Experimental Psychology and Educational Method.

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EXPERIMENTAL PSYCHOLOGY AND EDUCATIONAL METHOD.

To understand the true relation between the science of Psychology and the art of education, one should know something of the relation existing between science and art in general, between theory and practice as commonly understood. The law of causation operates everywhere. Nothing comes by chance. Scientific laws and general truths underlie every art but come into demand only when empirical art is found insufficient. This fact has been seen in every department of human activity; in medicine, in manufacture, in agriculture, and there is now beginning to be a science of education. Science and art are closely related: in formulating its theories and establishing its general truths, science must ever go to art for fact, for data upon which to build, and by which to correct error.

Theory, in turn, renders practice more free in its activity, throws new light on cause and effect, and gives insight into new possibilities. The artisan can now employ reason to advantage, and can pre-
dict with certainty; he is forced to grope his way no longer but can traverse new and better, though yet untried, paths with safety.

When teachers first began to teach, a knowledge of the subject was deemed the only essential. Socrates established the truth that whatever a man proposes to do, that thing he should learn to do before the doing is attempted. Notwithstanding this, it was not till within about a hundred years that a knowledge of method began to be recognized as an essential element in a teacher's qualifications. Teaching, even with method, was but an empirical art, a mere trade in which the underlying laws and truths of the human mind were considered of little or no importance. All other arts, aided, guided, supplemented, and corrected by their correlated sciences, made rapid progress. Labor, time, and material were saved; production was increased both in quantity and quality, while the art of education was the most unprogressive of them all. This was due to the fact that, concerning the human mind there was far more theory and speculation than observation and experiment. Many able educators were thoroughly interested, but the great multitude of conflicting theories and the bitter antagonism of opposing schools whose adherents revelled in abstract metaphysics, never condescending to investigate a human mind save perhaps their own deranged ones- these, I say, convinced the disheartened practical men that from such a metaphysical chaos they could expect little aid.

Knowledge alone- knowledge with method, both had been found inadequate. Psychological theories in general have ever been of such a
nature that they could scarcely have been carried into the class-room, even had they been correct. Within recent years men have been endeavoring to secure data from actual observation and experiment, from close study of the child, from measurements and tests; this data to be made the basis of general truths of human nature. "The art of education is now seeking to ground itself on scientific truths or principles" - page 4 of Sully's "Teachers' Hand-book of Psychology" - and again from page 8 - "What is really wanted as the groundwork of education is a body of well-ascertained truths respecting the fundamental properties of the human being, from which the right and sound methods of training the young may be seen to follow as conclusions."

Much has been done in recent years to collect this body of truths. Well-equipped laboratories for research in experimental psychology have sprung up in both Europe and America. In addition to the work done in these laboratories very much has been gained by tests and measurements made on school-children. All this work will be better understood and its significance more fully recognized after a brief survey of the function of sensation, this being the principal field of experimental investigation.

All of our ideas, our imaginings, and our reasonings are based on retained sense-impressions. This statement alone, though brief, shows the great value and necessity of a correct understanding of the senses and of memory, for this alone can lead to correct method.

Taste and smell are lowest in the scale of refinement. Their sensa-
tions are often vague and indefinite and frequently confused one with another. They are of little importance as knowledge-giving senses."

Touch is of great educational importance for it is through this sense that we obtain our clearest ideas of roughness, smoothness, texture of materials, form, and magnitude. The muscular sense gives sensations of bodily movement and also of the nature and degree of resistance to movement. It is thus the chief source of our ideas of weight, hardness, density, inelasticity, etc. Our clearest conceptions of form and magnitude require the use of this sense. A large share of our knowledge as well as much of the pleasure of life comes through the sense of hearing. Music as a source of pleasure and refinement has long been recognized, and when we think of spoken language and all the variety of nature's sounds we can not doubt the importance of hearing as a knowledge-giving sense. The sense of sight is preeminent in the scale of refinement. Its great utility throughout life, its wonderful value as a source of both pleasure and knowledge and the extreme delicacy and complexity of the organ of sight serve to make the sense a fit subject for study and experiment.

In the Educational Review of January, 1895, will be found a very suggestive article, "Tests on School Children." So valuable is this and so well adapted to our present purposes that we can well afford to give place here to an epitome of its chief points. The first sentence throws much light upon the reasons for such investigations: "We have come to recognize clearly the necessity of being sure that children possess no
defects that incapacitate them for school work or for which allowance
must be made in instruction." Tests should be begun when the child en-
ters school or before and kept up at regular intervals. Defects and
abnormalities, though slight, will thus be discovered at a time when
proper training and treatment can do very much toward improvement or
cure. Much trouble is often experienced by pupils in singing or in
drawing simply because the particular sense-organ concerned is defec-
tive. The exactions of ignorant teachers make school-life burdensome
to these unfortunates, while on the other hand careful tests would be of
inestimable benefit to them.

1. Tests on the memory.

In the tests for memory five distinct methods are proposed
a. Ten meaningless syllables are read to the pupils and they repeat as
many as they have remembered, this being the test for the auditory or
ear-memory.

b. For testing the eye-memory a set of ten syllables is printed on cards
and exposed to view for a definite time, usually for about five seconds,
time being given for the pupil to read them once. If six are remember-
ed we may say his ability is six-tenths of the maximum, or supposing
the average ability has been found to be five syllables, his standing
would be six-fifths, this method of grading being applicable to all
tests.

c. The pupil reads the syllables aloud from the card and afterward
repeating as many as he has retained, this constituting a test not only
for the combined eye and ear memory but also for the memory of the muscles used in speaking.

d. The pupil is required to copy the syllables from the printed card upon his slate. After erasing from the slate, a test is made to ascertain the number the pupil has remembered. It is plainly a test for the eye memory, the ear memory, and the muscular memory of the hand.

e. Ten complete and well chosen sentences are read to the pupil thus testing his memory for fact, a test in which the memory is aided by intelligence.

2. Extent of Consciousness.

For this, the author proposes but one test, that invented by Cattel, at Leipzig. The child is allowed to look for an instant at a card upon which is printed a number of letters. The exposure is made short enough to prevent counting and the pupil must guess at the number.

3. Eye space.

Pupils are asked to mark the middle points of straight lines placed in various positions before them. This test has reference to space as judged by the eye and has a practical bearing on drawing.


The pupil with arm free from the desk attempts to place the point of a pencil upon a dot on a card before him. He is also required to connect two dots by a line as nearly straight as he can make it at first attempt. The errors appearing in the two tests are accur-
Eye tests.

The eye tests are for sharpness of vision, for astigmatism, and for color-blindness. In the first record is made of the distance at which type of a certain size can be read. The second refers to the blurring of the parts of letters seen at a distance, while in the third a pile of variously colored worsteds are used from which pupils are asked to select skeins to match the one chosen by the examiner.

Hearing.

The tests of hearing have importance as a means of determining the range of the ear, discovering dullness of hearing, and ascertaining musical ability. In the first case a small Galton whistle is used to determine the highest tone and also the lowest which can be heard. With children it is only necessary to know that they can hear all the tones of the piano. The test for deafness is quite simple though not very accurate, measurement being made of the greatest distance at which the tick of a watch can be heard. In the test for sensitiveness to variations of pitch interesting results were obtained. "One little girl, six years of age, when asked to distinguish between two adjacent tones on the piano answered wrongly as many times as she answered correctly." With half tones she answered wrongly six times out of ten. In distinguishing which of two adjacent tones or half tones was the higher wrong answers were given about as frequently as correct ones. "Another girl of exactly the same age and in the same grade an-
7. Cutaneous Sensibility.

The tests of cutaneous sensibility may prove of considerable importance since it has been found that the criminal class is far less sensitive than the average person. An electric current passed through the skin is the best possible test for this although small cork weights of different sizes may be used with good result.

8. Suggestibility.

The last test proposed is for suggestibility. A weak current of electricity is passed through a small wire which is thus caused to increase in temperature. The pupil places his finger on the wire, the current is sent through and record is made of the number of seconds elapsing before the temperature is felt to rise. Three tests are made but in the second and third no connection is made, the very fact that the current is expected leading the pupil to believe that the wire is warm when it is not. The sensation is due entirely to the suggestions of the examiner, and the time required for the suggestion to take effect gives some idea of the suggestibility of the person.

In the American Journal of Psychology of April, 1892, may be found an article on "The Growth of Memory in School Children." The tests were made on about fifteen hundred Grammar School pupils of Worcester, Mass., together with some from both the High School and the Normal School of that place. A series of numbers was carefully arranged and read before the classes to be tested. The numbers contained
from five to nine digits, each number being called an observation. Nine observations constituted a test in the eighth and ninth grades while with other classes twelve observations were made at each test. Each class was tested on four different occasions, the order of the digits being entirely different for each occasion. In the lower grades, the first three observations of each test were made with five digits; the second three with six; the third three with seven and the last three with eight. In the higher grades and in the High School the first three observations were made with six digits and in the Normal School with seven. An observation was considered correct when only those digits which the teachers had dictated were present in the same order as that in which they had been read.

The tests do not apply to the retentiveness of the memory but serve to measure the memory span, and may be considered as tests of the power of concentrated and sustained attention; errors were of three principal classes; 1. displacement of the order of the digits; 2. substitution of other digits for those dictated; 3. mistakes in estimating the number of digits. The results of all these tests were arranged in tables from which the author has drawn some very interesting conclusions, a part of which are here given: The limit to the memory span for the pupils of the public school is six. The memory span increases with age rather than with growth of intelligence, it being a measure of the power of concentrated and prolonged attention.

Intellectual acuteness is more frequently but not necessarily
accompanied by a good memory-span and great power of concentrated and prolonged attention. Girls have better memories than boys. Ability in remembering groups of digits increases with practice. Pupils unconsciously remember digits that they heard a day before, when they are used a second time.

An article entitled "Some Influences which Affect the Rapidity of Voluntary Movements" appeared in August, 1892, in the same periodical as the above. The author made over four hundred tests to determine the rate at which one may tap on a Morse key. Three hundred taps were made at each test, the tests being made at all hours of the day and under greatly varying conditions of both body and mind. A single sentence from this article will show good reason for such experiments: "The fact that central activity is accompanied by the power to make rapid voluntary movements suggests that the rate at which voluntary movements can be made, may be taken as something of an index of central nervous activity." It was found that the slowest rate was at 8 a.m., and the most rapid at 4 p.m., also that a vigorous walk lowers the rate, while increased central activity, due either to close mental application or to excitement, was followed by an increase in the rate. These diurnal variations indicate differences in central nervous activity.

The same author as the above has written a most able and instructive article on "Fatigue." It is found in the "Pedagogical Seminar" of June, 1892. In this review of the article an attempt will be
made to restate the main points of the discussion and to give their application to educational method. The article sets forth the principal conditions which influence normal endurance; touches upon muscular fatigue and its relation to mental fatigue; gives the symptoms and results of brain-fag or mental exhaustion and closes with some very appropriate remarks concerning our present school system,

"Fatigue," says our author, "arises from exertion either mental or physical." We tire more readily when the work is distasteful or when the organs are unhealthy. The season of the year, time of day, condition of the atmosphere, loss of sleep, fasting, and amount of intervening rests all have their effect upon normal endurance and upon the amount of work one can perform. Alcohol temporarily increases the amount of work, while tobacco diminishes it. Rapid growth diminishes endurance. Anaemia, or lessening of the amount of blood in the body, has a marked effect on normal endurance.

Normal muscular fatigue is due in part to fatigue of the nervous centers and not wholly to fatigue of the muscles themselves. Oxygen is the one thing which gives immediate relief to fatigue.

Fatiguing examinations have been found to lessen the muscular power. It is believed that changes in the blood rather than the nerves bring about this result. Worn-out blood from a tired dog was injected into the veins of a vigorous one, producing in him all the signs of fatigue while no such change was seen when fresh blood was injected into a vigorous animal. Vigorous exercise of one set of muscles pro-
duced marked changes in the rapidity of movement in another set, although these latter muscles had been kept perfectly quiet during the exercise of the first. In normal fatigue, the mental symptoms may include loss of memory; lessening in acuteness of sense-perception; diminishing of the vocabulary; lowering of the emotional tone; and falling off in power to concentrate the attention. Rest and sleep bring renewed power. Mental fatigue causes temporary fits of color-blindness, loss of memory for common things, and a slowing of reaction time. Mental fatigue interferes with sleep thus making it much more wearing than bodily fatigue. Difficulty in fixing and holding the attention is given as one of the early effects of fatigue. A feeling of weariness promotes careless thought processes and slovenly habits of life.

Normal fatigue may give place to "brain-fag" in which the results are much more serious. In this condition of brain exhaustion the brain cells are unable to store up energy sufficient to meet the demands made upon them. The symptoms are according to Beard, impaired sleep; mind unpleasantly alert and following a train of ideas not desired; morning tire; worrying over trivial things; inability to bear responsibility; sudden collapse of the mental faculties; the mind seems for a time obscured by a cloud; defective and uncertain will; lack of power to inhibit, this having most dangerous and far reaching effects on the moral life; a pessimistic view of things; morbid introspection; exaggeration of slight illness; poor memory.

Perhaps no subject is of such vital importance, intellectually,
physically, and morally as this oft neglected one of fatigue. This is 
an age of hurry and excitement, an age in which education seems almost 
to be less of a growth than of a cramming and crowding process. The 
youth of today is so crowded through school and college that he is 
forced to sacrifice that for which he labors: power to think and do. 
Too little attention is given to the individual but rather a certain 
large amount of work must be done by all and done in a certain defin­
ite manner thus barring out spontaneity and originality and encourag­
ing habits of uninterested study. A thing is learned merely as a means 
to promotion. Although it may not be strictly true that "all diseases 
have their genesis in fatigue" yet we amy safely say that to our mod­
ern educational method is due many bodily diseases and abnormalities. 
Power in adult life is sacrificed for precocity in childhood; chronic 
fatigue is brought on, and since this is the basis of morbid conscious 
life we have thus introduced an ethical question of very great impor­
tance. So intimate is the relation between body and mind that our views 
of life, our reflections and interpretations are profoundly influenced 
by our bodily feelings.

This subject of fatigue brings up for discussion such practical 
questions as the length and frequency not only of recitations but of 
intermissions as well, with the nature and amount of exercise pupils 
should take. As it has already been seen that rapid growth diminishes 
endurance, it is almost unnecessary to add that it is wrong to exact 
the same amount of work from all, even of the same grade.
An article entitled "The Physical Basis of Precocity and Dullness," appeared as Vol VI., No. 7, of the "Transactions of the Academy of Science of St. Louis" under the date of March 21, 1893. "The weight, height, length and breadth of head, vital capacity of chest, acuteness of vision, nationality of parents, and many other facts were secured from thirty-thousand boys and girls." These measurements were made upon school children of St. Louis, largely by teachers themselves, and had for their object the discovery of such laws of growth as will aid in more scientific grading of schools, physical capacity rather than age or percentages, being made a basis for apportionment of school tasks. Weight has been found to bear such a close relation to strength that it was used in this work as an index of vital capacity. Several tables were prepared showing full results of the investigations and from these tables it was possible to obtain curves, the nature and importance of which may be seen from an examination of the conclusions which have been drawn from them.

Precocious children are heavier and taller and dull children lighter and shorter than the mean child of the same age. Successful pupils have larger chests than the unsuccessful. More advanced pupils have greater width of head than those less advanced of the same age.

These investigations show that there is a physical basis for precocity and dullness; that dull children are in the mean weaker and precocious children stronger than the average child and that mediocrity of mind is associated in the mean with mediocrity of physique. The
practical application to be made of all this is, according to the au-

"No child whose weight is below the average of its age should be
permitted to enter a school grade beyond the average of its age, except
after such a physical examination as shall make it probable that the
child's strength shall be equal to the strain."

The demand for immediate and practical results leads many per-
sons today to doubt the value of modern physiological psychology. They
forget the early history of geology, chemistry, electricity, and the
other sciences now of such practical value. The fundamental laws and
principle of these sciences were not obtained by a few unscientific
observations and experiments. Neither was the discovery of these laws
and principles immediately followed by their practical application.
Time is required in which to accumulate data; to put this data into
orderly arrangement; to obtain from this mass of details general truths,
and finally, to discover the application of these truths. The present
has no right to determine the final value of the material now being
so rapidly collected. In addition to the present beneficial results al-
ready suggested, far greater returns may be expected as the science de-
velopes. "Sagacious men are saying that the next years are to be the
Psychological Epoch. The most practical questions, the questions in
which men generally are most intensely interested - the questions of
health, education, government, and religion, which are deepest in the
conscious and unconscious life of the world, - these are the questions
for which modern Psychology is gathering force."