The psychology of intelligence and *g*[*]

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In his *Introduction to Modern Psychology*,[24] Professor Zangwill states that intelligence testing is "a technology whose theoretical foundations are distinctly insecure". Professor Hearnshaw,[6] Dr. Heim[8] and others have expressed similarly critical views in their recent writings. Now, as a specialist in the field of mental testing, I would willingly admit that I am primarily a technologist. But as you have done me the very great honour of appointing me your President, I feel obliged—as a psychologist—to do something about the "insecure foundations" of my trade. I hope to show to-night that by delving around, and making full use of the bricks and mortar that recent psychological and psychometric research have provided, we shall be able to integrate the apparently divergent and unrelated views of physiological, genetic and clinical psychologists, of mental testers and factor analysts, and to arrive at a more stable theory upon which the technological superstructure can be firmly based. This means, I fear, that you are in for a tough fifty minutes, but after all—to quote the proverbial schoolmaster—it hurts me more than it hurts you; and I hope that the effort will be salutary for all of us.

The Scaling of Test Performances. Merely for convenience, I am going start, as it were, at the wrong end, and outline what seem to me to be the essential facts established by the psychometrist, which our theory has to explain. I am making no assumptions yet as to what it is that intelligence tests measure, and will refer to it as I.Q.[† 22]—Terman-Merrill I.Q., or Moray House or Wechsler Performance I.Q., and so on. Such I.Q.s are clearly quite different from physical measurements of stable attributes such as height. They are best regarded as standard scores corresponding to percentiles in a representative population. For example, I.Q. 130 is that score which cuts off the top $2^1/_4$ per cent of an age-group, provided we accept the arbitrary figure of 15 as our standard deviation. True, [2]there are many tests which continue to calculate I.Q.s from Mental Age over Chronological Age in children, or over some constant divisor such as 15 in adults, notably the Terman-Merrill. But one is thankful to observe that they are gradually going out of fashion, since their standard deviations vary all over the place, and their I.Q.s have no consistent significance unless translated into percentiles. I.Q.s so calculated, moreover, are measures of rate of mental growth at that type of test—a concept which is far too obscure to be used in a logical manner. Thus teachers or clinical psychiatrists dealing with a child of 150 I.Q. certainly do not think of him as growing intellectually at one and a half times the average rate; but they are interested in his being the brightest child in a thousand of his age.

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[*] Presidential Address to the British Psychological Society delivered at the Annual Conference at Durham on April 16th, 1955.

[†] Elsewhere, I have supplemented Hebb's distinction between Intelligence A and Intelligence B by referring to test results or I.Q.s as "Intelligence C".

The standard score system assumes, of course, that whatever ability underlies I.Q.s is fundamentally normally distributed. I agree with those critics who say that this is an unprovable dogma. But it is a useful dogma, which seems to accord reasonably with common-sense observation of the relative rarity of very bright and very dull individuals. It obviously breaks down at the bottom end, and some alternative system of quantifying low-grade intelligence test performance is necessary. Maybe the Mental Age system is as good as any for this limited purpose. In other contexts where representative populations are not available, intelligence test scores are best expressed as percentiles relative to a specified group, for example Army recruits, or university students.

The Stability of Test Performance. Now the I.Q. is a fairly stable measure over quite long periods—less stable than would be expected from some of the statements of psychometrists in the 1910's and '20's, but more stable than some recent writers deduce from Dearborn and Rothney's, Honzik's[9] and the Iowa school's results. The correlation between similar (not necessarily identical) tests over the 6 to 11-year period, or over 11 years to young adulthood, does not normally drop below 0.70; and with a standard deviation of 15, this means a median variation or probable error of 7 I.Q. points. Most individuals stay within the same band of I.Q., but M per cent may rise or fall 15 or more points, and nearly 1 per cent may vary as much as 30 points either way. This refers to a single retest: with repeated retestings, fluctuations are about half as wide again.* Variability is increased also if the tests differ greatly in content, as when Terman-Merrill is compared with a group test; or a non-verbal with a verbal test. It is somewhat greater among high I.Q. than normal, or normal than low I.Q., groups; and it naturally rises when the standard deviation of I.Q.s exceeds 15 (as happens with Terman Merrill at certain ages), or when the norms for either test are too lenient or too severe, or when one test has been coached or practised more than the other. Last but not least, the I.Q. is much more unstable if measured before the age of 5; indeed, developmental or other quotients from 0 to $2^1/_2$ have virtually no predictive value for later I.Q.

[3]*The Practical Value of the I.Q.* This stability is probably at least as great as that of any other mental measurement, say educational attainments, and it allows us to make useful predictions of all-round educability in the primary or the secondary school, and of probable vocational level. To quote but one illustration[16]: Terman's high I.Q. children, representing the top $^1/_2$ per cent of the Californian school population, were followed up twenty-five years later. It was found that they were five times as likely as average children to end up in the two highest professional and business occupational groups, and seven times as unlikely to become semi-skilled or unskilled workers. Note that this prediction is actuarial—a matter of probabilities. No psychometrist can say for certain that John Jones, age 11, I.Q. 150, will become a professional or a labourer. But precisely the same is true of any other type of prediction. When you appointed me your President you could not be certain that I should not embezzle the Society's funds, though the odds in favour of the validity of your prediction were quite high, since the percentage of Council's previous nominations who have embezzled is statistically non-significant. As I have pointed out in my book on Personality Tests,[20] the clinical, educational or vocational

* The published investigations appear to confirm that the P.E. of variations at a single test is $0.6745\ \sigma\ \sqrt{(1-r^2)}$, while for repeated retests it is $1.349\ \sigma\ \sqrt{(1-r)}$.

psychologist who predicts from an all-round study of his subject's abilities, personality and circumstances is often no more successful, and sometimes less so, than the psychometrist with his objective aptitude, educational or other tests. Facts like these are generally ignored by those who criticize the mental tester for his inadequate theory or for his over-objective, quantitative approach to human beings. I.Q. tests alone may not carry us very far, especially in the vocational field. But the psychometrist is a scientist who discovers how valid they are, and supplements them by other types of predictive measure when required.

Environmental Influences on the I.Q. Now returning to the undoubted variations that do occur in I.Q.s, these should not be attributed forthwith to environmentally produced alterations in the intelligence the tests are trying to measure. There are all sorts of chance factors at the time of testing, such as differences in motivation or attitudes, and inadequate sampling by the tests themselves, that account for most of the irregularities. However, some individuals do show consistent and prolonged upward or downward trends, and we have the evidence of Freeman's work on foster children and Newman and others on identical twins brought up apart that large environmental changes may bring about alterations of some 10, or at most 20, I.Q. points. The Iowa school and Schmidt have claimed considerably larger effects, but adequate confirmation from well-controlled experiments is not yet forthcoming. Extreme environmentalist statements are further contradicted by the appreciable correlation that exists between the I.Q.s of orphan children and the socio-economic status of true parents who have not brought them up.[11] Competent experts like Burks in America and Burt in England calculate from such figures as Freeman and Newman's that the hereditary contribution to I.Q. variance is three or more times as great as the environmental. Even this fairly small environmental component prohibits us from making genetic inferences, such as that national intelligence is [4]declining or that one race is more intelligent than another. But a more important point which has been generally neglected is that the figures refer solely to environmental differences as they exist in the North American white or the British cultures. They do not cover the effects of environmental uniformities, and we shall see later that these play an extremely important part in intellectual development. And when cultures differ more widely, as say the British and the Australian aboriginal, any I.Q. comparisons become quite meaningless. Again, the calculations have mostly been based on I.Q.s of children of primary school age; environmental differences tend to become wider at the secondary stage and in early adulthood. After 11, the majority of the population receive rather poor quality education which they often resent; they leave school at 15 and enter jobs and indulge in leisure pursuits which provide little intellectual stimulus. But the more privileged receive a better education for a much longer period, tend to enter jobs which make more use of their brains, and are more likely to keep up cultural leisure activities. Such differences have been shown to have a considerable effect on I.Q. Husén[10] finds that adults who obtain full secondary and university education have a 12-point advantage over others, of the same initial I.Q., who left school at 15. And I have demonstrated that the lower I.Q. strata, in less intellectual jobs, begin to decline in intelligence test performance earlier and do so more rapidly than do the higher strata.[*] [4]

[*] Cf. also the fanning out of adult test norms in the Raven Matrices and Vocabulary tests.

Factorial Analysis. Turning now to the results of factorial research: how much can we accept as established psychological fact? Heim would say very little or nothing at all, and she illustrates her contention by the unresolved dispute between Slater and others regarding the age at which spatial ability emerges as a distinctive factor. Most British factorists would agree, I think, that factor analysis is an exploratory and suggestive rather than, by itself, a conclusive technique. But two features of Spearman's theory are thoroughly substantiated, and a third feature is definitely wrong. First there is the tendency towards positive correlation among all abilities. The child or adult who is superior in reasoning problems tends to be above average not only in memorizing and vocabulary, but also in arithmetic, mechanical comprehension, and even in handwriting, reaction time and sensory discrimination. Correlations may sink to zero or even slightly negative in highly selected groups, but in a representative sample the theory of an underlying *g* factor is perfectly tenable, whatever its psychological explanation may be. Secondly, the hierarchical organization of abilities is clearly indicated in the sense that the more complex intellectual functions generally show a greater involvement of this *g* factor than do the simpler rote cognitive functions and sensory-motor capacities. Note that although Thurstone and his followers favour a rather different picture of the mind's abilities from that of Burt and myself, their recognition of second-order factors implies agreement with my two statements.

The third point, where Spearman went wrong, was his belief in the [5]determinacy of *g*—that any sampling of cognitive abilities would yield one and the same *g*. Sub-types of ability or group factors, or what Spearman called overlap of specifics, is far more pervasive than he envisaged; and the result is that all our samplings of abilities are more or less biased by group factors. For example, the *g* obtained from a battery of miscellaneous verbal group tests differs from that yielded by Terman-Merrill type tests in having a stronger verbal component. It also involves a group factor for doing multiple-choice as distinct from creative-response items; and the speeded conditions under which all the group tests are given introduce a different work-attitude factor. The reason why conventional intelligence tests used in selection at 11+ seem to measure a rather narrow and artificial kind of ability—or, as grammar school teachers complain, to select the "spiv" type of pupil—and the reason that clinical psychologists seem to get a better indication of intelligence in everyday life from Terman-Merrill or Wechsler, is the presence of these group factors. Such criticisms are often much exaggerated, since the major factors in both types of test are the same *g* and *v*. But they do contain sufficient truth to demolish the psychometrist's contention that he can determine the essence of intelligence purely through statistical analysis of test scores. Actually we are back very much where we were in the early '20's, when no two psychologists agreed in their definitions of intelligence. We must recognize that there is no external criterion for deciding that this kind of item is a better indication of intelligence than that; we can choose whatever manifestations of complex cognitive processes that each of us thinks most appropriate, and each will arrive at a somewhat different intelligence. What factor analysis has really shown is that intelligence must be regarded not as any single identifiable type of ability, but as a very fluid collection of overlapping abilities, comprising the whole of mental life. It is perfectly legitimate, therefore, for Thurstone, Guilford and other American factorists to classify abilities under a dozen or fifty or more fairly distinctive categories and largely to ignore the second-order or more general factors, whereas in this country we mostly prefer to classify by progressive subdivision, beginning with

as inclusive a *g* as possible, then major verbal vs. practical factors, and so on. But any classification is a matter of convenience. We may eventually reach some agreed scheme, but it is illusory to hope for any comprehensive and objective taxonomy at all analogous to that of chemistry or botany.

Influence of Emotional Factors on Test Performance. Another respect in which most of the psychometric work of the past forty years or so has been somewhat misleading is that, inevitably, it has treated intelligence as a purely cognitive variable, abstracted from the social and emotional context in which intellectual functions normally operate. In individual testing it is possible for the skilled tester to keep motivational factors reasonably constant, at least among normal children. Nevertheless, child guidance clinics often report cases whose intellectual development has been inhibited through emotional maladjustment, and who show spectacular rises in I.Q. after treatment, which do not seem to be attributable to mere lack of co-operation at the initial testing. In group testing we rely [6]rather largely on the resemblance of the situation to that of school teaching and examining to induce the necessary rapport. Experimental studies of altered motivation (for example, offering monetary rewards) generally yield negative results. However, as I described at last year's meeting,[21] an investigation by Mangan[13] brought out some of the effects of testees' attitudes. When difficult, untimed power tests of ability were used, scores depended largely on the testees' persistence as well as their *g*; whereas when easy, speedy cognitive tests were given, the set towards speed on the one hand or accuracy on the other hand had a marked influence. Such attitudinal factors have generally escaped notice, because our group tests have compromised between the persistence and the speed types, and have managed to maintain a fairly uniform set throughout. They become more obvious when we try to extend American or British made tests to other cultures whose work attitudes differ widely from our own. As Biesheuvel[3] and others have pointed out, the performances of primitive peoples are distorted not merely by their different educational backgrounds, but also by the fact that they don't seem to get the point of doing their individual best to answer silly questions, or to fit pictures and blocks together, as quickly as possible.

Despite our attempts to keep intellectual and emotional traits distinct, a certain amount of overlapping is widely reported. Neurotic patients in general do not score below average on intelligence tests, but delinquents and criminals usually do so. Terman's high I.Q. children were superior in character traits, and the *w* or character factor tends to correlate positively with *g*. Authoritarian and conservative vs. radical attitudes seem to show little, if any, overlap with I.Q.; but patriotic attitudes yield more substantial coefficients of –0.3 to –0.4 in several American researches.

Further effects of emotion on intellectual functions are recognized in the clinical psychologist's methods of diagnostic testing. Though there is considerable doubt as to the consistency of Wechsler-Bellevue or other test score patterns in the various neurotic and psychotic syndromes, a beginning has been made in isolating group factors which are particularly susceptible to differential deterioration: for example, Furneaux's speed factor among psychotics, and Lovell's[12] conceptualization, categorizing or flexibility factor which I described at the Annual General Meeting a year ago.[21] A puzzling fact to be explained by any theory of intelligence is that many types of brain damage, including prefrontal leucotomy, seem to have no consistent effects on I.Q. Nevertheless, deterioration attributable to damage, or to age, is more

readily observable in tests involving unfamiliar reasoning and performance test problems, in speeded tests, and in tests involving flexibility and the formation of new concepts, than in tests such as vocabulary which depend more on acquired information and on habitual modes of problem-solving.

Definitions of Intelligence. So much for the facts. You can see that there are quite a lot of them, although I have condensed as much as possible. Turning to theory: there are said to be almost as many different definitions of intelligence as there are psychologists. However, they can be classified into three main groups, which I will designate as the opera-[7]tional, the biological and the psychological. Operational writers consider that theorizing about the nature of intelligence has proved fruitless; it is best regarded as "what the tests measure", and should be investigated by factor analysis of the relations between different tests, and through empirical research into what tests enable us to predict about people. While I am sympathetic to such views, I have already pointed out that factors are not determinate—that we must have a theoretical framework to guide our choice. And the remarkable successes in prediction that we have achieved so far have likewise depended on our having some conception of what it is we are trying to measure.

The biological approach contrasts the relatively mechanical responses of lower animals, based on fixed tropisms, reflexes or instincts, with the more versatile and adaptable behaviour of higher species, including man. Thus many definitions stress capacity for profiting by experience, adaptation to environment, plasticity or ability to learn by trial and error, or, still more, by insight. There are many difficulties here, particularly in view of the recent work of comparative psychologists such as Tinbergen.[15] It is only too obvious that our most successful intelligence tests make very little attempt to measure modifiability or learning capacity; also that many people whom we would consider highly intelligent, who usually do quite well on our tests, are not actually very well adapted to their social and physical environment. But a more acceptable reformulation is possible, along the lines suggested by Hebb and Piaget. In lower species, the organism's behaviour is more directly and immediately determined by innate neural and biochemical patterns and by external stimulation (to which it becomes conditioned); whereas at higher levels, intervening processes occur to a greater extent in the central nervous system between stimulus and response, culminating in what we call thinking. By itself, of course, this does little to tell us how far any particular piece of behaviour is intelligent. But it has the great advantage of linking up, not only with psychological approaches, but also with factorial findings and current practice in intelligence testing. For the more complex intellectual problems which we use to differentiate between more and less intelligent humans, and which show the biggest *g*-saturations, are surely those which make most use of abstract concepts, and involve most internal thinking. The same theory takes us some way in describing perceptual generalization, transfer and problem-solving in such intelligent species as the rat and the ape.

Thirdly, psychological definitions: these have included a whole host of faculties—grasping relations, abstract thinking, reasoning, problem solving, originality, foresight, judgment, all-round mental efficiency, etc. What strikes one is not so much that they disagree as that they all overlap and that none of them provides any very precise guidance in devising intelligence tests. When tests are constructed in an attempt to sample two or more of them they correlate very highly, though—as

Guilford[5] has shown—moderately distinct group factors can often be established in highly selected populations. I would agree with Dr. Heim that we should not expect to be able to specify any one clear-cut faculty, but should [8]rather think of "intelligent" as an adjective applicable to all types of response, perceptual as well as conceptual, practical as well as symbolic.

The Bearings of Hebb's Work. Now all earlier work on the nature of intelligence has been put in the shade by Piaget's recent books and by Hebb's *The Organization of Behavior*[7] I cannot attempt to expound them fully or critically, but the following seem to me to be some of their most relevant points. They both show how the percepts and concepts, and the modes of perceiving and thinking, which adults accept almost as the natural order of things, are built up in childhood through contacts with the environment. In Hebb's view, the sensory-motor experience of the first year or two of life leads to the formation of groupings or "assemblies" of neurones in the association areas of the brain. The fully developed perception of shapes, sizes or objects involves autonomous activities or cerebral discharges which he calls "phase sequences". I find some difficulties with his neurological speculations, and prefer the "schema"—in Head's and Bartlett's sense—as the psychological element or unit of mental life, particularly since Piaget seems to employ schemata very similarly. The schema is an expectancy or anticipation which enables each experience entering consciousness to be charged with the integrated totality of previous relevant experience. Hebb provides considerable evidence of the dependence of such schemata on rich visual and kinaesthetic experience at an appropriate developmental age. Thus rats or dogs brought up as pets with a free run of a varied environment show greater learning and problem-solving capacity as adults than animals reared in the restricted environment of a cage. These early perceptual schemata are fundamental to the development of the higher-order ones which we call concepts or ideas, and which to a still greater extent operate as autonomous units in the association areas. They include not merely acquired information, but also modes of learning and thinking, and methods of tackling the sorts of problems we meet in daily life or in most intelligence tests. Like Harlow's monkeys, we learn how to learn.

Hebb's next point is his distinction between two uses of the word intelligence. Intelligence B is the intelligence that we recognize in daily life and which covers the intelligent thinking capacities that have been acquired during infancy and childhood, which also do not develop fully in the absence of suitable environmental stimulation. Intelligence A is an innate potentiality for forming, retaining and recombining schemata which is presumably dependent on the genes. It is the innate capacity for acquiring what we ordinarily mean by intelligence. It is, of course, purely hypothetical; we can never directly observe its operation, nor measure it. But it is a legitimate hypothesis, since, as I have already mentioned, we can prove hereditary resemblance apart from environment. Another strong argument in its favour is the existence of large differences in Intelligence B between different children in the same family, or between orphans in the same orphanage, which could hardly be attributable to environmental differences.

Hebb believes that he can account for the smallness of the effects of brain damage on mental efficiency in everyday affairs and on the responses [9]to Binet-type intelligence tests. Once phase sequences have become established, they are said to

become independent of particular neurones or brain pathways. Thus Intelligence B can survive extensive brain injury, or operations; but the capacity for building up new schemata may be more greatly affected. I would suggest that we need to add to this the notion of rigidification, as brought out particularly in Welford's work on ageing[23] and in Allport's recent book on prejudice.[1] Each schema that we acquire not only provides a basis for further development but also tends in itself to become stereotyped or rigid, and thus to inhibit further development or reintegration. Thus all-round mental efficiency or Intelligence B depends not only on the total number and complexity of schemata, but also on the degree to which we are able to differentiate or break them down and keep them flexible. And it is this aspect which has repeatedly been shown to be impaired by certain types of brain injury as well as by ageing. This flexibility may depend rather largely on personality factors such as authoritarianism vs. tolerance, and is thus intimately bound up with early attitudes to the parents, and with the success or failure of upbringing and education in developing rationality and objectivity of outlook. But here clearly we must turn to Piaget.

The Bearings of Piaget's Work. As Hearnshaw showed in his B.A.A.S. Presidential Address on thinking,[6] Piaget likewise emphasizes the historical aspects of our common modes of thought.[14] He insists also that intelligence is no one distinctive faculty, and cannot be reduced to, say, grasping relations or abstract thinking, but is present in all adaptations of the organism. Behaviour becomes progressively more intelligent the more complex the "lines of interaction" between organism and environment i.e. the greater the amount of autonomous cerebral activity. In the baby's early years, his behaviour consists predominantly of concrete and direct reactions to practical experience, and these sensory-motor adaptations tend to be one-way and inflexible. At the higher stages, culminating in abstract, logical reasoning, the individual's thinking is characterized by mobility—the capacity to generalize and transfer to new situations—and by reversibility—or ease of manipulation of ideas. After the first year, language plays an increasingly important part, not only in providing labels or symbols for conceptual schemata, but also in the classification and stabilization of perceptual ones. In between the sensory-motor and the logical stages comes an egocentric stage, when ideas are largely irrational, inconsistent, syncretistic and intuitive, bound up with the child's own needs and interests. Here I would differ from Piaget in regarding this, not so much as a stage of childhood around 5 to 7 years, but as a stage in the development of each class of ideas, which may occur at any age. In economic, political, social and religious matters, in the bringing up of children and the treatment of criminals, and in personal relations with other people, it persists even among most adults—as has been well brought out by Thouless in his books on straight and crooked thinking.[18] On the other hand, children much younger than 5 reach the rational stage in some of their practical activities, say in block-building or in manipulating furniture to reach a desired object.

[10]This rationality aspect of intellectual development is largely ignored in intelligence testing, since test items are chosen as far as possible to avoid personal involvement or controversial content which might evoke egocentric thinking. At the same time, several investigations do suggest quite a close overlapping between conventional *g* tests, tests of flexibility, of concept formation in young children and older persons, and tests of rational, unprejudiced thinking in adults. But I feel that an

adequate formulation of the role of drives and emotion is one of the main lacunae in intelligence theory. On the one hand, it is obvious that emotion disrupts the flow of cognitive schemata, and that maladjustment often inhibits intellectual growth; while on the other hand no intellectual development could occur in the absence of frustrations and need reduction, and motivation by interests. In most other respects there seems to me a very close fit between the theoretical framework suggested by Piaget's, Hebb's and Bartlett's writings, and the psychometric facts that I have outlined.

Conclusions Regarding Intellectual Development. Both the psychological and the psychometric approaches agree in showing that intelligence in daily life, together with the approximation to Intelligence B which is measured by our standard tests of *g*, are largely acquired. The hereditary component, as shown by calculations based on foster children, twins, etc., appears to be predominant largely because of the vast amount of experience that all children within any one culture obtain in common, though it also, of course, does reflect genuine innate potentiality or Intelligence A. Environmental differences between families within a culture, or children within a family, certainly exist, and account for the 25 to 30 per cent environmental variance which Burt and others admit. But this component is comparatively small among young children, since such children are in the process of acquiring the comparatively simple perceptual and conceptual schemata, for which even quite poor homes provide sufficient environmental stimulation. Most children at this stage can see and manipulate similar shapes and objects, and come in contact with common pictorial and other symbols, and hear speech that is adequate to their mental level; moreover, from 5 to 11 they almost all undergo a highly standardized type of schooling. But in adolescence and early adulthood, when they are acquiring more complex concepts and modes of thought, the environmental differences attributable to different levels and lengths of schooling, and different vocational and leisure experiences, probably widen considerably. As I have shown elsewhere,[19] the correlation between *g* tests and educational attainments rises until, in an unselected population of recruits, it becomes virtually impossible to separate them into orthogonal factors.

I know that psychologists have usually postulated a clear distinction between intelligence or inborn ability and acquired information and education, but this seems to be breaking down, for example, in contemporary American writings. I would say that a relative distinction may still be useful between the more general qualities of comprehending, judging, reasoning, and efficiency of thinking—on the one hand—which are largely acquired in the course of everyday living without much specific [11]instruction, and—on the other hand—such skills and knowledge as are specifically taught, whose absorption and retention also depend to a greater extent on the person's interests in those fields and on his personality traits of industriousness and stability. That these two aspects of ability can be separated to some extent is shown by the existence of children with I.Q. much higher or lower than E.Q., though the correlation between them even in the primary school is of the order of 0.85. But I do not accept the formulation that intelligence (i.e. Intelligence B) causes or makes possible the acquisition of attainments. One might equally say that the attainments cause the intelligence.

However, we have still to consider the questions: why is Intelligence B, at least as measured by our best tests, as consistent as it is over quite long periods; and why

does even the most thorough and sympathetic schooling seem to be incapable of raising the intelligence of really dull pupils or bringing their attainments up to anything like normal? To answer these we must, I admit, fall back to some extent on hypothetical individual differences in innate potentiality, Intelligence A. I would like, though, to couple this with the effects of deep-rooted emotional factors which favour or hinder intellectual and educational growth. For apparently irremediable backwardness is undoubtedly sometimes resolved by appropriate psychotherapy. But there is another important reason, namely the essentially cumulative nature of mental growth, and Hebb's demonstration that certain schemata are much more difficult to acquire if opportunity is denied at a particular age, or stage of development. A child who is brought up from 0 to 5 in an exceptionally unstimulating environment will be handicapped, however good the schooling from 5 onwards. Equally, of course, the intelligence tests that we apply at 11+ do, to a considerable extent, show potentiality for profiting from secondary education, although they certainly do not measure pure inborn ability. This potentiality is the product of initial genetic schema-forming capacity and of the cumulative effects of experience and emotional adjustment up to that age.

A corollary of these views is that it would be more logical to give up the term intelligence tests, particularly at the 11+ examination, where it causes continual misunderstandings and controversies with teachers and parents. If we substituted some such label as academic aptitude tests, it would leave us free to experiment with types of intelligence test items which could be proved empirically to add most to the prediction of future educational success, over and above what was predicted by conventional scholastic examinations and objective attainments tests and teachers' estimates. The items chosen for experimental trial should try to bring out the general level of concept development and symbolic thinking. But more specifically they should be based on a careful theoretical analysis of intellectual and educational growth in the 'teens, in the light of the writings of Piaget and other psychologists and of the great educational thinkers. Useful guidance might also be obtained from Guilford's[5] factorial explorations of the higher intellectual faculties.

Conclusions Regarding Factors. I will now attempt to reconcile the [12]findings of factor analysis with psychological theory. How can we account for the tendency towards positive overlapping of all abilities? I would suggest that there are three reasons why such generality occurs. First there is Intelligence A—some innate quality of the nervous system which makes humans more capable than lower animals, and some humans more capable than others, of acquiring and recombining habits, percepts and concepts and schemata of all kinds. Secondly, the essentially cumulative nature of mental development implies that those who, in early life, acquire a richer stock of perceptual schemata and verbal labels, are better able to build up the more complex and more flexible schemata necessary for conceptual thinking. Thirdly, some individuals are reared in a more intellectually stimulating and emotionally adjusting environment than others; and this contributes during childhood, adolescence and early adulthood to the abilities they manifest in almost any kind of situation. Others are relatively starved, or emotionally frustrated, so that their schemata not only fail to reach as great complexity, but also become set and rigid, thus inhibiting the acquisition of new ones; and their overall intellectual efficiency begins to decline, perhaps before they have grown to full maturity.

On this view, we might also expect to find the hierarchical organization of abilities. Imagine that we could collect a broad sample, not merely of abilities commonly tapped by present-day tests, but of every conceivable kind of behaviour and thinking that was recognizably intelligent or adaptable or efficient. Then the highest common factor, or *g*, of this sampling would be identical with Intelligence B. And naturally the more complex and abstract items, those furthest evolved from the sensory motor level, would turn out to be the most inclusive or *g*-saturated. Sir Godfrey Thomson's[17] theory of bonds seems helpful here, though I prefer the notion of schema to that of bond as being less apt to suggest the mechanical operation of associations. He criticizes any attempt to regard factors as unitary powers or organs of the mind, and thinks of the mind as consisting rather of an immense number of bonds. A mental test involves the operation of many such bonds, and two or more tests tend to correlate because they draw on the same pool. A certain structure or organization is imposed on the mind, partly perhaps through the influence of genetic factors (for example, in musical aptitude), partly through temperamental factors and interests, and largely through upbringing and education. Thus all the bonds or schemata concerned with number work, or with rote memorization, and so on, become rather closely linked. Hence, certain abilities or group factors do tend to emerge rather consistently and distinctly in the investigations of different factorists, despite their frequent disagreements. But *g* is almost impossible to pin down, as it were, because it represents a sampling of the totality of bonds; and whatever samples we draw are apt to be biased in the direction of the type of problems we choose, or by the type of presentation and the conditions of testing. Partly through Binet's and Terman's psychological genius, partly I daresay by luck, the *g* in Binet-Simon and Stanford-Binet scales was a fairly good sampling of Intelligence B, that is of the totality [13]of abilities which we recognize as intelligent in everyday life. No group test nor, I suspect, the Terman-Merrill, Wechsler-Bellevue or W.I.S.C. have been as successful from this point of view, in spite of their superior reliability and statistical sophistication. But I expect we could do better if we started again now and applied our psychometric expertise to tests which were based on a more clearly worked out psychology of mental development.

An important point to remember is that this totality of functioning will differ considerably in its nature and content at different stages of human growth. Our use of the term intelligence has made it appear that we are trying to measure one and the same thing in the 2-year-old, the 5-year-old, the 14-year-old and the 50-year-old, which is quite fallacious. In particular, this has landed us in difficulties over adult intelligence, and the age at which it is supposed to reach its maximum. If we are content to regard adult intelligence as capacity for dealing with abstract ideas, for manipulating verbal and other symbols, for grasping relations, and for new verbal learning, then our conventional tests sample it fairly effectively, as they do among children. In the average individual this *g* does go on increasing only so long as education and full exercise of the intellectual powers continues and, as I mentioned earlier, it usually starts to decline after leaving school or, at the latest, by about thirty years. But Intelligence B in adults should be something much broader. Full intellectual functioning is expressed in practical judgment, business acumen and artistic creativity, in success at skilled jobs and in social relations, and in all that goes to make up wisdom, judgment and experience. Obviously our tests constitute very poor samples of such an intelligence, and many of its aspects probably stay up or even go on improving until senescence.

Quite possibly—though here I have no strong views—we should make better progress if we gave up trying to measure the general factor for the time being, and instead concentrated on more specialized functions which could be shown by factor analysis to be fairly distinctive and to remain reasonably homogeneous in content over considerable age ranges. A profile of scores on tests which adequately sampled such functions would, of course, be much more valuable to the clinician or diagnostic tester than a vague, global I.Q. of indeterminate content. At the same time, such faculties would always show considerable overlapping hence it would be legitimate to combine the scores from the various tests weighting them in such a way as to yield any *g* in which we were interested. One weighting, for example, found by multiple regression analysis against educational criteria, would give us predictions of academic aptitude; another weighting would probably give a better indication of practical adaptability in daily life, yet another of schizophrenic deterioration, and so on. But I think that the effective realization of this step is a long way ahead. We need a great deal more fundamental analysis of the nature of mental development to guide us in choosing, and measuring, suitable faculties.

I am very conscious of the shortcomings of the crude sketch that I have been able to offer to-night, and I would end by inviting the collabora-[14]tion of the comparative psychologist, the neurologist, the child or genetic psychologist and the educationist, and the clinical and medical psychologist, in elucidating our subject matter. If I have been able to show that there is no inevitable conflict between their aims and those of the psychometrist, but that we can work towards the same end, I shall be satisfied.

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