SCIENCE

NEW YORK, JULY 28, 1893.

SYSTEMATIZED GRADUATE INSTRUCTION IN PSYCHOLOGY.

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Instruction in psychology cannot be said to have been placed on a sound basis till it consists of a series of carefully graded teaching from elementary text-book instruction to the highest kind of original work. Haphazard work here is just as bad as anywhere. It is self-evident that the student of psychology should properly apportion the amount of time spent in its various departments and in the other sciences he will have need of. The man who starts with the supposition that the way to study psychology is to go into the anatomical laboratory on the one hand and to take heavy courses in Greek philosophy on the other, is losing much valuable time. It is hereby not implied that no time is to be given to these subjects any more than that geometry and history are to be omitted from a man's education. But when a man has finished his college work and goes to the university he is supposed to have received his general culture and to be ready for his life-work.

The specialist is a man of broader knowledge than the dilettante. The difference between the two is that the latter browses at random, while the former reaches over a much wider field, but with a careful selection and coördination of the portions related to some central point. There is a maximum of energy and health which a man can employ in work; if this capital is invested in a careless way it will bring in small returns; the man will never really gain a complete training in anything.

The problem of a specialist is to go over as much ground as possible; to do this it is necessary to pass rapidly over the less valuable portions in order to have time for the valuable ones further on. Moreover, no essentials should be overlooked, no matter how distant they apparently lie. This last requirement is probably the most important of all. There is many a psychologist to-day who is fatally weak in some one or more points; it would be easy to find those who, although making measurements, know nothing of the science of measurement, or who, using light, heat, etc., as tools in their experiments, have little idea of the laws of the forces they are handling. To remedy all these defects in the dilettante way a man would have to study a couple dozen sciences; since life is too short to learn even one with any respectable thoroughness, the only way to do is to take just what will be of the most advantage to the psychologist, always bearing in mind that an hour too much on any one point means an hour too little on some other one.

It is the first problem of the psychological laboratory or the psychological department to so arrange its courses as to satisfy these requirements. As my own experience may possibly be of use to some one I will indicate briefly the outline of a system of instruction designed to meet this want. It is to be borne in mind that I am not speaking of college work with the object of general culture, but of serious university work for one who desires to study psychology.

As the science of psychology to-day is based on measurement and experiment, the work of the student must begin with some considerations on the method of making experiments; this should be followed by careful work in the theory of measurements, treating of the probability integral, the mean variation, etc. This work resembles somewhat the corresponding work given in physical measurements, but although the mathematical principles are the same, the treatment differs considerably. One of the great differences between psychological and physical measurements is that the conditions cannot yet be as accurately controlled as in physics; our mean variations are thus greater and the deductions we can draw from the results are not the same. In this respect psychological measurements on a single person somewhat resemble measurements taken once on each of a large number of persons. Partly for this reason, but mainly also for the sake of mental statistics, a study of the methods of statistics has to be made. The making of measurements brings in the study of fundamental and derived units and the construction of apparatus. The study of the various subjects of touch, sight, hearing, etc., requires a consideration of the physical processes used in stimulation. Thereafter the usual psychological subjects are, in a lecture course, to be treated in detail.

Hearing lectures will never make a psychologist; the fundamental course for all special instruction is the laboratory work. The student must be trained by repeated exercises in making the measurements explained in the lectures, including exercises on touch, temperature, hearing, sight, in the graphic method, chronometry, dynamometry, audiometry, photoptometry, colorimetry (psychological), etc. This should be followed by work in the construction of apparatus, elements of mechanical drawing, use of tools, etc. It is of great importance not to have too many men at work at the same time, at least not until psychological laboratories are much enlarged. During the past year the average attendance on this course in the Yale laboratory has been eight, an unpracticable number. Even with the enlarged equipment for the coming academic year, the number admitted to this practice course will have to be limited.

The object of university instruction, as distinguished from college training, is to develop the love of research, to train the student in research methods, to furnish him with the requisite knowledge and skill, and finally to provide him with the apparatus and other means of work for carrying out such investigations as may be best for him to undertake. The requisite knowledge of the psychological methods is gained from the laboratory course, the training in the difficulties and methods involved in research is obtained by placing the newer students as helpers to the advanced ones. The importance of this last arrangement can hardly be overestimated. It is the one in vogue at Leipzig and elsewhere.

It is a very dangerous thing for a man to take up a problem for investigation unless by previous experience with some one else he has found out that research is the hardest kind of work and has learned the thinking, the untiring patience, the courage under defeat that are called for at the various stages of work.

If we regard the research work as a means of training, it is an important matter to the student that he shall not undertake problems with rather indefinite boundaries or those where he may perchance run wild or be led into careless work. There can be no better training than that found in the investigation of a single point where the most careful measurements and manipulation are required. Once the student has learned the proper habits he will do far better work with suggestive and uncertain problems than could otherwise be hoped for.

If a student has had the proper general culture in philosophy, physics and mathematics, such a course as that outlined ought to make a thorough psychologist out of him. If he has not had the proper college training it behooves him to make it up as fast as possible. In the first place, an acquaintance with German is absolutely indispensable. Some acquaintance with the epistemological theories of the day is also necessary. A thorough scientist in psychology could not get along without knowing some-thing about calculus, at least enough to follow the developments in such works as Müller's *Grundlegung* or Weinstein's *Physikalische Maassbestimmungen*. The more physics he knows the better.

OUR CRIPPLED WEATHER SERVICE.

BY JAMES P. HALL, BROOKLYN, N.Y.

A recent order of the new Secretary of Agriculture stops all the scientific research which, until this month, was being conducted by the United States Weather Bureau, and limits the functions of the experts in the Central Office to mere forecasting. Quite apart from all personal and political considerations, this is a lamentable event on many accounts.

It appears to be necessary, even in this enlightened age, to prove afresh that "pure science" is a prerequisite to most of our material progress. We are still under the necessity of making out that Columbus, who conceived that other lands lay to the westward of the great Atlantic, who visited one potentate after another to secure aid for his schemes, who haunted the courts and camps of Ferdinand and Isabella year after year, and who backed up his case with only the calculations of "pure science," really served Spain in particular, and civilization in general, quite as well as the "practical" men who handled the ropes and sails of the three caravels. We must elaborately demonstrate, all over again, to some of our fellow-countrymen that the unknown inventor of the mariner's compass and those other "pure scientists" who make charts showing the deviation of the needle, have conferred as great benefits on mankind as the pilot who uses that quivering bit of steel in bringing his ship safely across the seas. We must be prepared to face a question whether the captain of a New England fishing smack who thumbs his almanac to find out at what hour the tide rises or falls on a given day is not, after all, the superior (as an agent in civilization) to those learned astronomers and mathematicians who compute the tables for that little pamphlet. We must not be surprised if sane, intelligent, even eminent men, tell us that all the amazing development in steel production which we have witnessed in Europe and America in the last quarter of a century would have come just as soon—perhaps sooner—if Henry Bessemer had not carefully evolved his wonderful process from chemical theories and laboratory tests, nor ought it to startle us if some one insists that the sweating laborer in a rail mill, who grasps with tongs the fiery snake which emerges from the rollers and drags it away to have its ends sawed off, does more toward the building of a safe and lasting road than the expert who sits at a table and figures out the precise cross-section of rail that will give the greatest resistance to all the complex strains to which those bars must be subjected in service, even though these calculations extend over years and are based on long-extended and carefully designed tests. We cannot count on the universal acceptance of our opinion—if it happens to be our opinion—that Roebling, in computing the exact size and number of the wires to hold up a bridge over East River, and in drafting all the plans for that wonderful structure, was at all comparable in usefulness with the truckman who now drives a two-horse team across it every day. If we positively assert that the projectors of the great railway systems beyond the Mississippi have done more than the men who drove spikes with sledge-hammers to open up that region to settlement and to provide outlets for the enormous grain and pork product which has resulted, we know not how soon nor how flatly we shall be contradicted. We may meekly hint that the physician who prescribes does as much to cure us as the drug clerk who compounds the prescription; that the arithmetic maker is as much of a public benefactor as the corner groceryman who foots up the total cost of ten pounds of sugar and two pounds of coffee; that Edison, who perfected the incandescent lamp after long years of experiment with no end of substances for his filament, did as much to give us an electric light as the man who tacks up cloth-covered wire in our offices and screws pear-shaped globes into wall-fixtures; that Graham Bell was quite as instrumental in enabling us to converse over a wire with people a dozen miles away as the patient girl who answers our ring and sticks a little brass plug in a hole for us; and that we owe as much to the long array of designers, from Watts to Buchanan, who have brought the locomotive engine up to its present perfection, as the engineer on the "limited" express for the marvellous speed we make in going to Chicago; but we must not mistake for conviction the tolerance with which these utterances are received.

And so in meteorology. There are minds so constituted that they regard the observer as the equal or superior of the inventor of the barometer and thermometer; the "practical" man who jots down figures on a map and then draws "isobars," "isotherms" and wind signs on it as more useful than the pure scientist who, without touching pencil to paper, studies the movements of high and low pressure areas across the country, and the man who guesses what changes will occur during the next twenty-four hours, in the shape, size, position, intensity and other features of the cyclonic and anti-cyclonic systems, are doing better work than one who discovers and formulates the laws that govern those changes, and thus renders forecasting possible. What makes this the more amazing is the insufficiency of our present rules for weather predictions. The principles involved are not yet fully established. The most successful experts in this line realize that they are working under only a provisional code that must be greatly modified and supplemented. There is not a science so young and undeveloped as meteorology; there is not a bureau in the national government whose maxims and procedure are not better established, nor, when one considers the immense and varied interests—railway, shipping, agricultural, commercial and individual—which are affected by the weather, is there any branch of the service which affects so many people, and affects them so directly, as this, unless we except the postal business? Not to strain every nerve to improve the quality and character of the work by fuller inquiry into fundamental theories is folly, if not crime. Such a policy of neglect involves direct waste, as ignorance always does. Our expenditure, year after year, would not thus be made to the best possible advantage. On the other hand, to use one per cent ($10,000), out of the $1,000,000 appropriated for the bureau, in expert work, would be a measure of true economy by gradually revealing how best to use the rest. That has been true of the bureau from the start; and it has never been a wiser course than it would be now. Any manager of a creamery, sawmill, cotton factory, iron foundry or railroad who deliberately threw away such a chance as this for improving what everyone recognized as the inadequate facilities of his business, at a trifling cost, would be set down by "practical" men as strangely blind or culpably reckless.

ANALOGOUS VARIATIONS IN SPHAGNACEÆ (PEAT-MOSSES).

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IN the "Origin of Species" (6th ed , p. 126) there is the following passage, under the heading of "Analogous Variations:" "As all the species of the same genus are supposed to be descended from a common progenitor, it ought to be expected that they would occasionally vary in an analogous manner, so that the varieties of two or more species would resemble each other, or that a variety of one species would resemble in certain characters another and distinct species,—this other species being, according to our view, only a well-marked and permanent variety."

A clear example of this is of considerable value in the support it gives to the theory of descent; but, as Darwin goes on to show, there are several reasons why such examples are not common.

A very striking illustration is, however, to be seen among the peat-mosses, or species of Sphagnum, and, as I do not know that anyone has drawn attention to the facts from this point of view, I think it may be of interest to present them briefly. Many of the facts quoted below are taken from a paper by C. Jensen (translated in the *Revue Bryologigue*, 1887, p. 33, by F. Gravet), entitled "Les Variations Analogues dans les Sphagnaceés."

Sphagnum acutifolium may be taken as a typical species of the genus; in its most characteristic form it is a plant with tall, slender stems, bearing at intervals fascicles of simple branches of two kinds, the one (divergent) stouter and more or less horizontal,