, supplied the original models on which they are framed. In many there is more than a suggestion of real improvement of existing models, if not of actual invention. It would appear that imitation, far from being a purely hereditary reaction, marks rather the point where childhood escapes from the thrall of hereditary impulse. It has to vary its play in presence of models that have had no complete precedent, but belong to an ever-changing succession of things. More than one adult inventor, examining the work of a boy, has been startled now and then by its suggestiveness, and

has realized more than ever before how far the play impulse may pass beyond the fixity of the hereditary orbit.

It is certain not only that children have a certain advantage (which is lost later in life) in registering fine impressions, but that the very simplicity with which they group and disconnect these impressions opens to them the doors of invention. It was to the play of children that the science of optics owed its initial impulse. As to the fineness of touch impressions in early childhood, this was made use of notably in the silk industry, where, for some branches of the work, only little children under the age of 7 were engaged. But it is only in very recent days that we have begun to use these peculiar gifts and aptitudes in the school training of young children.

Sense Training. A few of these methods may be described here. To begin with, I have had large letters made, the form of which has been sunk in hard clay, and the child puts a tiny forefinger in, so as to feel the whole length and curve of every form. After a while it does this blindfold, and even learns to name the different letters by merely feeling them.

For little children, I have graded wooden blocks, by which they can begin to compare different lengths and thicknesses; I also use wooden tablets of very simple construction, with geometrical forms inset, beginning with the square and circle, and later adding prisms, cones, spheres, cylinders, etc. I have also painted insets of animals and, in a very short time, children get used to handling them. Meantime they begin to swing circles on the blackboard and blackened tables (for the tables can all be used as writing boards). The first consecutive lines they make are curved for the most part, and they tend to reproduce the curve in other lines. Not all, however, show this tendency. Some babies of 3 and 4 draw wonderfully good straight lines—vertical and horizontal, and later oblique. It seems that the motor control necessary to draw carts, barrows, houses, can be won easily in early childhood, and must simplify the whole problem of

learning to draw, though one has to confess that the power of observation and comparison necessary to fix the relation of the different parts of anything does not come easily even to children who draw any simple geometrical form freely and well.

Reading, Writing, and Drawing. All this practice in motor exercises and sensory experience does, however, serve a child in good stead when he comes to deal with other school subjects. The fact is that the children profit by their tactual experience so rapidly, that they soon pass beyond it. By using the wooden letters and tray, a very indolent and rickety child learned the letters in two days. Later, he laid the letters so as to form words and sentences. After a month or two, these exercises were discontinued. Our experience goes to show that such concrete methods, precious at first, should not be carried on longer than a month or two. It would seem that, though a child is helped at first by the use of wooden letters, through the sensations of movement as the eyes move over their large surfaces, and as the fingers touch and handle and place them, yet, for the actual storage of visual memories of words, this kind of exercise helps not at all. Letter memories are stored in Broca's convolution. But word-memories are stored in another region of the brain, and *attention* to written words depends on the waking of a higher centre, whose activity appears even to be hindered by long use of letter memories and motor memories connected with what is for beginners a good system. For this reason, we paint large words in bright colours—names of things that are to be found in the school, such as door, sand, chalk, book, coat, girl, spade, barrow, etc.—and give them to the children of 5 as early reading exercises. When these are learned —and the children are very eager to find out the words on the cartons—short sentences are printed up and easy reading books opened.

So far as writing is concerned, however, the progress made in drawing lines and circles, and in drawing or filling in outline geometrical forms and patterns, is much more striking and rapid than the

advance in reading. Here the muscular memory plays a great *rôle*, following the principle already laid down that the large route of the nervous system must be well beaten out first, while the farther and finer tracks and by-paths are reached later. The first movements in writing or drawing are large arm movements, and control of the lower arm, wrist, and fingers is aimed at later. Control of the large muscles is won very quickly, even by the 4 and 5-year-olds. It is true that, in order to succeed, the teacher must aim at giving much practice. The child must draw, not five lines, but hundreds, without being afraid to go on and correct his fault by practice. A child of 6 who had never learned to write at all made such rapid progress in this way, that in a month or five weeks he wrote a better hand than any of the 9-year-old children in the class; and this rapid progress showed itself from the moment that he turned from drawing curves, lines, circles, etc., to drawing letters and putting them together in words. The explanation, of course, is that he had learned to make all the necessary movements, and had only to note the new adaptation of forms and figures, no one of which offered any difficulty to him. One may note that even very little children learn to draw and write well without any guiding lines at all.

Apparatus. All the apparatus needed to help young children in the development of their motor and sensory powers can be made very cheaply. For weighing exercises and tests, I have used pill boxes; and for dressing exercises—such as lacing, buttoning, etc.—strips of cloth nailed on boards answer the purpose very well. Such apparatus was used by Séguin. Of course, one does not keep to these alone. In a garden, and among leisured friends, a child learns fast, defying the keenest eye to follow the veiled processes of unfolding life.

It is astounding how soon many children pass beyond these aids. One girl of 4, for example, used the knot-tying board only for one day.

Observational lessons can be given very well by means of a colour wheel and coloured papers; but

for details of this I must refer readers to a book published in 1904, *Education Through the Imagination*, in which I have tried to show the *rôle* played by Memory as a stimulus to the Imagination.

Speech-training. Owing to the want of physiological method, hand-training was long left out of account in schools for young children. And even now, for the same reason, speech-training is often passed over. Very often one hears the two subjects put in opposition, as if they had nothing to do with one another. Yet it is hard to see how man worked out his power to speak unless aided by hands, and certainly the neurones of the motor and visual centres associated with the auditory centres are developed in proportion to the specialization of the fore-limbs.

Most of the children in our schools have speech defects, and a great many of them have *serious* defects that affect even their health.

In support of this, I can cite the work done in the Evelyn Home with pupils of 8 to 14 years old. Most of these pupils were girls, but there was a good proportion also of boys from the elementary schools. They were not selected because of speech defects though most of them had had an operation at the Home for the removal of adenoids. They had great difficulty in using the lips, or saying even a very easy word beginning with a consonant. The nostrils were of course, very tight, and for this humming as well as breathing exercises were given. These defects vary a little from generation to generation. They are not found always in districts where a dialect is spoken (a dialect is often vigorous speech enough), still less in old forms of speech that have been given up by the " cultured classes " and city dwellers. But there is a pathological kind of speech which is common enough, and it is always the result of a kind of weakness or failure.

Briefly, we may say that the great falling off is in the *labials*. The toddlers, for their part, are eager to use these sounds, and begin to practise them ardently, doubling them always in their early efforts, as in *Ma-ma*, *Da-da*, *Bo-bo*. It is necessary only to

encourage them in these exercises in the nursery, and they will go on to others that are more difficult. The first and easiest exercises are, however, those which the child himself practises first, that is, sounds beginning with a consonant and ending with a vowel, such as *Ni, ma, do, gee, na,* etc. When he has really mastered these, he will start on more difficult syllables and words such as "Black," "plate," "drove," and in doing so he will be already floated past many of the shoals on which our older children have made shipwreck. Such difficult words as "alp," "elk," "oil," and others beginning with a vowel, can follow. Where there is one special failing, as in children who cannot say "s," they must be taken alone. All this forms a very great work for the nursery school. It is not easy to correct speech defects at the age of 12, or even 9, when the vocal organs have adapted themselves to a bad habit of speech. At 8 or 10, indeed, it is almost time to start another language, such as French, the oral learning of which should help to perfect the speech-training.

The Relation of Sense-training and Intellectual Training. From all this it appears that to deal with sensory and motor training is to give intellectual training, for the two cannot be separated. Take, for example, the visual image of a word. It is received and stored in its own special part of the brain, but it is also referred to a higher centre whose awaking involves attention and consciousness of the meaning of the image. This awakening of the higher centre (attention centre) is the great desideratum, and it is the real triumph in all forms of sensory exercise. The blind man has not a keener or finer touch-sense than seeing people. But he interprets his touch sensations, and often his hearing, in better ways. This is why he knows the things he touches, and also senses the lull about a large object (a lamp-post, for example) in a way that amazes us. (There is always a noise and rumour going on even in a quiet atmosphere. Where a big object stands, this is broken or silenced. The lamp-post makes a quiet interruption, as it were, as a stone makes a stop in a running stream.) This

is why Helen Keller, deprived of the two great senses of Hearing and Sight, yet interprets the vibrations and surfaces around her so as to build up a fine mental and spiritual life. In schools and out of schools, it is the power of *attention* that is trained in all these sensory drills, and this is the power that fixes the status of any human being.

The educational systems of yesterday busied themselves mainly with instruction; and no one can afford to despise them, for, not only were they successful in turning out good scholars, but they also gave incidentally a training in will power. They failed signally not with the gifted or average child, but with the abnormal and sub-normal, with children whose condition they did not understand. Modern education may be said to have begun with the study of the abnormal. By turning back to these, it begins to understand failure as well as success. And failure is not nearly so terrible, so final as it used to be. It is found that there may be an evolution of power by exercises that one can learn, by drills that fix the attention on stimuli offered to the various senses. They may, and do, render consciousness clearer and life more vivid. A still greater thing it is to know that the millions of children born may be raised to a higher level by having their childhood and youth freed from overwork and semi-starvation. They can be assured of food, clothing, and shelter, and trained in the use and management of these. They may have a physical education that will ensure the nervous system. This kind of preparation should fit children later to profit by a liberal education. For lack of one and all of these things, a great part of all the money, time, and strength spent on elementary education has been wasted; and the producing and saving power of the race has been diminished to an extent we can but dimly imagine.

We want thousands of nurseries with nursery schools attached to them, and thousands of young girl probationers to learn the new arts of nurture. We want to give nurture as we once gave

book-learning to the masses, because nurture is more important in its effects than mere lessons of any kind can be.

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SECTION XV

ACTIVITY

EDUCATION through activity is the watchword of one school of educational reformers, but the activity they demand is not activity as such, but the special form of activity which involves purposive movement. This form of activity, more accurately known as motor activity or motor expression, will alone be considered here. All systems of training necessarily include some attempt to stimulate and control the pupils' activity; but, so long as the intellectual conception of education was dominant, this aim was subordinated to other considerations. In recent years, however, successive social movements and changes in the world of thought, have led to the fuller recognition of the importance of activity. Thus we have witnessed the introduction into the schools of organized games, practical science, manual work, technical instruction, and the like. But the tendency has been to confine the encouragement of activity to certain definite departments of school life, whereas we are now faced with the demand that similar methods should be systematically applied throughout all types of schools. One group of writers on education has gone so far as to subordinate knowledge and feeling to activity, and to speak of training in behaviour or activity as the primary aim of education. [See *e.g.* James: *Talks to Teachers* (pp. 28 f.) Dewey: *Educational Essays*, and *The School and the Child.* Bagley: *The Educative Process* (p. 22).] It is not necessary, however, to adopt this extreme position in order to maintain the view that the pupils' own activity should play a more prominent part in the process of education than it does in most schools at the present time. Some change in this direction seems, indeed, to be demanded both by the teaching of psychology and

by the results of educational experiments. The statement that we learn by doing has been shown to hold, not only when our learning is by imitation or by experience of results, but also when it is mainly a process of ideal construction. It is evident, for instance, that manual skill and habits of behaviour are acquired through our activity; but it is also true that our scientific knowledge and our ethics and philosophy are abstract and unreal unless based upon adequate experience derived from our active contact with actual things and persons. Again, the activity in which an emotion finds expression is an essential element in the emotional process and, if the activity is checked, the process is diverted from its normal course. The serious effects which may follow from the repression of activities connected with a strong emotion have been emphasized by Freud and others, but the same principle holds good in the case of any interest. Unless appropriate opportunities for activity are provided, the interest inevitably suffers.

Effect on School Life. The recognition of the importance of activity has led an increasing number of schools to modify their aims and methods. The boy or girl is trained to be a worker rather than a scholar in the narrow sense, though it may be a worker in some field of thought. A practical acquaintance with some typical human activities, and the knowledge derived from first-hand observation or experiment, are valued highly. Hence manual work becomes important as a means of intellectual and moral training. The manual training schools, says William James, " will give us citizens of an entirely different intellectual fibre." [See *Talks to Teachers* (p. 35).] In a few schools the pupils have been taught to carry out, on a small scale, certain important processes. In some schools a systematic attempt is made to reproduce on a small scale certain activities of importance in industrial or social life. Thus the pupils may be taught the elements of some skilled trade, either as part of a general education or as a preparation for a specific type of calling (*e.g.* in Junior Technical

Schools); or they may perform some of the fundamental operations of social life as is done by different schools in different ways (*e.g.* the Chicago University Elementary School described in Dewey's *The School and the Child*). Again, they may develop a legislative and judicial system of their own, as is done to some extent in the public schools and others in which the common life is organized on similar lines —a striking example of a thorough-going application of which system was the Little Commonwealth at Evershot, in Dorset. Even if the traditional curriculum is to a large extent retained, the classrooms may become the scenes of co-operative activity, as *e.g.* in dramatic representations. The results attained by the encouragement of activity on these and similar lines prove that the movement is one of great educational significance.

The Importance of Purpose. In order, however, that activity may play its proper part in the educational process, it is necessary that much of the activity should be purposive—the expression of the child's own interest—and that it should be subject to objective or social control. Thus, for example, the boy should make things, not solely for the sake of the skill acquired by making them, but partly for the value of the product. Boys do not become good carpenters by making useless models. It is true that the accomplishment of some difficult task, or the performance of some feat, may have a real interest of its own, and that this interest may have great educational value. But the interest in achievement is normally associated with an interest in the results attained, and should be developed in connection with it. On the other hand, activity brings us up against the realities of our environment, and is effective only when it recognizes the objective conditions with which it has to deal. A boy must saw his wood straight if his box is to shut. He must use tact and judgment if he is to be successful as a football captain. The control to which activity is subject ought, however, to be that involved in the conditions under which it is carried on—not the control of arbitrary external authority. School

rules, for instance, should embody the conditions of healthy corporate activity, and not be felt as despotic enactments. Control thus exerted is not antagonistic to purposive activity, but is necessary to its efficiency. Activity is a potent instrument of education, because it helps the individual to master his environment by obedience to its laws.

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SECTION XVI

PLAY IN EDUCATION

PLAY is whatever is worth doing for its own sake. It is the satisfaction both in children and in grown people of the instincts—or innate tendencies to conscious action—other than fear, the avoidance of pain and discomfort, and the physical hungers for air, food, and the sexual relation.

Some people, Herr Karl Groos for instance, would except in their definition of play the "serious" manifestations of these instincts—meaning those that help to preserve the individual or the species. Such limitation may be desirable in biology, but would be a stumbling-block in dealing with education. In the case of some of the instincts—such as curiosity, nurture, rhythm—there is no special kind of manifestation that could be distinguished as "serious" in that sense; and in the rest—such as hunting and fighting—the difference, as seen from the inside, is merely that the "serious" form, when it appears, is usually (but not always) the more intense. Meantime, play is to the child precisely the most serious thing in life. And it is the play instincts, especially that of belonging, or loyalty, that constitute the most serious element in work.

Instincts expressed in Play. The most important instincts expressed in play are those toward making, knowing, nurture, rhythm, hunting, fighting, belonging, and self-assertion. The last named is the instinct of self-creation and self-preservation in the ethical sense, and involves the assertion and maintenance of a social personality.

There are many play instincts ancillary to the above, such as handling and controlling; dissecting, exploring, classifying; teaching and petting; chasing, lying in wait, jumping upon and throwing down; hiding and running away; striking and wrestling; talking, leading, following, imitating, and running with the crowd.

There are also preliminary instincts urging the practice of the rudimentary powers on which the exercise of all the rest depends—such as grasping, wielding, digging, locomotion, walking, running, jumping. Climbing and escaping instincts, of much importance in children's play, belong also to this class.

The Relation of Play and Growth. All these instincts, it will be observed, are, in bud or blossom, tendencies toward those forms of action in which human efficiency consists. Their function in the child is to superintend his growth. They are set to work in him in plastic infancy to mould him to their service. Such, indeed, as Herr Groos has pointed out in his *Play of Animals and Play of Man*, is the explanation of the whole phenomenon of infancy.

Specifically, the part of play in growth is twofold. So far as the structure of body and mind is pre-determined, play is the condition of their realization. But to a great extent the body and mind of man are not pre-determined. The form of bone and muscle depends partly upon their use. Nervous co-ordinations and mental habits are the direct result of action. And the variety in the expression of the play instincts corresponds to this margin of variation in the instrument thus placed at their disposal. These instincts as given to the child are themselves unfinished, and become completed only through exercise such as play affords. This is particularly true of the more important ones. "Make," "know," "hunt," "escape," "fight," "nurture," "belong," "assert yourself," are commands leaving wide discretion as to their execution. The building may be made of sand or blocks or paint, perhaps of sound or thought, and there are many practical problems to be solved in its construction. Knowing implies experiment, discovery, organization, the use of a vast variety of methods. Hunting may be carried on with sling or bow or gun, with hook or net, with falcon, horse or boat. The simplest form of contest or pursuit is very complicated. And so with all the rest. Even the

ancillary instincts, thrown out as hints of how to go to work, present difficult problems in their application. "Throw something at him" involves selection of missile and considerations of direction, range, and the probable motion of the creature aimed at. "Strike him" sounds simple until you try it on a living specimen.

The gap thus left between each instinct and its execution is filled in by the child with several kinds of structure. Through the intense and constant practice and absorbed attention that play prescribes, he stamps upon his mind the facts with which the instinct calls on him to deal; stores away, in the form of habit and acquired reflex, an effective method of dealing with them, and at the same time trains his body in the execution of such method. He thus acquires a second nature, supplementary to the first, through which he precipitates the great constituent instincts upon practical methods of expression. So that man has, in the special indefiniteness of his leading instincts, and the consequent possibility of variation in their method of expression, the great advantage of the adaptation of his mind and body, and of the very instincts themselves to his actual environment.

And he has another great advantage. Through instinctive discipleship as prescribed in the imitative and belonging instincts, he tends to make these adaptations in the light of social, and therefore cumulative, knowledge. It is through the teaching of parents, of older children, of professional teachers, and of public opinion and social institutions, that the child becomes heir to all that the ages have acquired.

The instincts which are thus given, through play, the charge of human education not only embody the active principles in which man's practical powers are contained—they also comprise his spiritual nature.

Play Periods. The major play instincts are the elements of human life and genius. All the gods are impersonations of them; the saints and heroes are their exemplars. They are the constituting

elements of man, and each man is alive in proportion as he embodies them.

Play is not the pursuit of pleasure; it is obedience to direct commands promulgated in the form of ideals bearing their own credentials on their faces. It is the pursuit of ultimates, the doing of those things that are worth while for themselves. Subordination to these, the forgetting of all else in effort toward their realization, is its moral attitude.

The play instincts do not, however, all appear at the beginning nor all at once, and some of them assume successive forms. It results that the child passes through successive stages of growth, each dominated by a special group of motives.

The first period, that of babyhood, is lived in the child's spiritual relation to his mother, who is then not only his playmate but his social world.

Then comes the dramatic age, from 3 to 6, ruled by the child's impulse to impersonate whatever interests him, expressive of the instincts to know and to project himself into what appears so admirable. Rhythm becomes prominent in song, speech, and motion, and construction more absorbing.

Then comes the Big Injun age, from 6 to 11, in which self-assertion in its more obtrusive form predominates.

At 11, the instinct of self-assertion, though still growing in intensity, is superseded in its leadership by the belonging instinct, shown in team games and gangs. This, from 11 to 21, is the age of loyalty, in which Man the Citizen attains his growth. It might be divided at 14, because of the appearance at that age of the dawning sense of membership in society as a whole, and the consequent strong desire to make good in grown-up life. In that case, the period from 14 to 21 might be named the apprentice years.

Girls are much like boys in the first two periods. They are a little more precocious, are a little less assertive in the Big Injun age, and less given to fighting; and they differ greatly from boys during the age of loyalty, having much less team sense and

no natural tendency to the peculiarly violent plays in which it is expressed. The play of sex in the form of coquetry appears earlier in girls than in boys, and they are generally thought to be the more romantic at a later period.

The order in which the play impulses appear follows to a considerable extent that of their appearance in the race. But a child, especially in the early stages of development, is very different from a grown creature of any epoch, and observation is a surer guide to what he tends to do than whatever knowledge we may possess of his remote ancestors. The theory of recapitulation is, however, useful in suggesting what to look for.

The importance of recognizing in education the various stages of the child's growth is very great. The more important instincts do not actually lapse if they are ignored, but their period of stress passes, and with it the susceptibility of mind and body to their impress.

SECTION XVII

ADOLESCENCE

ADOLESCENCE includes the years from pubescence to relatively complete maturity. In temperate zones it usually extends from the fourteenth to the twenty-fifth year for boys, and is one or two years earlier for girls. In the United States, Crampton has found a range of four years in the attainment of pubescence.

Physical Characteristics. The body grows more rapidly at adolescence than at any time after the first year of life. Growth in height begins at eleven or twelve years in girls and a year or two later in boys, and is nearly complete by seventeen or eighteen. Growth in weight follows, reaching its culmination by seventeen or eighteen, but continuing more slowly for an indefinite period. Studies by Moon, West, Hrdlicka, and others indicate that, before twelve or thirteen years in girls, and fifteen in boys, the spine grows more slowly than the leg bones; afterwards, more rapidly. Between thirteen and twenty-five years, the epiphyses of the arm, shoulder, and leg bones ossify; the pelvis of girls is modified both in shape and size, and the bones of the sacrum and coccyx unite. Ossification of the skull is completed about the twenty-second year. Porter found that in girls the length of the face increases most between twelve and fifteen years, and in boys between fourteen and seventeen; while, in both, the breadth increases most between fourteen and fifteen years. Between twelve and nineteen years, the average distance between the eyes increases 10 mm. Muscle weight is estimated to be 32·6 per cent. that of the body at fifteen years, 44·2 per cent. at sixteen, and 45 per cent. at twenty-six. The growth of individual muscles is parallel to that of the bones to which they are attached. Mühlmann's measurements show the most rapid increase in heart weight between fourteen and

fifteen years, with a slow rise from ten and a slow fall to twenty-five years. Guy estimates that the rapidity of the beat lessens three to six beats per minute between twelve and twenty-one years. Truslow gives the ratio of the volume of the heart to the width of the ascending aorta as 56 to 20 before puberty and 97 to 20 after, so that the blood pressure is greatly increased and circulation time lengthened. Marro states that the chest circumference increases ·62 to ·76 m. between eleven and nineteen years; Zak gives the increase from fourteen to fifteen, the period of most rapid growth for boys, as 4·1 cm. Vital capacity is at its highest a year later, according to Kotelmann; but runs parallel, according to Pagliani. In girls, Pagliani found that both chest circumference and vital capacity grow more regularly.

Per cent. of growth of brain weight continues to diminish; but Kaes and Vulpius believe that in the later teens the middle layer of the cortex develops, first in the parietal and central parts, and then in the temporal and frontal, correlating with the development of abstract thought.

Probably the digestive tract, including the liver, alters relatively little during adolescence; but the composition of the urine is greatly modified. The pancreas and spleen grow more rapidly; the sebaceous, salivary, and probably the lachrymal glands function more and the pigmentation of the skin is altered. On the other hand, the thymus and thyroid glands atrophy more rapidly and the fat lessens, especially in boys. The few statistics as to testes and ovaries show that they are growing rapidly in weight and altering in dimensions.

Intellectual Characteristics. On the intellectual side, we must note, first, that the rapid growth of the middle layer of the cortex seems to condition a general excitability which may pass into abnormality if not guarded against by developing the sense of reality and the synthetic aspects of mental work. Meumann believes that, while the child below twelve years thinks and wills in individual impulses, the child above emphasizes the relating

aspect more and more (*e.g.* simultaneous apprehension of unarranged points or lines is 3–4 for the twelve year old, 5 for the fourteen year old, and 4–6 for the adult). Estimation of the number of simultaneous sounds rises from 5–6 for eleven and twelve year children to 6–8 for those of fourteen years. Power of fixation of attention also increases greatly after twelve years, and, with it, better memory for sense perceptions and greater reliability of testimony. Turning to the special senses, Hall states that taste becomes more discriminating and appetite more capricious, sweets, sours, and animal food being more desired, and a craving for stimulants often appearing. Smell seems to become more acute, and the love of strong perfumes marks this age. Probably the temperature sense is heightened in the later teens. The heightened activity of the skin glands increases the skin consciousness, so that Hall notes a touch hunger, showing itself in the desire to rub and scratch the skin, though fineness of touch discrimination lessens with the increasing skin surface, since no new touch end-organs are formed after birth. Carman and Gilbert believe that pressure-pain sensibility also lessens. Meumann's tests on boys of thirteen to fourteen years with the kinematometer showed in them the same power of discrimination as in himself; and estimations of short distances are as correct in twelve year old children as in many adults. Active perception of visual form seems to reach a maximum in boys at fifteen, and then to diminish slightly. Discrimination, both of shades of colour and intensity, seems complete at fourteen; but Gilbert found that form perception improves between fifteen and sixteen, and that the simultaneous apprehension of letters increases throughout the college course. The love of drawing increases in some children, and both sexes crave strong colour stimuli. Seashore's tests indicate that discriminability of tones does not improve between ten and fifteen, but Gilbert found a steady growth. On the side of musical performance, the change of voice and lessened motor control are likely to cause

self-consciousness and dislike of expression for a time.

Memory tests by Lobsien and Netschajeff show that the greatest rise is past by twelve years. After this, there is a slow but steady progress in the memory of objects, inarticulate sounds, numbers, and words naming sounds, visual objects, touch and muscle qualities. On the other hand, words expressing emotion and abstract ideas are much better remembered during adolescence than before. The greatest difference between boys and girls comes between eleven and fourteen years. For isolated words, Boyd found the memory best at thirteen years for girls and fourteen for boys, but at seventeen or eighteen for sentences and an idea involving an abstract conception. Immediate retention, according to Meumann's tests, improves most rapidly between thirteen and sixteen years, then more slowly, reaching a maximum at twenty-five. Winch's and Smedley's tests harmonize with his. All Aussage tests show that now the relational aspect of memory comes more to the front. Errors due to suggestive questions are only one half as numerous at fourteen, and one third as numerous at eighteen years as at seven. Colvin and Myers found that the image type is also especially modified in early adolescence, changing gradually from the visual and concrete to a relatively verbal type, which is likely to involve auditory and motor as well as visual factors, and in which associations and meanings play a larger part than at an earlier age.

Though inexact, the study of A. J. and I. Rosannoff on associations in normal children shows that, from eleven years onward, reactions are more like those of adults than of younger children. Goett found the same true of children over twelve: repetition of the reaction word is only about half as frequent; contrasts and compounding of the stimulus word with another increase noticeably; predicate and subjective or personal reactions diminish; and the sex complex is practically always present. All observers agree that reaction times lessen, probably becoming as short as in the

adult by the seventeenth year. Studies of Ziehen, Meumann, Winteler, Wreschner, and Rusk show that reaction times become longer and, presumably, associations more difficult in the following order: (1) To react with a part if a whole is named; (2) the reverse; (3) to name a co-ordinate; (4) to name a free concrete term; (5) a super-ordinate; (6) a subordinate; (7) a free abstract term; (8) a causal relation. Ziehen found no causal relations below eleven years, and Meumann found a great increase in them at thirteen and fourteen years, especially in natural science. This interest in cause, together with the heightened sensory activity and love of exercise, forms the basis for the new interests in Nature and Art. Hall emphasizes the former especially. Youths and maidens love to think of infinity in space and time, and to become filled with the sense of the vastness of the universe. The heavenly bodies and the sky are sources of mystery and stimuli to the imagination, the feelings, and the religious sentiments; while, at the same time, the practical applications of science appeal to them strongly. The formal science usually taught in secondary education has, however, little interest for them.

Hancock's returns show that ability in arithmetical reasoning increases rapidly between thirteen and fifteen years, and Lindley's that interest in arithmetical puzzles culminates somewhat after this age. Mrs. Barnes found that interest in the truth of a narrative is slight even at fifteen years, while that in name and age is strong from the beginning. Miss Patterson's returns also indicate that understanding of the meaning of historical dates is small before twelve years. Studies by Williams, Conradi, Bullock, Henderson, and Kirkpatrick all show a great increase in the reading curve, culminating at fourteen or fifteen years, and then steadily falling. Many youths spontaneously set about enlarging their vocabulary by the aid of slang, foreign languages, and the study of the dictionary. The sentence structure usually becomes more complicated and the use of words more precise.

Attitude to Society and Religion. The attitude towards society and religion changes profoundly also. Naturally, the development of the sex instinct modifies all relations to the opposite sex. Many students believe that there is, first, a tendency for each sex to draw away from the other, and that, therefore, co-education during the high school age is undesirable. This is neither adequately proved nor disproved as yet. Later, the opposite sex is attractive, and motivates a large part of the adolescent's behaviour. Boys tend more to "show off"; girls, to develop reserves and to exercise critical judgment. Both develop pronounced tastes for personal characteristics in the opposite sex. Normally, selection and mating culminate in marriage, usually between twenty and twenty-five years for women in temperate climates, and somewhat later for men.

In the adolescent, the social instinct also enlarges in all directions, especially in hero-worship and in friendships. Team-work becomes characteristic of most games; gangs and clubs multiply. The individual's attitudes toward the various social groups which he touches run the gamut from the dictatorial to the slavish. Finally come the highest developments of the social instinct in morality and religion. The moral judgment of the adolescent is markedly crude, but his conscience is sensitive exactly because his social sense is now so new and acute. He is rebellious against unreasoning obedience to any authority, but much on the alert to be the type approved by his associates. He confuses the customary and the right when his own group follows the customary; but when his group stands for the new right against the customary wrong of another group, he learns the distinction. The adolescent is as yet more likely to tell the truth to his friends than to his enemies, to justify an unrighteous bargain because it is clever, and to rebel against just punishment unsympathetically administered. But he is uneasily conscious of the defects of these attitudes and needs but little stimulus to attain higher ones. This additional

spur usually comes from religion, which tends to convict the adolescent of his unrighteousness. The child attributes the blame for his unhappiness or misfortune to other persons; but during adolescence there is a remarkable change, most truly called conversion, marked by the adolescent's consciousness that he himself is often the guilty cause of harm to himself and to others. In our civilization this usually takes the religious form of conviction of sin and a sense of helplessness without Divine aid; but even if there has been no religious instruction, it usually occurs in normal youths and maidens because they find themselves unable to meet the more complicated social situations into which they are now thrust, and the resulting condemnation and contempt of their associates convicts them of weakness if not of sin. This conviction, or the lack of it, together with the youth's faith that he can transcend his defects, is, perhaps, the most significant single indication for future success or failure, because it makes for teachableness or for incorrigibility in all fields of effort. Studies of religious conversion record the largest numbers of conversions between sixteen and seventeen for boys and a year or two younger for girls, followed in a considerable number of cases by a period of backsliding, and at about twenty by another rise of religious interest on a less emotional and more reasonable basis. It is a question whether the backsliding is not due to the unwise forcing of dogmas upon the adolescent, thus necessitating a later painful reconstruction of belief. Psychologically, it is significant that nearly all races mark the attainment of pubescence by rites and ceremonies intended to test the worthiness of the youth for adult responsibilities and privileges. Often prolonged fasting and the endurance of severe physical pain are required; the ability to resist fear is tested; reverence and obedience to the spirit world are demanded, and in some cases the youth's probation is not completed until he has heard a special call from the great spirit. In modern civilization the only representative of these initiation

ceremonies is confirmation, which is too commonly limited to a narrow religious meaning, but which should mark the fact that the youth has faced about from the egoistic outlook to the altruistic, and is acquiring the endurance and steadfastness which can belong only to the person who has lost small interests, fears, and hopes in the search for the ideal man. With this spiritual change, the youth passes into later adolescence, and is well on the way to the adult standpoint.

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SECTION XVIII

THE TEACHING OF SEX HYGIENE TO GIRLS

THE question of how young people first come into contact with the facts of sex demands careful consideration by parents and teachers. Many mothers, either intentionally or from moral cowardice, postpone all mention of such subjects to their girls until the latter are nearly or quite grown up; others leave it entirely to chance how and where their daughters shall obtain this knowledge. As a matter of fact, a girl rarely reaches puberty without having sought information on the subject, or had it accidentally or intentionally thrust upon her.

Some time ago an inquiry was made amongst the girls of a certain school to ascertain from what source each had derived her first information about the relation of the sexes. The sources recorded included not only young companions, teachers, and women-servants, but also tramps, grooms, brothers, and various other men and boys.

The Duty of Parent or Guardian. Even mothers who realize that they have a duty in this matter are too apt to assume that the difficult problems which gather round it need not be faced until their children "begin to grow up." The truth is that it is at birth that we all begin to grow up, and to the daily small habits begun in infancy the moral strength of mature life owes much. Many quite little children fall into bad habits through the ignorance of those in charge of them. A garment which rubs where it ought to be loose; hands straying over the body in bed, instead of being tucked under the pillow or cheek; carelessness in the manner of washing; or publicity where there ought to be privacy, are all examples of things concerning the avoidance of which the careful mother will be on the look-out. Modern children are apt to begin much earlier than those of former generations to

ask questions about the origin of life. As a rule, they take their own existence for granted, but the arrival of a new little sister or brother generally results in questions being asked as to where it came from. If the fullest confidence exists, as it ought to do, between a mother and her children, it will be to her that these questions will be brought. When they are asked, the essential things are that the answers given shall be absolutely true and as brief as possible.

The Importance of Truth. Nothing is commoner than to put such questions off with untruthful romances and joking answers. The child is told that the baby came in the doctor's bag, was brought by the nurse on the stork, or was found in the garden under a gooseberry bush. Many people, otherwise truthful and accurate, seem to regard this subject as one upon which it is allowable to make these untrue or absurd statements, never realizing that thereby they are giving stones, when bread of a specially good quality is required of them. How much better to tell the little child, truthfully and reverently, that the baby grew in its mother's body until it was big enough or strong enough to live separately. To know this only makes the child realize how entirely it belongs to the person it loves best in the world.

A very little new information is received by a young child as a full explanation. Therefore be brief. Satisfy its curiosity, which is nothing but a healthy thirst for knowledge. When further questions arise, it will come again to hear more. Only when untruths are told, and mysteries made about these things, is a less healthy curiosity developed, and the child comes to feel there is something unclean about what she ought to be shown is holy.

Direct Teaching in Home and School. When real education begins, not only do natural history, botany, and zoology contribute to a helpful mental background for this special teaching, but all interests and all knowledge help to fill the mind with materials for thought, and so keep out morbid and undesirable ideas.

Natural science, and observation of plants and animals, provide a language and analogies by which mothers and teachers can explain things otherwise in danger of becoming too personal.

Reference to sex, as we have said, is to be avoided with the younger children until they themselves bring questions. No mother, however, or woman who is taking the place of a mother towards girls, ought to allow them to go away to school, or reach puberty, without making an opportunity to tell them of the changes which are about to take place in their physiological functions. She ought also to explain their meaning and importance, and give the girls directions how to manage their health at that time. All this should be done in as simple a manner as possible, without fuss and sentiment. Mothers and teachers ought fully to be aware of the mental instability natural to the time of puberty and adolescence, and do all in their power to watch over the mental poise and balance of the girls for whom they are responsible. This is best accomplished by remembering that they are passing through the age of altruism, and that free opportunities of working for or helping others will be their wholesome and natural outlet. The greater liberty to work and mix with their fellow-creatures which is to-day given to girls is hence resulting in a sounder type of young womanhood than was common in the last century. A girl who has regular work, and opportunities of throwing herself into the lives of others, is less likely to spoil her life and that of her children by an unhappy marriage. She will not marry, as many of her ancestors did, for the mere sake of being married.

Before concluding, we wish to enter a strong protest against all class teaching to children on the subject of sex as it relates to human beings. The needs of one differ from those of another and, while individual talks may be of the greatest service, general lectures may only do harm. The expediency is quite different from that in the case of older women.

SECTION XIX

THE TEACHING OF SEX HYGIENE TO BOYS

Few parents or teachers who have faced the facts are satisfied with the negative practice of leaving sex-impulses to develop without educational recognition. There is good reason to believe that a little wise and friendly counsel would often save a wholesome life from avoidable unhappiness and enfeeblement. But the basis of ascertained fact as to the results of sex-instruction is still so narrow, that no dogmatism is permissible. Sex is a very personal quality, with extraordinarily subtle implications; and its discipline, like that of the religious emotions, is to be sought along lines of indirect, as well as of direct, culture.

Many shrink from the responsibility of breaking into the adolescent's reserve of mind. But there is no psychic violence or brutality in good, sound physiology which does not make the grotesque assumption that man has no reproductive system.

Doubt is also expressed whether teachers would be justified in attempting intrusion into what ought to be a parental responsibility. But it does not appear that parents do much in the way of discharging this particular responsibility. Few are able to utilize the indirect, impersonal, biological approach. The personal aspect of the case rises too obtrusively in the boy's mind when his parents speak to him about sex. Moreover, children who most need guidance, because of inborn predispositions to go wrong, are least likely to get it from their parents. The upshot of the *laissez faire* policy is that information regarding a central function in life is picked up haphazard, often in an inaccurate and discoloured form, often from sexually precocious or perverted acquaintances. While every care must be taken not to give premature instruction, every educationist will agree with Stanley Hall as regards the importance of getting the right

presentation first, pre-occupying the mind with a dignified, wholesome view.

Considerations that should Influence any Teaching. Supposing it to be granted that there should be *some* indirect or direct sex-instruction in boys' schools, we would make three preliminary notes—

1. In man we have to do with somewhat general and vague sex-impulses, not with precise and sharply-defined sex-instincts such as we see in many animals. Thus we have, in regard to sex-functions, very little instinctive knowledge of what various phenomena mean, or of what is quite normal, or of what is to be carefully avoided. We should, therefore, remember that a boy may slide into bad habits without being well aware of what is happening.

2. Too much must not be expected to result from teaching sex-hygiene, for habits are formed in the concrete by habitually doing or not doing; and if the moral tradition of the school or the conditions at home and elsewhere tend to the establishment of a vicious habit of word, thought, or deed, it is not likely that sex-instruction will serve as much of a counteractive. On the other hand, straight, firm teaching has great efficacy in sweeping away morbid curiosity, pruriency, and sniggering. And, again, if a boy has confidence in his teacher, he may get rid of a worrying obsession by having a quiet talk.

3. The mode of sex-instruction attempted should not be far ahead of contemporary public sentiment, and it is plain that it must be differentiated with reference to the various sections of the community and the ages of the pupils. What we suggest is a graduated series of methods, leaving it, of course, to the discretion of the teacher to discover and decide how far along the series, or along any line in the series, it is profitable to go.

What May Safely be Done. We say " discover," for one of the greatest difficulties is that we know so little, except through reminiscence, of the way in which the boy looks at sex and its expressions.

(*a*) Much may be done to promote wholesome

adolescence by developing external preoccupations and responsibilities, by opening up paths of legitimate excitement, by disciplines in self-control and in enduring hardness. Above all, as Stanley Hall says, develop motor activities.

(*b*) There is strong hopefulness in trying to establish associations between sex-impulses, regarded as the physical basis of love, and the chivalrous, the poetic, and the romantic. Without drawing morals in any tedious way from school-studies in history and biography, it is surely possible to make the fact clear that "control and chastity make marriages happy and nations strong; while the *corruptio optimi* is already hell." In indirect ways it may be possible to create a school-tradition which sets a premium on self-control, courtesy, and healthy-mindedness. It has often been found possible to put an end to jocularity of speech about "love," and vulgarity of mental attitude towards "sex."

(*c*) Many teachers have recorded the value of Nature-studies in clearing away the clouds that gather about sex. Much may be done—without in the least spoiling good botany and zoology—to let the open air into the whole subject of sex and reproduction, removing it from a human and personal reference, and studying it in its natural setting. This is perhaps easier in rural conditions, where some of the phenomena of sex and reproduction are too familiar to excite remark or cause embarrassment; but we may recall Thoreau's wise saying: "For him to whom sex is impure there are no flowers in Nature."

(*d*) Some are inclined to go a step further, maintaining that, as the boys cease to be children, there should be quite frank counsel given in regard to the dangers of adolescence and the best ways of dealing with them. Some head masters have straight talks with their boys; others lend books or tracts of good advice; in many cases the most effective counsel is that of the school physician, who can speak with most authority and without any embarrassment.

We would conclude this brief treatment of an extremely important subject with a quotation from the volume on *Sex* (see References): "Whether the sex-instruction is direct or indirect, through hygiene or through Nature-study; whether it is given by the parent or by the head of the school, by the science teacher or by lending booklets—care must be taken not to anticipate interest; not to excite; not to say what is untrue; not to teach what will have to be unlearned afterwards; not to make false mysteries (such as dusting a stigma with a pollen-laden feather might dispel); not to deal with the pathological; not to frighten; not to pretend that men and women are angels; and, above all, not to say too much."

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