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THE DIFFERENTIATION OF VOCATIONAL APTITUDES¹

BY CLARK L. HULL

Yale University

The object of this paper is to discuss the significance of aptitude testing as a technique in solving problems of vocational guidance. The method proposed is one so flexible in character as to make possible its coordination with the analysis of interests, the personal interview and other methods of guidance in such a way as to give each approach the weight which it should have in order to contribute its maximum to accuracy in the forecasting of aptitude.

At the outset of this discussion it is important to point out that there is a tremendous amount of misinformation concerning the value of aptitude tests. If time and space were available, it would be desirable to state the many faults of psychological tests. No one knows quite so much about their weaknesses as those who are actively engaged in experimental research in the field of tests.

One of these weaknesses is associated with the so-called problem of the "measurement of intelligence." I wish at once to make my position quite clear on that point. In vocational guidance, at least, we should not think of intelligence in general but of intelligences. To be quite specific the Binet Simon tests measure only a very narrow range of ability. It is very misleading to call this intelligence, with the implication that it is the only form of intelligence or aptitude. The fact is that the Binet tests are really tests of academic aptitude—primarily the aptitude for learning the subjects in a common school curriculum. The Binet tests are not even tests for all of the common school studies. There are, obviously, many other aptitudes in addition to the academic. No one knows how many. It is most unfortunate that the notion has become current that the scholastic type of intelligence is the only form of intelligence or desirable aptitude.

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It is too often assumed if a child is known to have a mediocre aptitude for school learning that he is necessarily mediocre in everything else. This is very far from being the case. By way of illustration I should like you to consider the case of Jim Goodwell. Jim Goodwell was a classmate of mine in grammar school. We used to stand in a row with our toes on a chalk mark and spell. We had a system whereby the person who missed a word moved down one step and the person who spelled it moved up above him toward the head of the class. I remember that Jim always stood very near the foot of the class. I can see him now. At the beginning of each recitation the person who had been at the head the day before would be at the foot. As the first word came along Jim would always get ready to move down; even before the word reached him. The same general picture obtained throughout all of his school work.

But in the years since our school days Jim has forgotten all about his tribulations in the grade school. He has become a prosperous farmer. He owns broad acres of land and large barns and has much money in the bank. I suppose that in this world's goods Jim Goodwell is decidedly more prosperous than any of the people who looked with disdain on his ability to master the common school subjects. This is by no means an isolated case. Nearly everyone can point to cases which are very similar. Many historical characters have shown a somewhat similar picture. To mention one or two, I may recall that Goldsmith was never able to master mathematics. Even the great Napoleon was regarded by his Latin teacher as a boy without intellectual gifts and when he took his final examinations at the Military Academy, he is said to have passed them only "after a fashion."

In this connection I recall the case which Walter Dill Scott likes to relate concerning his dumb salesman. It seems that Scott was trying to develop intelligence tests which would enable him to select efficient salesmen. When he came to compare the test scores with the success of the men he found one case in particular which depressed him. This one man showed by his intelligence test that he was almost feeble-minded, yet he had one of the very best sales records of the group. He took the matter up with the employer and found this interesting situation. It seems that the salesman in question was a large and jovial individual, overflowing with the milk of human kindness. His job was selling pickles to small retail grocers. He would go to the grocery store and engage the wife of the grocer in conversation, inquiring about the ills of the children

and showing genuine interest in the family. Then he would talk pickles to them and they would buy all that the trade would stand. But the man was so feeble in his scholastic capacities, that the Company was forced to send along with him an assistant to take down the orders. However in the capacity to sell pickles the man was a kind of genius.

This lack of correlation between academic aptitude and vocational success is so marked that when university students have been told by the Dean, for the last time, that they must withdraw because of defective aptitude for university studies, I have uniformly been able to counsel them with the greatest optimism. I assure them that all is not lost by any means. I advise them to go back home and to enter business and get rich. They usually accept my advice. In such cases the ordinary course is for the boy to apprentice himself in the arts of buying cheap and selling dear; in the course of a few years wealth accumulates; in due time he may even look forward to becoming President of the Kiwanis Club!

It is clear, I think, that every person has a certain potentiality for every possible vocation in the world. Probably in no two of these many potential aptitudes is any man exactly alike. The question arises at this point as to the manner in which the numerous potentialities within each human being distribute themselves over the range of ability. Some research has been devoted to this subject. The indication is quite clear that the various aptitudes of a given person tend to cluster about a central tendency and to scatter themselves out in each direction in fewer and fewer numbers. Thus for a given person the greater part of his potentialities lie in a middle range, whereas a few scatter out in the direction of comparatively high ability and a corresponding scattering tails off in the direction of very low ability.

From the point of view of vocational guidance a further very pertinent question arises at this point: How much better is the average person's best aptitude than his worst—how many times more efficient is his aptitude at the upper extreme than his aptitude falling at the lower extreme? Here, the experimental evidence is not as clear as we should like. The present evidence indicates rather strongly that the average person's highest or most efficient aptitude is somewhere between $2\frac{1}{2}$ and 3 times as great as his weakest. If this ratio turns out to be true of vocational aptitudes in general, as it probably will, it becomes a matter of tremendous individual and social significance that each person should pursue the vocation which

lies at his highest extreme of efficiency rather than the one which lies at the lowest extreme. It is the job of vocational guidance to see that this is done. To put the matter in a different way; it is the job of vocational guidance to indicate to the youth seeking vocational advice that vocation, of all those in the world, in which he has greatest potentiality of success. This involves something more than vocational prognosis. It requires differential prognosis,—a very different thing.

To accomplish differential vocational prognosis in any adequate manner, many things must be done. In the first place, we must know which are the type aptitudes. It is quite evident that many of the almost innumerable vocations of the world will turn out psychologically to be rather similar in the human talents necessary for success. These groups of psychologically similar vocations I shall call vocational types or type occupations. Before any really scientific vocational guidance can be carried out we must know the grouping of the important vocations in this respect. At the present moment we have only the haziest notions as to what these groupings are, or even as to how many important type occupations exist. I have occasionally expressed the conjecture that there might be forty or fifty type occupations, but this is nothing but a guess. What is worse, we do not yet possess the necessary mathematical devices or the experimental procedures by which the several type occupations may be isolated. I am glad to tell you, however, that some of the best minds in this country are occupied with this problem and to predict that before long we shall probably be possessed of both the mathematical devices and the experimental procedures.

But suppose we had our type occupations isolated and there should turn out to be as many as fifty important types. What is the next step? Obviously we must determine which of these various type occupations each individual is best endowed to pursue. Without further preliminaries, I submit to you that there is fundamentally only one way in which this can be done. We must determine in comparable quantitative terms his potential aptitude for every single one of these type vocations. This is what I described above as differential aptitude prognosis.

If we were to proceed upon the current practices in the matter of aptitude testing this would necessarily involve the construction of a battery of tests for each type occupation. If there were fifty type occupations there would need be fifty aptitude test batteries. Please observe what this would involve. Probably no person could

be tested on more than two aptitude test batteries in the course of a day and do himself justice; one in the morning and one in the afternoon. At this rate it would require twenty-five days of the subject's time, to say nothing of the time required of an expert examiner to put the subject through such a system of testing. This clearly would consume practically all the working days of the month, to which must be added the time required to score and interpret such a mass of test results. Such a huge amount of labor would prohibit the undertaking almost at the outset. It is clear that if aptitude testing is to operate effectively in vocational guidance some other method than that now in vogue must be found.

It is not at all difficult to conceive of a vastly more effective system. It is clear that according to the system of aptitude testing now in vogue, the fifty test batteries would have an immense amount of duplication of test units. Certain tests would appear in nearly all of the fifty test batteries. Other tests would appear in perhaps half of them. Yet other tests would appear in fewer batteries, but still in more than one. Briefly stated, the solution of this duplicating test problem is to organize a single universal test battery which will contain all of the test units which would appear in any of the particular test batteries which might be organized for separate type occupations. In this universal battery the individual test units would be administered but once. There might be 50 or 60 such test units. Perhaps this would consume two or three days, but surely enormously less time than would the testing by current methods.

The next step would be to make separate forecasts for all of the type vocations from the test scores thus secured on the universal aptitude battery. It happens that mathematicians have developed certain statistical devices by which separate forecasts of distinct aptitudes may be made from the same set of test scores. These mathematical devices are known as multiple regression equations. In plain language a multiple regression equation is a formula into which the scores from a battery of tests may be substituted and which, when solved, will yield the best possible prediction for a given aptitude that may be secured from the set of data in question. Each vocation must have a separate formula developed especially to predict it. This means that if there were 50 type occupations there would need to be 50 aptitude forecasting formulae developed; one for each vocation. The development of these prediction formulae is a somewhat technical matter and involves considerable experimental as well as mathematical analysis. Indeed, it is a fair sized research

problem. But once the prediction formulae for the various vocations have been developed all that is necessary in order to obtain differential forecasts is to substitute the test scores first in one formula, then in another and so on until in the end there will be obtained a forecast for each one of the type occupations. In brief, then, the proposed system would have a single test battery from which all of the aptitude forecasts would be obtained by means of a multiplicity of prediction formulae all based upon the same set of tests.

Once a complete set of comparable aptitude predictions has been made a rational and scientific vocational guidance becomes possible. The youth seeking vocational guidance may now pass down the list of quantitative forecasts seeking out those vocations in which his potentiality is weakest. These may be carefully avoided. He may then examine the list to find those vocations in which his potentiality appears to be greatest. From the latter list he may consult his interests, tastes and the opportunities of his particular location and status in life and make a choice which will no longer be due essentially to chance as is often the case at present.

It will be at once obvious to everyone familiar with the present state of vocational guidance that the picture which I have painted is very far from present realization. What I have tried to do is to indicate what seems destined to be the ultimate course in this field. Before anything like what I have sketched will be realized an immense amount of research must be carried out. As already indicated we must develop methods and techniques for the isolation of the type occupations. Then these techniques must be applied until the type occupations have been discovered. There must be, in addition, extensive research, carried on for the development of the multiple regression equation, by which these type vocations will be predicted from the test scores of the universal aptitude test battery, each equation probably involving a major research. Moreover, there must be extensive research carried on which will widen the range of our aptitude tests.

The pressing need for the wider sampling of traits which will assist in making aptitude forecasts is evident upon considering the efficiency of present-day aptitude tests. It is the habit of psychologists to report the validity of their tests in terms of the correlation coefficient. This coefficient is a decimal ranging from .00 to 1.00. Most aptitude tests at present yield a correlation coefficient with the aptitude predicted, ranging from $+.45$ to $+.65$. Most persons who are not technically engaged in aptitude testing quite naturally take

this value as a statement of aptitude forecasting efficiency. Nothing could be more misleading. The actual forecasting efficiency of a test battery correlating $+ .45$ with a criterion is only about 10%, whereas the correlation of $+ .65$ has the efficiency of only about 25%. Probably there has never yet been constructed a test battery which had an actual forecasting efficiency higher than 30%. It is not my wish to discourage anyone in the use of psychological tests. Nevertheless the truth must be told. To me these facts constitute a challenge. We must sample a wider range of evidence to the end that our test batteries will yield more efficient aptitude forecasts.

It is notorious that tests in current use tend to stress the verbal and scholastic elements out of all proportion. Our present tests involve altogether too much pencil-and-paper psychology. There is a healthy movement at present in the direction of investigating the relationships between anatomical, chemical and physiological constitution on the one hand, and temperamental and emotional traits on the other, to aptitudes. These fields of investigation are difficult and very laborious, but there is reason to hope that ultimately we shall be able to tap sources of vocational potentialities which are at present entirely ignored.

I should like to cite one particular approach to this with which I had been more recently concerned. It is the matter of suggestibility. There is a very widespread belief that for a person to be suggestible is an unfortunate thing. In my laboratory, we have within a few weeks found evidence which indicates that this is completely in error. We find in the case of some 60 pupil nurses that a test of suggestibility showed positive correlations with some half dozen character traits which were generally regarded as desirable. Some of these are sympathy, tact and cooperativeness. It is also very generally believed, possibly through the influence of the Binet-Simon tests, that suggestibility is an evidence of feeble-mindedness. Experimental evidence seems to indicate that with ordinary hetero-suggestion there is actually a small positive correlation with university grades. Certainly there is no negative relationship.

In the direction of securing more adequate samples of the evidence necessary to make effective vocational forecasts, I venture the prediction that when the system which I am speaking of gets under way we shall find the testing done under somewhat different conditions from those obtaining at present. I should not be greatly surprised if groups of young people who are seeking vocational guidance would be invited to spend a number of days in a specially pre-

pared environment where the facilities for testing would be much more favorable than is ordinarily the case. It would be desirable that these people should spend some time in such a place so that the strangeness would have largely disappeared; and so that their diet and sleeping hours might have become equalized. In such an institution it would be possible to test a great variety of chemical and physiological functions which are not now even considered. It is conceivable that such an examination might consume a period of a week or even longer. This may sound very extravagant, in the light of present practices, but I submit to you: Would it not be worth spending a week or even a month of the time of a youth if by so doing he minimize the danger of choosing a vocation which is even a little less advantageous than his best?

Fortunately a part of this program is already completed. Once the test scores from a universal battery such as that sketched above are available there is the very considerable task of substituting them in the prediction formulae in such a way as to obtain the several aptitude forecasts. This is a very considerable task. Somewhere between 1500 and 2000 arithmetical operations would probably be necessary in the obtaining of 50 aptitude predictions. In addition, if this were done by ordinary methods there would certainly be grave danger of arithmetical errors. It happens that recently while engaged in the design of an automatic correlation calculation machine I hit upon a design for a mechanism into which could be placed any number of forecasting formulae in the form of a perforated metal band, somewhat resembling a music roll in appearance. With the machine so equipped, it would be possible to utilize also a piece of perforated paper tape upon which had been recorded the test scores of the subject on the universal battery of tests. This piece of perforated paper would be in the form of a band so arranged that it could go round and round through the machine like a belt over a wheel. And each time it went around, the machine would substitute the test scores in one of the forecasting formulae and automatically make the aptitude prediction for that subject on the vocation for which the formula had been constructed. The final form of the machine's design is such that each time a prediction is made the prediction itself will be stamped down as a number on a card opposite the name of the vocation in question. These predictions will be made automatically by the machine one after another without any attention whatever from the operator. When the last of the 50 predictions has been made and recorded by the machine it will ring a

bell calling the operator who will take out the card. It may then be presented to the person seeking vocational guidance. He may look down this series of comparable quantitative aptitude predictions and choose his vocation rationally as previously indicated.

No doubt this all sounds very much like an extravagant Utopian dream. I am glad to be able to tell you that the machine of which I have just spoken is not entirely a dream. One of these machines was constructed under my direction at the University of Wisconsin at a cost of some \$3000. The money was furnished by the National Research Council. This machine is really able to make aptitude forecasts although the automatic recording attachment has not yet been constructed.

To sum up the situation: We know something of the problems which are facing us and we know a good deal about how these problems must be solved. I believe I have indicated to you fairly accurately what the nature of the ultimate development will be. The program is essentially one of experimental research. The goal will not be reached in five years. I have hopes that in ten years we will have made a very substantial beginning. Possibly it will come sooner but one thing is sure: It will mean a continuous adjustment for a long, long time. There will probably never be a time when the vocations will be completely stabilized. This means that there must be a continual readjustment, a discarding of vocations no longer of importance and the inclusion of other vocations newly come into existence. I believe, however, that some such program as outlined here quite possibly could become operative within a decade, with the result that the placing of people in vocations suited to their natural aptitudes might easily raise the general efficiency of the population ten, fifteen or even twenty per cent without increasing effort.