THE EGYPTIAN

JOURNAL OF PSYCHOLOGY

Vol, VI February-May 1951 No 3

PROGNOSTIC TESTING IN SECONDARY SCHOOLS IN EGYPT A STATISTICAL SURVEY OF FACTORS INVOLVED IN SECONDARY SCHOOL SUBJECTS

by

Hassan Moh. Hussein Ph. D.

Asst. Prof. of Statistics. Fouad 1st University

I. — AIM OF THE INVESTIGATION IN THE LIGHT OF FACTORIAL RESEARCHES

Prediction seems to be a phase of great importance throughout the whole educational process. On entering a school a child is tested in order to predict whether he is fit to follow successfully the course of education given by this school.

The child has later to take periodical examinations in the school with a view to predict again whether he is fit for promotion from one class to another. Even at the end of his educational career, a student gets a diploma or degree not merely as a license by means of which he can get some sort of work, but a certain amount of prediction is implied of his fitness for certain types of occupations. But school success was found to be an insufficient criterion for predicting success in future life. For this reason experimental psychologists had to devise a scheme besides certificates for deciding, more successfully if possible, the occupation which best fits a certain pupil. That is how vocational guidance and selection started.

Guidance aims at selecting the occupation which will best fit a particular individual, whereas selection attempts to advise employers or vocational training authorities on the relative merits of various candidates for employment, promotion or training. The data investigated by the vocational

adviser is of a variegated nature since "the adviser endeavours, before formulating advice, to make a comprehensive survey of the financial, social, geographical, and other circumstances, the physical characteristics, the level of general intelligence, the special aptitudes, the attainments, the interests and the disposition of his subject, and to compare this with the reports he has available about the circumstances involved in various occupations and about the demands they make in regard to physical characteristics, general intelligence, special aptitudes, attainments, interests and disposition."(1)

Aptitudes - Abilities - Factors.

Strictly speaking the term 'aptitudes' refers to intellectual powers which have an innate basis, e.g. general aptitude, verbal aptitude, mechanical aptitude or musical aptitude.

Abilities refer to the stage of development of these aptitudes at a given moment in the life of the individual as affected by training and environment.

Factors may be regarded as the loadings in some particular aptitude or ability. Thus a test of mechanical aptitude would probably have a certain loading in g (general aptitude) and a certain loading in m (mechanical factor) etc. Obviously such loadings have to be calculated by factorial analysis, and in spite of the vast amount of work done by factorial analysts, there is no unanimity of opinion as to the existence or interpretation of such factors as g, V, m, n, F, K, S etc., which are too often regarded by the non-expert as perfectly precise terms.

In the present study, as will be seen later, the investigator chose some of these factors which, it was surmised, would have an important bearing on the marks obtained later at the School Certificate Examination in Egypt (in Arabic called "Thakafa"), which is a well standardised examination. It is hoped to be able, through this investigation, to predict with a certain degree of precision, a boy's marks in the "Thakafa" examination a year or so before he actually takes the examination by using his marks in some tests of general intelligence and special aptitudes.

Discussion of Factors.

1. *The General Factor (g).*

Spearman declared, as early as 1904, that "all branches of intellectual activity have in common one fundamental function (or group of functions) whereas the remaining or specific elements seem in every case to be dif-

ferent from that in all the others." (2) He thus formulated his "two factor" theory, and since then a great number of investigations have been made to prove it or disprove it. Most notable among these investigations were those of Stephenson, Brown & Stephenson, and Alexander in England. In America the most important was the Chicago Unitary Trait Study inspired by Thorndike, planned by Spearman and the results statistically elaborated by Holzinger in nine successive booklets the last of which appeared in 1936. The work was later on carried a step further by Holzinger and Swineford.

It is suggested that all these researches agree in affirming the existence of "g" as formulated by Spearman in 1904. In addition, Spearman was enabled, in 1946, by means of the Chicago experiments to give "g" a psychological interpretation as a "combination of noegenesis with abstractness". (3)

Besides these there are some other authors who are sometimes regarded as opponents of "g", like Kelley and even Thomson, "whereas they had accepted it definitely enough and had only preferred their own special interpretations of it." (4)

2. *Verbal Factor, or Factors.*

"From the earliest times — long before any concept of 'factors' at all — the nature and function of words had provoked some of the keenest, not to say fiercest, feuds throughout psychology. Indeed these dated right back to epistemology and even ontology, generally under the designation of 'logos'. And the battles only intensified when the storm-centre shifted in the Middle Ages to the analysis of abstract thought." (4)

The subject was under investigation ever since, but apparently Miss Davey, a pupil of Spearman, was the first to investigate the problems of language factorially in 1926. She did not conclude, however, in favour of a verbal factor. In 1931, Stephenson applied eight verbal and eight non-verbal tests to 1037 children and found one group factor extending rather evenly through the verbal tests, but no group factor in the non-verbal tests.

The Chicago Unitary Traits investigation of Spearman and his associates attempted to find out the breadth of this factor and found that the loadings of the varions tests with the verbal factor tended to become smaller as the operation got more complex; e.g. as it brings in generalization or memory. (4)

The stability of the verbal factor was also studied by different investigators. Alexander found that 'V' was uniform, i.e. unaffected by

the subject's age and experience. On the other hand the more recent results of Denison and Spearman at Chesterfield did not show this uniformity.

Thurstone, in his investigation of primary mental abilities, found two verbal factors V and W. (5) 'V' was said to enter in 13 of his tests which were evidently logical in character. In all these tests the subject must deal with ideas, and the factor is evidently characterised primarily by its reference to ideas and the meanings of words. 'W' entered in 6 tests in which the subject deals with single and isolated words. This factor seems to have as its principal characteristic a fluency in dealing with words. It is to be expected that some of the verbal tests have appreciable saturation in both factors, such as the Opposites test, in which the subject deals with words and also with ideas.

In short all these investigations and numerous others on the same subject lead to the conclusion that more research is needed in order to ascertain what exactly is implied by the term "verbal factor".

3. *Mathematical Factor, or Factors.*

It may be said that investigators were interested in finding, among other things, whether there was a group factor common to all the three branches of school mathematics-arithmetic, algebra and geometry, or to any two of these branches, or whether there was a group factor for each branch separately. And some were interested in the view that there was no such factor or factors and that all needed for success in mathematics was a certain amount of the previously discussed general factor 'g'.

Brown made the pioneer fundamental approach to this problem in 1910. He found a group factor operating in geometry but no group factor common to both geometry and arithmetic. The first to apply the factorizing method systematically to the problem was Collar in 1920, and found that, "the sole factor common to all the higher arithmetic does not stop short at this, but extends universally; it is, in fact, neither more nor less than pure 'g'. The only thing that is genuinely characteristic of arithemtic lies in its lower or merely computative division." (6) A very important investigation of a similar nature was carried out by Miss Rogers. The result was "to refute the common assumption of any factor (other than 'g') shared by arithmetic and geometry (pure). The union of these two into the single science as 'mathematics' appears to be only a matter of practical convenience". (4) Miss Oldham found that arithmetic, algebra and geometry seem to have no large enough group factor to justify their being placed in one class for purposes of examination.

On the other hand Thurstone found a number factor N involved in eight of the 56 tests of primary mental abilities. These eight tests were mainly concerned with ordinary arithmetical computations. Blackwell also studied this subject and his results confirm the complex nature of mathematical ability, indicating that in this composite mathematical functioning certain definite factors are involved, and that these intellectual factors are different in boys and girls. (7)

It would appear then that still more research is needed in order to be able to make definite statements about the existence or non-existence of one or more factors for mathematics. May it not be that success in mathematics depends more on 'g' than on any specific mathematical ability ?

4. *Factors Mechanical, Practical, or Spatial.*

Cox found a group factor "m" the endowment of an individual with a high degree of which may make him a good practical mechanic, but it needs a certain amount of "g" as well to carry him into higher professional walks. Regarding the nature of this factor "m" he found the outstanding feature in which the "m" tests differ from customary intelligence tests and from other tests not affected by "m" is in the spatial character of the material employed together with the particular kind of thinking about this material.

Alexander found a practical factor "F" which plays a part in all concrete situations, in all practical planning and doing. The work of Drew also produced evidence for the existence of this factor and of its place in the methods of selection for technical education.

Koussy, applying Spearman's tetrad-difference technique, discovered a factor "K" common to all the spatial tests. This factor was psychologically interpreted as visual spatial imagery or mental manipulation of spatial material, and was supposed to be necessary for success in spatial problems calling for apprehension of lines, areas and volumes.

Thurstone found a factor "S" entering into 13 of his tests of primary mental abilities. (5) He writes: "We seem to be justified in characterising this factor as facility in spatial and visual imagery. It is probably the same factor as the spatial or visual group factor in the experiments of Kelley." (8)

A great deal of research has been carried out with regard to these factors, but it is yet too early to say how and to what extent, if any, they are interrelated.

5. *Character Factor (Persistence).*

When psychological tests such as intelligence tests, verbal tests,

numerical tests, spatial tests etc. are intercorrelated with tests of various school subjects, it is found that a factor runs through the latter but not through the former. Alexander found such a factor which he took provisionally to measure something of the nature of "persistence". It appears also in the works of Miss Carey, Wilson, Russell, Flanagan and Miss Ormiston. This character factor "X" is not of the nature of an ability but a trait of character.

The Need for Guidance in Egypt.

If a secondary school pupil in Egypt wishes to join a university he has to go to school, after passing the "Thakafa" examination, for another year called the "Orientation Year". The pupil can then join one only of three sections : Arts, Mathematics, or Science. Pupils are usually placed in either of these sections according to the marks they receive in the "Thakafa" examination.

In the present investigator's opinion this method of selection for different sections is not ideal and he thinks that if a set of psychological tests can be devised so as to enable schools to predict, if possible, a pupil's marks in this examination before he actually takes it, this set of prognostic tests could be usefully employed for selecting the pupils best suited for one or other of the three sections of the "Orientation Year".

II. — DESIGN OF THE EXPERIMENT

Choice of the Tests.

The set of tests to be used for this prognostic purpose has to include tests for the general factor 'g' together with four special abilities which would be expected to be positively correlated to scholastic success; viz. the verbal ability (v), the mathematical ability (n), the mechanical ability (m) and the ability of visual perception of space (S). A group of 13 tests was prepared for the purpose as follows :

A. — The "g" battery.

This battery consisted of six tests :

1. *Classification* (*g*1) — A non-verbal test containing twenty items, each of which is made up of five figures. Four of these figures belong to the same family but the fifth does not. The subject has to find this one and underline it.

2. *Analogies* ($g2$) — A non-verbal test containing twenty items, each of which is made up of three figures followed at a small distance by five others. The subject is to underline that one of the five figures which goes with the third in the same way as the second figure goes with the first.

3. *Overlapping Shapes* ($g3$) — A non-verbal test containing six geometrical diagrams each of which is made up of three out of five certain figures which are : square, triangle, rectangle, circle and pentagon. Numbers are written inside parts of these diagrams and the subject has to specify the figures inside which each of these numbers is contained. This test contains also twenty items.

4. *Alphabet Series* ($g4$) — A test containing twenty items, each of which is made up of a number of letters arranged according to a certain rule. The subject has to discover the rule in each case and use it to write down the next four letters on four blank lines.

5. *Correlate Eduction "B"* ($g5$) — A non-verbal test containing twenty items, each of which is made up of two figures inside a rectangle. The subject is to imagine the figure at the bottom of each rectangle placed on the one above it such that three specified points A, B & C fall respectively on three corresponding points X, Y & Z and has to put a dot where a fourth point D would fall.

6. *Completing Sentences* ($g6$) — This test is made up of twelve sentences. Here and there in each sentence there is a bracket containing three alternative words or phrases one only of which makes the best sense, this has to be underlined by the subject. In the twelve sentences there are thirty six such places of option.

As can be clearly seen the six tests described above are all among the famous tests universally accepted as good tests of the general ability. They are mainly non-verbal although the sixth is markedly verbal. The fourth is slightly verbal but markedly mathematical. The third and fith were supposed to involve something similar to that involved in geometrical thinking. The first and second tests besides being highly saturated with "g" are also highly saturated with "K" according to Koussy. (9) On the whole this would seem a satisfactory battery for "g", since each test is highly saturated with "g" and including at the same time some broad factor — verbal, mathematical or spatial — which is common to some, but not all, of the others.

B. — The Battery for Mathematical Ability.

This battery is made up of three tests :

1. *Number Series* (*n*1) — This test contained twenty items, each of which was made up of some numbers, sometimes symbols, arranged according to some rule. Multiplication, division, addition and subtraction, and various combinations of these processes are employed in forming the different series. The subject is to discover the rule for each example, and write down the next two terms on two blank lines.

2. *Block Counting* (*n*2) — A non-verbal test containing four piles of blocks, all the same size and shape but arranged differently. In each pile five of the blocks are marked A,B,C,D, & E. These letters are written again beside the pile, and the subject is to study each pile and write opposite each of these letters the number of blocks touching the block bearing the letter.

3. *Dependence and Variation* (*n*3) — This test contains twenty items each of which begins with an algebraic relation. Some alteration is then assumed to occur to one of its symbols and the subject is then asked to deduce what would happen to another symbol. The answer is indicated by one of the four letters a,b,c, or d meaning respectively "remain the same", "become larger", "become smaller", or "cannot tell".

The three tests taken here are all of the types used both in England and in the United States of America for testing mathematical ability. If the mathematical ability was made up of both numerical and geometrical abilities, as mentioned above, then these three tests were thought by the present investigator to be enough to test both. The first is expected to test the number factor as it obviously deals with numbers. The second is included to test the geometrical factor, since it is concerned with the manipulation of figures which is a principal element in geometrical problems. Whereas the third is expected to call on deductive thinking which is essential to progress in most branches of mathematics.

The second test is also found by some workers to be one of the good tests of "mechanical ability". It has also been found by Thurstone among the good tests of "S", the visual perception factor. The third is clearly of a highly verbal nature and success in it would seem to depend largely on verbal comprehension as well as ability to think logically or ability in functional thinking.

C. — The Battery for the Verbal Ability.

This battery is made up of three tests :

1. *Comprehension* (*v*1) — A test containing ten items, each of which starts with a proverb followed by four others. Two and only two of these four have nearly the same meaning as the first proverb. The subject is to find these two and mark them thus (×).

2. *Inventive Synonyms and Opposites* (*v*2) — This test contains twenty items, each of which starts with a word followed by two blanks, in each blanck there is a letter. In the first blank after the word the subject is to write a word meaning the same as the given word and beginning with the letter in the blank. In the second blank after the word he is to write a word meaning the opposite to the given word and beginning with the letter in the blank.

3. *Word Building* (*v*3) — A test made of two sections, in each section there is a long word like "FOOTBALLER", and the subject is to make as many words as he can using only the letters in the given word. Short words are allowed as well as long ones, but a letter is not to be used more times than it appears in the given word. Three sample words are given in each section.

The three tests just described are all of a very highly verbal nature. These tests were chosen to meet the possibility of the existence of two verbal factors (V & W) actually existing, as Thurstone found. As has already been mentioned, 'V' is characterised primarily by its reference to ideas and to meanings of words, whereas 'W' has as its principal characteristic a fluency in dealing with words.

The first of the three verbal tests is obviously concerned with ideas and meanings of words so it would test 'V'. The second is also concerned with meanings of words so it also would test 'V', but the choice in each case being restricted to a word beginning with a given letter it involved also fluency in dealing with words which would make it at the same time test 'W'. The third test did not seem to deal with ideas and meanings of words so it would simply test 'W'.

D. — The Test of Mechanical Aptitude.

A test (M) was made on similar lines to Cox's Mechanical Explanation Test 1. It contained three problems each beginning with a diagram followed by several questions. After each question there are several suggested answers only one of which is correct. The subject is to show the

correct answer by putting a ring round its number.

This test by itself would not, of course, make a battery but as already mentioned the "Block Counting" test is also supposed to test the mechanical aptitude.

Formation of the Tests :

Having decided on the types of tests to be included, in each of the first three batteries mentioned above, a large number of items of each kind of test was then made up. By inspection, introspection and individual application on friends and colleagues some of the items were discaredd as unsuitable. Eventually a number of items for each test was decided upon as fit and faultless. This number was taken for each test twice as big as the number of items intended to be kept in the final form of the test. These tests were then applied to about a hundred boys in an ordinary secondary school in Cairo without any time limit in order to enable every pupil to try every item of every test. As a result of this application the degree of difficulty of each item was calculated and the items were arranged, within the tests according to their difficulty beginning with the easiest as usual. Each test was then divided into two parallel forms A and B equal in all respects and each containing half the number of the original items by taking item 1 in form A, items 2 & 3 in form B, 4 & 5 in form A, 6 & 7 in form B, and so on till we get to the end of the test. We thus obtained two complete batteries of tests very similar in nature, size and level; one of them made up of Form A of each of the tests while the other included the other Form B of each.

The twin sets of tests (batteries) thus formed were then applied separately on another, but similar, group of boys on two successive mornings under conditions as near being identical as possible. The scores of the boys on the two forms were then compared with each other and the coefficient of correlation between them was then calculated, thus getting the coefficient of reliability of each test. The result was very encouraging as the reliabilities of most of the tests were rather high. In this experiment notice was taken of the time needed by the quickest boy in each test; this gave an indication what the optimum time limit of each test should be.

Guided by the result of this previous experiment one form only of each test (either A or B) was decided on as more suitable and was, therefore, taken as the final test to be included in the corresponding battery. These batteries in their final shape were now prepared and ready for application. These tests were duplicated in two pamphlets; one containing

the six tests of 'g' while the other contained the three tests for mathematical ability, the three tests for verbal ability and the test for mechanical ability. The first pamphlet needed only 29 minutes for actual solution of the tests, apart from time employed in understanding the instructions for each test. The second pamphlet needed 33 minutes for actual solution of the tests. Allowing for the time necessary for understanding the instructions and examples at the beginning of each test and for handing out each pamhlet in succession and collecting them, it was found that the application of the complete set could be usually done in two class periods which means 100 minutes.

Application.

The tests in their final Arabic form were then applied in March 1947 to two groups of pupils almost equivalent in size and standard but of opposite sexes, but all preparing to take the "Thakafa" examination in June of the same year.

Group A — consisted of 60 girls from Sanieh Secondary School with ages ranging from 16 years to 20 years, and having a mean age of 17 years 11 months.

Group B — consisted of 70 boy from Farouk First Secondary School with ages ranging from 14 years to 18 years, and having a mean age of 16 years 2 months.

Both groups were taken from well established, similar government secondary schools of a non-selective type. They can be considered representative samples for the sake of our experiment.

The distributions of scores on each test by each group were drawn, and their curves were found to have the following characteristics :

1. They are very nearly of the usual bell-shaped type, in spite of the small size of the sample, which justifies their employment for our investigation.

2. The mean and mode of the scores on each test being not widely separated in most of the tests, shows that the difficulty of each of these tests is of a suitable standard for the kind of pupils we had in mind.

3. The graphs showed also that the scores on each test were nicely spread over the complete range, which proves that these tests are of a highly selective type.

It was also found that the mean scores on each test by both groups were very similar. The differences between each two corresponding means, on being tested statistically, were found non-significant except in the case of Block Counting (n2) and Synonyms and Opposites (v2). Later analysis

showed that (n2) has its highest loading in 'S', the spatial factor; and (v2) has its highest loading in 'V', the verbal factor. It also showed that boys seem to draw more on 'S' and girls seem to draw more on 'V'. This perhaps explains the significant excess of the average score of the boys in (n2) over the girls, and also the singificant excess of the average score of the girls in (v2) over the boys. This, of course, is in accord with the results of previous investigators.

III. — ANALYSIS OF DATA

In June 1947, all the pupils in both groups took the "Thakafa" examination, which is a well standardised examination. The great care taken in setting the question papers and in marking the answer sheets goes a long way to make the result of this examination a fairly good criterion to compare with the results of the above mentioned tests.

For this purpose the marks of each pupil in each of eight papers were taken. These subjects were as follows : —

Arabic Language, History, Geography, Algebra, Geometry, Physics, Biology, and Drawing.

On testing the difference between the mean score on each subject by both groups statistically, it was found to be insignificant except in the cases of geography and algebra, and to a smaller extent in drawing.

Thus, in all, we had twenty one measurable variates; thirteen psychological tests and eight examination papers. Taking the scores of each boy, or girl, on these and calculating intercorrelations between them we had 210 different correlation coefficients for each of the two groups. These correlation coefficients were calculated by applying Pearson's Product-Moment Formula on the raw scores.

Factorial analysis was then applied to the two matrices of correlation corresponding to groups A and B. Both matrices were factorized by Thurstone's Centroid Method, and then the matrix for group A alone was factorized again by Burt's Simple Summation Method, for the sake of comparison.

IV. — THE RESULTS

Three factorial patterns were thus obtained, two for group A of the girls and the third for group B of the boys, and they were all in fair agreement. In each case four factors were found ample enough to account for a large part of the variance of the given variables. These factors were

the same in nature and came even in the same order as regards the percentages of their contributions to the variance.

Thus we may conclude, as far as this investigation may allow us, that there are mainly four factors determining success in the work of the secondary school in Egypt. These four factors are 'g' the general factor, 'X' a factor in character which we have already referred to as long-term persistence, 'V' a verbal factor and 'S' a factor of spatial perception. They enter in different proportions in the determination of success in the different school subjects.

Arabic Language — Success in Arabic seems to depend mainly on 'g' and on 'X', the latter being of greater importance. 'V' plays no part in determining success here, and perhaps this is not as odd as it may at first glance appear to be. The examination in Arabic consists of Composition, Grammar and Literature. 'g' seems to be more in demand for the first part whereas more 'X' is needed for the last two. Mere memorizing would be sufficient for these.

History — The girls' group shows that history necessitates 'X' and 'g', whereas with the boys it necessitates 'X' and 'V'. Actually history as taught in Egypt at this stage needs little more than committing a few dates and incidents to memory; there is little scope for personal ability in thinking for oneself. Girls, as a rule, tend to learn such things by heart and thus draw heavily on 'X'. So all they need for success, after having learnt the material well is a slight amount of 'g' for understanding the questions and deciding which parts of the material would supply the right answer. Boys, on the other hand, are not so fond of memorizing but prefer to keep in mind the general outlines of the subject, for which they need less 'X' than the girls. To answer the questions successfully in such a case they need 'V' to help them put the general ideas they have into words.

Geography — Geography seems to draw on 'X', 'S' and 'V' from the girls and on 'S', 'g', 'X' and to a smaller extent 'V' from the boys. The difference here may be explained by inferiority of boys in studiousness than the girls which is quite prevalent, in Egypt at least, at this stage. This is also obvious from the high loadings of all the school examinations of the girls with the factor 'X' corresponding to lower loadings of the boys. Girls draw here also on 'V' more than boys do. On the other hand, boys draw much more on 'S' than girls. The need for this factor 'S' here is quite obvious, since good map drawing is a great help in obtaining a high mark in a geography examination. The boys' success in geography seems also to depend on 'g' which did not seem so necessary for the girls.

Perhaps it is this use of 'g' by the boys in geography, and their obvious superiority over the grils in 'S' that made their mean score in this examination significantly higher than the mean score of the girls.

Algebra — In both groups algebra seems to be mainly dependent on 'X'. In the girls' group it is also affected by 'V', which is quite understandable since the algebra examinations usually contain problems the wording of which has to be well understood before solving them, and in solving which accuracy in expression helps a great deal. On this side we may be safe to expect girls to be more keen than boys.

There is nothing in this to justify the significant excess of the boys' mean score in this examination over the girls' mean score; but the question paper itself explains that. Owing to a slight difference in the syllabuses for the boys and the grils there were two alternative questions in the paper one of which intended for each sex separately. The question for the boys was of a much more straightforward nature which might have helped to raise their marks.

Geometry — The same thing, more or less, may again be said about geometry. With the girls, 'V' seems to play a great part in determining success in geometry, which may again be explained as already done in the case of algebra by the girls' keenness on expressing themselves more accurately than boys, which would be a great asset in a geometry examination. Besides verbality, success in geometry seems to be affected in both groups almost equally by 'X'. Girls seem to draw as well slightly on 'S', whereas boys draw more on 'g'. This again is explained by the nature of the question paper which contained questions of both practical and theoretical types. Girls, as a rule, can score more marks on the practical type of problems, which needs 'S'; while boys can, as a rule, score more marks on the theoretical type, which needs 'g'.

Physics — Physics is affected in both groups by the same three factors 'X', 'S' and 'g' which is only to be expected since a good part of the examination is bookwork depending on 'X'; another part includes problems that need thinking, and thus 'g'; while illustration by diagrams is also needed here and helps a great deal in raising the mark, which makes 'S' necessary. In the girls' group the loadings show that 'V' also is of some importance, and this again can be explained as in the cases of algebra and geometry.

Biology — Success in biology seems to be determined solely, in the case of the girls, by 'X' and to a much smaller extent by 'g'. This is also acceptable since the syllabus of biology given at this stage can easily be mastered by mere memorizing and very little of it necessitates original

thinking. In the case of boys it depends on both 'X' and 'S' almost equally, and on 'g' to a smaller degree, which shows again, as in the case of physics, that boys manage to raise their marks by good diagrammatical illustration, thus making up for a lower standard of 'X' by a higher standard of 'S'.

Drawing — Success in drawing depends, in the case of the girls, on 'S', 'X' and 'g'; while in the case of the boys it depends only on 'g' and 'S'. Perhaps this means that success of the girls here depends more on long practice and drill than on ingenuity and inventiveness; while success of the boys depends much more on the latter.

Superiority of girls in 'X' might account for the fact that the average mark of the girls in drawing is significantly higher than that of the boys.

***

To sum up the previous results we can say that there are mainly four factors which determine, to a great extent, the success in the various papers of the "School Certificate Examination — General Section" in Egypt. These factors are termed here 'g', 'X','V' and 'S'. The relative importance of these factors in scholastic success as a whole, on a percentage basis is "X" 66; "V" 15; "S" 12; "g" 7 in the case of the girls, and "X" 49; "S" 26; "g" 18; "V" 7 in the case of the boys. 'g' is the well known general factor of Spearman. 'X' is a school factor, already indicated in previous investigations, which seems to be a factor in character, probably long-term persistence. 'V' is a factor of a verbal nature which seems to account for comprehension of words and sentences and ability to express one's thoughts verbally with exactitude. 'S' is a spatial factor involving the manipulation of shapes and probably the ability to reproduce visual images.

In terms of these four factors the degree of success of a pupil in the various papers included in the above-mentioned examination may be predicted, with a certain amount of precision. In other words, prognosis of a pupil's ability in each of these various subjects can be affected.

This prognosis may be affected by means of several methods, the best of which would probably be to form a number of regression equations, one for each subject. Each equation would predict the expected mark of a pupil in the corresponding subject in terms of his share of each of the four mentioned factors. The share of a pupil in each of these factors can be measured by the weighted sum of his scores on a particular group of the above tests.

It is suggested for this purpose to start by rejecting the non-verbal

classification test (g1), the word building test (v3) and the mechanical test (M).

The battery for measuring 'g' would be made up of :

Non-verbal analogies (g2), overlapping shapes (g3), alphabet series (g4), correlate eduction B (g5), completing sentences (g6), number series (n1), block counting (n2) and variance and dependence (n3).

The battery to determine 'V' would include :

Alphabet series (g4), completing sentences (g6), comprehension (v1) and synonyms and opposites (v2).

The battery for 'S' would consist of :

Overlapping shapes (g3), correlate eduction B (g5) and block counting (n2).

The factor 'X', being a school factor, involving long-term persistence cannot, of course, be measured by these short-term tests. It may probably be measured best by means of the average of the total marks the pupil has obtained in the previous examinations taken by him in his secondary school career. There is no danger of "Halo Effect" (10) appearing here since the answer papers of the pupils are always given secret numbers before being marked, so that the identities of the pupils remain unknown to the examiners.

It is, of course, obvious that two such sets of regression equations are necessary, one for boys and the other for girls since there are some differences due to sex as already noticed. The marks estimated from such equations will, at best, be only approximate, but in large groups may correlate highly with the actual marks.

It may also be noticed, in passing, that we have found some sex-differences corroborating the results of previous investigations, and corroborated by actual observation and experience.

First of all, we found that the contribution of 'X' to success in scholastic work is distinctly higher in the case of the girls than it is in the case of the boys. This is quite in accord with actual expectations since, as the present investigator can testify from long personal experience in teaching both sexes in Egypt, the girls at this stage at least are much more zealous on their work and thus are better at long-term persistence. We also notice that girls take advantage of their superiority in 'V', whereas boys take advantage of their superiority in 'S'; and thus their success in the various subjects is determined accordingly.

This investigation, so far, does not seem to prove the existence of a number factor. This is not strange since the tests did not include any of the elementary arithmetical processes and no arithmetic examination

was amongst the examinations taken in the analysis. Thus the investigation does not exclude the existence of a number factor either. In any case, its existence or non-existence is immaterial to our investigation since the study of arithmetic in secondary schools is discontinued in the third year, and thus it is not one of the subjects in this examination, and no other subject in the examination is concerned with elementary computations.

BIBLIOGRAPHY

1. Bartlett, F.C. & Others. 1939. The Study of Society. Chapter by Rodger, A.
2. Spearman, C.E. 1904. " 'General Intelligence' objectively determined and measured". A.J.P.
3. Spearman, C.E. 1946. "Theory of General Factor". B.J.P. XXXVI. Pt. 3.
4. Spearman, C. & Wynn Jones, Ll. 1950. Human Ability.
5. Thurstone, L.L. 1938. "Primary Mental Abilities". Psychometric Monograph, No. 1.
6. Collar, D.J. 1920. "A Statistical Survey of Arithmetical Ability". B.J.P. XI.
7. Blackwell, A.M. 1940. "A Comparative Investigation into the Factors Involved in Mathematical Ability of Boys and Girls." B.J.E.P. X.
8. Kelley, T.L. 1928. Crossroads in the Mind of Man.
9. El Koussy, A.A.H. 1935. "The Visual Perception of Space." B.J.P. Monograph Supplement, No. 20.
10. Holzinger & Swineford. 1939. The Stability of a Bi-Factor Solution. pp. 55, 56.