

and so it happens that men are stamped as the best who certainly would not justify such a conclusion were they submitted to a more general ordeal.

Competitive examination, no doubt, secures the man who knows most of some subjects; but until it test mental, moral, social, and physical, as well as intellectual qualities—even if it can do that—it cannot be admitted that it is what it professes to be, a provider of the best.

It is said that no better mode of providing public servants exists, and that it is better than the old system of patronage with all its abuses. It may be so, but there are many who think otherwise, and who believe that selection, after a *thoroughly qualifying test* has been passed, would be better, and who also think that some method of selection might be found which should obviate the possibility of jobbery or abuse of patronage. In any case there is room for improvement in the present system, and if the movement which has been initiated by this Review effect this, it will be of national service.

IV.

By FRANCIS GALTON.

THE question has been often put to me by persons engaged in education, whether feasible measurements could be applied to test the physical capacities of candidates. It is allowed very generally that the present system of examining into the intellectual capacity is one-sided, and that if it could be supplemented by a trustworthy examination of the bodily powers, the inferences it can afford would be increased in value. My own experience of varied forms of measurement has been large, and justifies me in speaking with assurance as to the time they take and their cost.

The problem is to give marks for physical qualifications just as they are now given for intellectual ones, in order to pass those candidates who, being a little under par intellectually, are far above par bodily: conversely, to weed out those other candidates who, not being particularly fit in respect to their brains, are at the same time of decidedly inferior physique. The relative weight to be assigned

for intellectual and bodily excellence is a question of detail, most important no doubt, but one that need not be discussed here.

We must not expect too much from physical tests, while we should be very cautious not to underrate their real value. They are open to obvious objections, but the chief of these are equally applicable to all examinations, and if disregarded in those already in use, may claim an equal right to be disregarded in those about to be proposed. The first is, that they test no more than the proficiency of the examinee at the time they are applied. He may be ill-prepared, or else he may have been so well trained for the special occasion as to give a fallacious idea of his average working capacity. The second is, that all systems of examination are inadequate in breadth. The present examinations do not test all the useful faculties of the mind, neither would any others that might be suggested test all the useful faculties of the body. This is perfectly true, but we may learn a great deal of both of them, and must be contented with what we can get. The list of bodily measurements that will be suggested is brief but useful, and would perfectly serve as a commencement. We may feel assured that any newly-established system will become improved by experience, and that tests not thought of at first will be afterwards devised. The examination of any faculty is a difficult art, not be perfected offhand.

The measurements I now propose would determine these facts: (1) stature; (2) weight; (3) strength; (4) breathing capacity; (5) reaction time; (6) swiftness of movements; (7) hearing power of right and left ear separately; (8) keenness of sight of right and left eye separately; (9) colour sense. All these tests, except one of which I shall speak in which a gymnastic bar is employed, are, or were, in use by me at my Anthropometric Laboratory at the International Health Exhibition in 1884—at which nearly ten thousand persons were measured—or in my present laboratory at South Kensington.³ Other tests could, I think, be added, viz. for the power of resisting both physical and mental fatigue, but the experiments I have made are not sufficiently advanced to justify speaking with confidence. Before considering these tests separately, it may be mentioned that the use of knowing the stature is to give a correct estimate of the value to be assigned to breathing capacity. A tall man is likely to have larger lungs than a small man, and he would want larger lungs. A table of figures has therefore to be consulted in which statures are written along the top, and breathing capacities are written down the sides. The measure of weight is to serve in an exactly similar way for correcting the observed determination of strength. Two of the most

³ It is attached to the so-called Western Gallery which runs parallel to Queen's Gate and contains the Science Collections of the South Kensington Museum. The gallery is entered either from Queen's Gate or from the new Imperial Institute Road, and the admission is free.

important tests in the list are those of keenness of eyesight and of the colour sense. It is impossible to perform them satisfactorily in the variable light of a London day, which ranges between murkiness and brilliancy. The tests should be made in a uniform, and therefore with an artificial light, and not be applied until the eye has had time to accommodate itself. For this reason the whole examination ought to be conducted in a room whose general illumination is not brighter than that under which the tests of sight are made, and these should be the last of the whole series. Electric lighting would be especially convenient, as it shows off all the colours. We will now consider the tests separately in their order.

HEIGHT AND WEIGHT.—These simple measures need no remark, except that it takes an easy $\frac{3}{4}$ minute to make and to record each of them.

STRENGTH.—A method much used in the gymnasia attached to American colleges is to record the number of times that a man can successively pull himself up to the level of his chin on a gymnastic bar. This measures his strength relatively to his weight, therefore no correction for weight is needed. I myself have only used two instruments for testing strength: one was Salter's dial that registers the strength of pull, like an archer with his bow; the other was another of Salter's dials to measure the strength of squeeze. Experience showed that these two measures ran so closely together that I have now discarded the former. An improved design by the Cambridge Scientific Instrument Company enables the grip of the instrument to be adjusted to suit the hand of the examinee, and appears to afford a much fairer test than the older form. Allow $\frac{3}{4}$ minute for making and recording the squeeze test, and $1\frac{1}{2}$ minute for the gymnastic bar—total, $2\frac{1}{4}$ minutes.

BREATHING CAPACITY.—This is a most important datum, because it determines the maximum amount of continued exertion that can be made on an emergency. The instrument I have used is of a well-known design; it works on the same principle as the immense gasometers that are attached to gasworks. Three successive trials can be made and recorded in $1\frac{1}{4}$ minute, and these are sufficient.

REACTION TIME TO SIGHT gives in a numerical form the same sort of information about the quickness of eye and hand that would be derived from an exact knowledge of a man's quickness in shooting snipe or rabbits, or as a fencer. There are numerous instruments for measuring it. That which I am now using is not minutely accurate, but is quick and easy to work, and might be made to work still more easily. There are two falling rods, set free by the same act. During their course downwards, when they are falling fast, the shorter of them suddenly uncovers a window slit; thereupon the examinee, as quickly as he can, presses upon a key that arrests the other rod. The excess of distance travelled over by the second rod is marked on an appro-

priate scale that gives the elapsed time in hundredths of a second, between seeing the light and making the response. The same apparatus gives the reaction time to *Sound* by merely pushing a bolt. This arrests the fall of the first rod at the instant before its top reaches the level of the window, and the examinee presses the key as quickly as he can after hearing the blow of the rod upon the bolt. It is possible to make three successive trials with the eye and three with the ear in less than three minutes. Other instruments of extreme accuracy, and familiar to physiologists, are available; but I know of none of these that can be easily set and read off both quickly and surely by a not very skilled examiner. I am now constructing an entirely different instrument which promises to act the best of any.

SWIFTNESS OF MOVEMENT was tested by means of a rather coarse apparatus, in which the sinuous trace left on the bar that was moved, by means of a pencil attached to the end of a vibrating rod, gave a measure of the velocity of the bar; and $1\frac{1}{2}$ minute sufficed for the test. I have thought of simpler plans but have not yet tried them. There are numerous methods dependent on the use of electricity, by which the time occupied in moving through a small space can be measured with extreme accuracy, but they are costly and tedious in use. My test was applied to find the swiftness with which a straightforward blow could be given with the fist. The precise form and application of this test should, however, be reconsidered.

HEARING POWER.—It is not difficult to determine this relatively, but most difficult to do so in terms of absolute measurement. The source of sound that I should propose would be three tiny hammers, with axles running through their handles, and severally lifted and let fall by electro-magnets worked from a distance. In order to avoid uncertain echoes and reverberations, I would enclose them in a strong stoneware jar, with a small opening turned towards the examinee. This entirely checks the transmission of sound in any other direction, while a wooden box, however thickly covered with felt, is curiously ineffective. The hammers should strike on anvils of different materials, in order to produce different qualities of sound, because a man may hear one kind of sound with facility, though not another. The examinee would not know beforehand which of the sounds to listen for, or when it would be made. He would have to state what he heard when standing at each of two, or perhaps three, specified distances indicated by marks on the floor. Allow three minutes for this test.

KEENNESS OF SIGHT.—This is easily and well tested in young persons under a uniform light, by an instrument that I have long used, in which little blocks carrying numerals printed in diamond type are set at various indicated distances from the eye-hole. When the persons tested are past middle age, the indications are affected by

the gradual loss of power to adjust the focus of the eye to various distances. The optical apparatus of the eye may in other respects be perfect, but acuteness of vision will fail for precisely the same reason that the image in a camera will be blurred, however good the the object-glass may be, if the mechanical arrangements for setting it at the proper focus act imperfectly. Otherwise, the test is exactly parallel to that of noting the degree of clearness with which a camera can throw the image of a page of a book, printed in small type, upon its screen. In addition to this, Snellen's well-known Test-types would be used at the ordinary distance of twenty feet. It is advisable in all tests of eyesight to duplicate the apparatus, that the examinee may have time to puzzle over it and satisfy himself as to what he can do without keeping the examiner waiting, who will then leave him for a while, and go on with another. Under these circumstances, $1\frac{1}{2}$ minute is quite sufficient for the examiner.

COLOUR SENSE.—A full and rigorous examination of this requires costly apparatus and much time, but the rough way of testing it by means of coloured wools is easy enough, especially with the instrument I have long used. The examinee is left to himself, to take as much time as he likes, and finally he puts four pegs into holes opposite to four blocks of wood out of a long row of them lying side by side in a frame, on each of which a differently coloured wool is wound. He is set to match certain colours, and he puts the pegs into the holes opposite to the colours that he selects as matches. Then the attendant raises a hinged flap which exposes the numbers inscribed in large type on the feet of the blocks, from which it is seen at once whether the right selection has been made. The order of the blocks in the frame can be changed at pleasure. Using duplicated or triplicated instruments, this test does not occupy more than half a minute of the tester's time. He has merely to raise the flap and to record the result. I have some new instruments on trial of a more delicate kind. One contains strips of variously tinted glass laid on white paper, which could be used if thought preferable.

Adding together all the estimated times, the total does not exceed a quarter of an hour. I feel sure that, with proper management, that would be sufficient. Many more measures, and in part quite as troublesome ones, are now made at my laboratory in that time, and the experience at the Health Exhibition was the same. An examiner working eight hours a day could easily test many more than twenty-five persons. He need not be highly skilled, though he must be accurate, methodical, cool, and painstaking. My present superintendent was a sergeant in the army, who had held positions of considerable trust and was strongly and deservedly recommended. At the Health Exhibition I also employed a sergeant; I had besides a boy to help with the papers, and to give prefatory explanations. Moreover, I had the advantage of frequent and vigorous help from

the optician who made the instruments. At M. Bertillon's laboratory in the *Bureau des Signalements* in Paris, where about one hundred suspected criminals are measured during each forenoon in a variety of ways, there are two measurers and two recorders. I found the charge of threepence per person sufficient to cover all the costs of measuring at the Health Exhibition. The same just suffices to cover that in the laboratory at Cambridge, but I supplied the instruments in both cases.

In my present laboratory no charge is now made, but I could certainly defray its maintenance by a charge of a few pence for each person if it were uniformly well attended. Therefore, neither in cost nor in administration need the establishment of a laboratory to test the physical qualifications of candidates, present any difficulty.

V.

BY DR. PRIESTLEY.

ONE of the evils arising from the present examination system, in its many ramifications, is that it induces men to read and work merely for examination, instead of the attainment of knowledge in its true sense. Students, if industrious, pore over their vade-mecums, or summaries of the subjects for the pass, and evince a strange unwillingness to attend the instruction of eminent professors, to whom probably they have paid fees, in accordance with regulations which prescribe attendance as part of the usual curriculum. In thus withdrawing from the lecture-room they lose all the advantages arising from personal contact with the professor—an influence which must count for something as a factor in education, when, as is commonly the case, the professor is a man of eminence, and is possessed of a distinct personality of his own. Such a teacher, it is evident, is able not only to infuse vitality into the subject he teaches, but he must be competent to give students a broader and more comprehensive view of their studies than can be gathered from any epitome which professes to be sufficient for the purposes of examination.

This indifference to the advantages of higher education is especially exemplified among medical students, a large proportion of whom are more bent on picking up points and details which may best serve