The Irish Journal of Education, 1969, III, 2, pp 75-94

INTELLIGENCE AND HEREDITY: SOME COMMON MISCONCEPTIONS

CYRIL BURT
University of London

The concept which has given rise to the so-called 'nature-nurture controversy' was that of a genetic component entering into all intellectual activities For ease of reference it was termed 'intelligence' The widespread use of the term by later writers has resulted in a confusing variety of meanings The factual evidence for a genetic component is here summarized in some detail and the influence of environmental factors briefly discussed Several important corollaries for practical education are drawn from the conclusions thus reached

INTELLIGENCE THE BASIC CONCEPT

The old controversies about intelligence and its inheritability have cropped up once again in current discussions on the reorganization of schools and the classification of pupils within the school Mr Short, for example, Secretary of State for Education and Science, has recently assured us that there is now agreement among psychologists and educationists that the capacity we call 'intelligence' is not due entirely to nature, but also partly to nurture, and that in any case no method can be devised which measures innate capacity accurately Intelligence tests (so-called) and the resulting IQs no longer command the unquestioning deference they once received Mr Pidgeon (14, 15), Deputy Director of the National Foundation for Educational Research in England and Wales, goes further still, and rejects outright what he calls 'the capacity theory' Professor Butcher (5) and Professor Vernon (17) in their books on intelligence incline towards a tentative compromise which would discriminate between 'different kinds of intelligence'

These and similar pronouncements that have appeared of late in educational and psychological journals would seem to indicate that many of the writers are singularly ignorant of the early history of the subject and of how the word 'intelligence' came to be introduced into the modern psychologist's vocabulary The idea of assessing the abilities of different individuals by means of standardized tests and other quantitative devices is due to Sir Francis Galton, who, as his biographer tells us, was 'the cousin

of Charles Darwin and the father of individual psychology ' In his book on *Hereditary Genius* (8), published just a hundred years ago, he starts by accepting the current distinction between intellectual (or rather cognitive) abilities on the one hand and motivational qualities (i e affective and conative characteristics) on the other He then proceeds to distinguish between the innate or inheritable tendencies influencing each and the post-natal or environmental conditions that largely determine their development and detailed manifestations Finally, he contends, his data also require us to recognize, in addition to special intellectual abilities or 'faculties,' a kind of super-faculty affecting all mental processes

Taken together, these three distinctions lead to the concept of a hypothetical factor or characteristic which is (i) innate, (ii) general, and (iii) cognitive Some short convenient label was obviously needed to denote it Galton talked sometimes of 'general ability,' sometimes of 'natural ability ' Binet, one of Galton's keenest admirers, adopted the same assumptions and the same basic concept Since the French word corresponding to 'ability' means something quite different, he proposed the term 'intelligence' —an old scholastic word which had been revived by Spencer and used by him in much the same sense Spearman devised a code of letters, with 'g' to designate the 'general factor,' whether innate or acquired, so I, rather pedantically perhaps, suggested 'i g a ' to denote 'the innate general cognitive factor ' In the end Binet's term 'intelligence' prevailed as the most suitable name In those days the word was seldom heard, except on the lips of a few erudite scholars However, like so many useful technical terms—'gas,' 'energy,' 'dimension,' 'nerves'—it quickly filtered into popular parlance, and so acquired a halo of vague and varying meanings As a result, writers whose memories do not reach back to those early days, commonly suppose that 'intelligence' had long been widely recognized as a distinctive characteristic, and that Galton, Binet, and their various followers were merely engaged in discovering what precisely was its nature and origin This is a complete misrepresentation Apart from a few dim anticipations, the super-faculty thus postulated by Galton was an entirely novel concept

The 'intelligence tests' devised by Binet and other psychologists who followed in Galton's footsteps, were intended to provide estimates of this innate component Professor Vernon (16) objects that innate potentialities cannot be observed, and what is unobservable is unmeasurable In the strict sense of the term that no doubt is true Like so many hypothetical quantities that are constantly being assessed in other branches of science, they certainly cannot be directly measured, but there is nothing illogical in

attempting to estimate them indirectly by inference from the observable effects they presumably produce Those who declare that 'the capacity called intelligence is not entirely determined by nature,' and contend that, by appropriate modes of instruction and training, it is always possible to increase a child's intelligence, or, as the Americans like to put it, 'boost his IQ,' are manifestly interpreting the term 'intelligence' in a manner which departs widely from that which Galton and Binet intended And when Vernon and Butcher talk of 'different kinds of intelligence'—'Intelligence A,' 'Intelligence B,' 'Intelligence C,' and so forth—what they are really describing are simply different ways of using the word

The same may be said of Professor Hunt In his well-known book on *Intelligence and experience* (12) he argues that the old notion of intelligence has been radically modified by recent work on the influence of environment The results obtained, he writes, lead to 'an entirely new conception ' Intelligence, so he believes, consists of central processes comprising strategies for processing information, which develop in the course of the child's interaction with his environment To describe children as 'developing strategies for processing information' seems a little portentous Certainly what he is here formulating is 'an entirely new conception', but for that reason it should be given an entirely new name

Professor Hunt goes on to protest against the idea of a 'fixed intelligence ' This he attributes to our 'conceptual habit of seeing the dimensions of objects as immutable ' Here once again there is clearly a confusion over the interpretation of terms If by 'intelligence' we mean a genetic characteristic of the fertilized ovum from which a given individual develops, then, by definition, its amount is 'fixed,' no matter how he actually develops it as he grows up Suppose I once received a legacy from my parents of £100 the fact that I may since have increased it by profitable investment or recklessly squandered it cannot alter the amount I originally inherited from them If, however, what Professor Hunt is referring to is the alleged 'constancy of the IQ' (as his later remarks would seem to suggest), the answer is that no competent psychologist ever regarded an individual's tested IQ as *absolutely* 'fixed ' The conclusion that, properly assessed, the IQ commonly remains *approximately* constant, was the outcome, not of 'conceptual habit,' but of repeatedly retesting large groups of children

In criticizing my use of the word intelligence to designate an 'innate general cognitive factor' Mr Pidgeon (15) remarks, 'This is not what I and most other people understand by the term ' Well, if his turns out to be the prevailing usage, I should not feel the slightest qualm over surrendering the name, but I most stubbornly refuse to abandon the concept Mr

Pidgeon, it would seem, would have us adopt something like Professor Vernon's recent definition 'the effective all-round cognitive abilities to comprehend, to grasp relations and reason (Intelligence B), which develops through the interaction between the genetic potential (Intelligence A) and stimulation provided by the environment' (16, p 214), in short, what I called 'general mental efficiency'—i e an individual's *actual* ability at the time of observation or testing, not the *potential* ability with which he was endowed at birth But the use of the same label for both these very diverse qualities can only lead to further confusion Many teachers and educationists, however, seem to cling to the extreme environmentalist position championed by Watson fifty years ago and by Helvetius a century earlier still, and would have us renounce the whole notion of innate mental difference All children, it is claimed, are born with equal ability * That ability, so we gather, is the ability to learn from environmental experience, and the disparities in intellectual achievement which are so obvious in the classroom and in later life, they ascribe entirely to differences in the environmental experiences to which each child has been subjected during the years of growth and maturation

THE GENETICS OF INTELLIGENCE

All these contentious statements plainly raise the fundamental issue of mental inheritance Galton's evidence from his collection of pedigrees was manifestly inconclusive Pearson applied the method of correlation, but his data consisted of teachers' ratings, and, owing to the varying standards they adopted, his results carried little conviction My colleagues and I decided to apply the same technique to data obtained with specially constructed tests It is of course a biological truism that, in every organism from the most primitive bacterium to the most transcendent human genius, all *observable* characteristics are resultants of both hereditary and environmental factors But there is a well recognized tactic for circumventing this recurrent difficulty The stock procedure is (so far as possible) to keep first one factor constant and then the other, and note the differences in the results obtained

In orphanages and residential institutions the environment may be regarded as pretty constant for all We accordingly tested and assessed the intelligence of children who had been transferred thither soon after birth (3)

*See, for example, the views of Mr C Graham (9), also those of Mr M Duane as reported in *The Times Educational Supplement*, May 23, 1969, No 2818

We found that the range of individual variation was quite as wide as in the ordinary school population, and that the differences in intelligence showed a marked correlation with that of their parents, who had in fact played no part in their upbringing To secure cases in which the children's genetic endowment was the same, while the environmental factors varied, we collected data for 'identical' twins reared apart The correlation between the assessments of the intelligence of the several pairs was almost as high as the correlation between two successive testings of the same individuals This could not be explained away by selective placement, since there was no correlation between the cultural level of the foster-home (to which the separated twin had been sent) and the cultural level of the actual parents of the pair (by whom the other twin had been brought up) At the same time, the differences in home and school conditions, which had no effect on intelligence, were clearly reflected in the low correlations for school attainments These were very much smaller than those for ordinary sibhngs brought up together in their own homes

Most psychologists who are familiar with the literature now seem willing to admit that, as a matter of theory, the mental differences between individuals may be due in part to genetic influences But, so they maintain, this is of little practical importance, since in their view the influence exerted by environment is very much larger, and in any case the attempt to assess genetic potentiality by means of so-called intelligence tests is far too unreliable to be of any genuine value Whether or not this contention is sound, however, is not a matter to be settled by mere *ex cathedra* pronouncements What is plainly needed is an empirical estimate of the inaccuracy of such tests or assessments and of the relative influence of environmental and other irrelevant conditions

The most familiar method of assessing children's abilities—that, for example, adopted in the so-called eleven-plus examination—is to use written group tests, which as a rule consist, largely or wholly, of verbal problems calling for verbal answers It is the marks or scores obtained with tests of this type (usually expressed in the form of an IQ) which our critics have chiefly in mind Now, to begin with, a facility in understanding and checking or writing verbal statements is itself a somewhat specialized ability, and one greatly influenced by the intellectual status of the child's own home as well as by the instruction he receives in school To some extent this defect can be overcome by making sure that the wording and sentence structure are so simple as to be well within the grasp of every child who is to be tested, and by adding a variety of non-verbal items But even so, when such tests are applied on a single occasion only, some pupils will inevitably fail

to do themselves justice owing to accidental causes—a touch of ill health, or some emotional upset, or the paralysing panic that is all too frequent on examination day Much better assessments can be secured if the test-scores are submitted to the children's teachers, and, where any doubt or discrepancy arises, the child is re-tested with individual tests

To estimate the amount of inaccuracy incurred with these different procedures, it is necessary to carry out what is technically known as an 'analysis of variance' How much of the variation between the different individuals is due to the influence of irrelevant factors? In a series of researches carried out by Miss Howard and myself (4) we found that with the best type of test rather more than 75 per cent of the variance was attributable to genetic differences and about 25 per cent to environmental influences and the intrinsic unreliability of all such methods When the scores had been checked and re-adjusted with the aid of teachers and of a supplementary interview in doubtful cases, the latter figure was reduced to about 15 per cent

This conclusion has been sharply criticized by Dr Heim (11) and others Our estimate for the correlation between the abilities of parents and their children, they say, is only 0 50 How then can heredity account for 80 per cent or more of the variance observed among school children when tested or assessed in much the same fashion? This brings us to the commonest and most serious misconception—one that is shared not only by nearly all our critics, but by many of our supporters 'Heredity,' they suppose, means 'the tendency of like to beget like'—the definition quoted by one of them from the *Oxford English Dictionary* What they fail to realize is that heredity is responsible not only for resemblances between members of the same family, but also for much of the differences

To those unacquainted with current genetics this further contention seems so surprising that it is worth while setting out in some detail the empirical evidence on which we have relied In our earliest investigations we began by applying tests of ability and attainments to members of the same family stock related by widely differing degrees of kinship We first collected pairs of identical twins, and then proceeded to test both them and their older or younger sibs, their half-sibs (if any), their first and second cousins, their parents, and so on, together with a random sample of unrelated children to serve as controls The parents of the twins and other sibs were of course uncles or aunts of the first cousins, and great-uncles or great-aunts of the second cousins For each type of ability or attainment we then calculated all the possible inter-correlations, and arranged the coefficients in a square table of the type familiar in factorial studies A

specimen table, calculated by my colleague, Miss Howard, is appended at the end of this article Evidently if we kept strictly to blood-relatives of the initial pairs of twins, our numbers would in many cases be extremely small However, there is no significant difference between the correlation between twins and their older and younger sibs and the correlation between sibs selected at random Nothing is therefore lost if we substitute coefficients for the latter pairs, similarly for other relationships, and we can also insert in our table correlations for twins, sibs, and unrelated children reared in different homes, in addition to those brought up together

A group factor analysis revealed four main types of factor (i) There is first a 'general factor' entering in varying degrees into the assessments for all members belonging to the same families, but not into those for unrelated children this we may take to indicate a *common genetic factor* (ii) There are secondly distinct group factors influencing in varying degrees those pairs brought up in the same homes, whether related or not, the resulting increments are most obvious in the case of assessments for acquired educational attainments These factors must consequently be regarded as the effects of *common environmental factors* Factors of both these types increase the correlations, and so must be producing similarities between the individuals so affected (iii) For intelligence the correlation between identical twins and their older or younger sibs is only 0 50, the correlations between the identical twins themselves is well over 0 80 even when reared apart This increment therefore indicates a *specific genetic factor* Since each identical twin inherits all the genetic tendencies, general and specific, which are inherited by the other twin, both factors increase the resemblance between twins In the case of the remaining sibs however some of the genes received from parents will be peculiar to each individual child, hence, with them the specific factors will produce not resemblances but differences (iv) Although two identical twins receive exactly the same set of genes, the correlation between such pairs never reaches unity Now, when the total variance in each of the correlated sets is the same, the correlation coefficient represents the ratio of the variance *common* to both sets to the total variance of either set, and the difference between the two variances is the effect of a specific variance, i e of factors peculiar to each set (cf 5, sect 40) In the case of identical twins these further factors cannot possibly be genetic Hence, provided the reliability of the assessments is reasonably good, they must in the main result from the effects of present or past environmental differences The same holds true in the case of the other correlations, which all fall far short of unity We are thus led to postulate the influence of *specific environmental factors* The two types of specific factor, genetic and non-genetic,

both tend to increase the differences between the assessments of the correlated pairs, and so to reduce the size of the correlations observed Readers who feel more at home with the terminology popularized by Fisher (6) in his analysis of variance may regard the 'general factors' as responsible for variance 'between families' and the 'specific factors' as responsible for the variance 'within families'

When the effects of the last three types of factor are partialled out, the residual correlations exhibit something very like Galton's 'proportional law of heredity' For identical twins the value rises nearly to 1 00, for siblings and for parent and child it is approximately 0 50, for half-sibs and for grandparents and grandchildren 0 25, for first-cousins 0 125, and so on, progressively diminishing in inverse proportion to the closeness of the kinship Apparently, if the number of steps in the relationship is n, then the coefficient of correlation is approximately $1/2^n$ This is precisely what we should expect from the principles of Mendelian inheritance if intelligence (like stature and other quantitative characteristics) was in the main determined by the transmission of a large number of genes, whose effects were small, similar, and cumulative, i e by what is known as 'multifactorial' or 'polygenic' inheritance In general every gene has two forms Putting the matter quite crudely for the sake of illustration we may suppose that in the case of intelligence, one form adds a unit to the true IQ, the other adds nothing Each parent transmits to each of his offsprings approximately half his genic material, in other words, half the child's genes come from his father and the other half from his mother If therefore marriage were a lottery and human mating absolutely random, the laws of chance would imply that, on an average, half of Tommy's paternal genes would also be inherited by his brother, Jimmy This therefore forms part of the basis for the 'common genetic factor' The other half of the paternal genes, inherited by Tommy but not by Jimmy, forms the basis for the 'specific genetic factor' The same holds good of the maternal genes It follows that the correlations both between father and son and between one brother and another would be 0 50 When the children grow up and produce offspring, the process of halving will be repeated Hence the correlation between grandparents and their grandchildren will be $\frac{1}{2}\times\frac{1}{2}=0\ 25$, and a similar process will recur in the case of remoter relationships

There are, however, certain complications Often the effect of one form of a particular gene tends to dominate over that of the other, this tends to reduce the size of the correlation Moreover in human beings mating is not entirely random There is usually an appreciable correlation between the intelligence of husbands and that of their wives this tends to increase

the amount of correlation between their children These further effects can be allowed for in deducing the values to be expected for relatives of different degrees of kinship When this is done, we find a remarkably close agreement between the expected values for the various correlations and the values actually observed Let me add that readers who are seeking a fuller survey of the available evidence will find it clearly and convincingly set forth in an admirable review of the whole problem by Professor Jensen (12) who also gives a detailed and up-to-date bibliography

THE RELATIVE IMPORTANCE OF THE VARIOUS FACTORS

However, what the educationist wants to know is not merely the bare fact of inheritance, but the relative importance of the different types of factor affecting the actual assessments obtained for the children tested or examined A rough estimate of the four factor variances can be derived from the group factor analysis But more accurate assessments can be secured if we base our calculations on the principles underlying Fisher's analysis of variance For most of the groups we have studied the amount of individual variability, measured by the standard deviation of appropriately standardized tests, is much the same, namely, 15 IQ points If instead of the IQ we take as the unit of measurement the standard deviation itself, the total variance of each group (the square of the standard deviation) will be unity, and, as we have already seen, the correlation coefficient may be looked upon as representing the proportion of the total variance common to both the correlated sets of individuals It then becomes a matter of simple subtraction to deduce from the correlations actually observed the proportional amounts of the variance contributed by each type of factor to the total variance Since the total variance is already known, we need values for only three correlations to deduce the four constituent factor variances The results arrived at by this simple method can be checked and often improved by employing a more elaborate procedure and a wider range of empirical data In the research already cited (3) I tabulated the correlations obtained for six different types of pairs Since the number of values observed is thus larger than the number of values to be computed, we may apply the principle of least squares, and the results so obtained will be far more reliable than those derived from just three somewhat fallible correlations Still more accurate estimates will be reached if we include in our initial data the total variances actually observed (instead of assuming them to be equal) and substitute covariances for correlations

By way of illustration, let us take the figures obtained for the group test of intelligence, since this is the method of assessment commonly used by most other investigators The proportions of the total variance contributed by the four main types of factor are (i) common genetic factor, 40 per cent, (ii) specific genetic factors, 38 per cent, (iii) common environmental factors, 15 per cent, (iv) specific environmental factors, 7 per cent If by way of confirmation we start with the average of the correlations reported by other observers, much the same proportions emerge, namely, 37, 36, 17 and 10 per cent The point to which I wish to draw special attention is this the influence of *specific* genetic factors which, it will be remembered, tend to produce differences between members of the same family, is almost as great as that of the *common* genetic factor which tends to produce resemblances

If we add the percentages for the two kinds of genetic factor, we get totals of 78 and 73 per cent respectively These tally quite well with the values already quoted for the total contribution of genetic endowment This final result is constantly misinterpreted Vernon (17, p 13), for example, supposes that I claimed to show that 'some 80 per cent of differences in intelligence should be attributed to hereditary factors, and 20 per cent, to environment' (cf also 7, p 323) Such a conclusion, he adds is 'not acceptable,' since the proportions would be much lower if the differences in environment were much larger, my figures would not hold good of the Eskimo boys or the Blackfoot Indians whom he himself has tested I entirely agree Vernon and others, however, have made the mistake of supposing that I was using the word 'intelligence' to denote what I have called 'general mental efficiency', whereas what I was attempting to determine was the efficiency, not of the individuals tested, but of the tests commonly used to assess their innate mental differences My aim was to show that more accurate assessments could be secured by a more elaborate type of procedure And of course I was concerned solely with the practical problems encountered in dealing with English school children, whose environmental conditions are comparatively uniform I went on to emphasize the different consequences that would almost certainly ensue as regards both the efficiency of the tests and the efficiency of the individuals in times or places where the environmental variations were much greater, yet even in British homes and schools the differences are sufficiently varied for certain out-and-out environmentalists to maintain that these and these alone are responsible for the multifarious mental differences we encounter among the children we teach However, what the problem really calls for are not sweeping *a priori* generalizations about the causal potency of the

environment as a whole, but detailed investigations into the specific effects of this or that aspect of the environment and of the strenuous efforts we make, whether as teachers, education officials, or social reformers, to adjust or ameliorate them

ENVIRONMENTAL FACTORS

For the most part the critics of the hereditarian view are content to rely on dogmatic affirmations and armchair argument Few of them have attempted anything like a systematic study of representative samples of children, based on quantitative scaling and up-to-date statistical techniques The general style of inference seems to be—'this, that, or the other condition in home or school *might* account for the apparent differences in ability quite as satisfactorily as the alleged genetic influences, therefore, they *must* do so'

The environmental factors most frequently invoked are those obtaining in the home, particularly such as distinguish the different social classes Formerly greatest stress was laid on the *economic* status of the family The commonest cause of backwardness was said to be the unmitigated poverty, which was at one time rife among the lowest grades of the so-called working classes In the modern welfare state, though a few sporadic cases of extreme destitution can still be found, economic conditions have now so much improved that they can no longer be regarded as a major cause Today therefore it is rather the *cultural* conditions in the home that are principally stressed In my own studies of the homes of backward children 'unfavourable intellectual and emotional conditions' displayed far higher correlations with backwardness than 'unfavourable material conditions' (2, p 127) In the better type of home, I said, the average school child 'will pick up almost as much general knowledge at home as in the classroom', his parents will have both time and ability to answer his childish questions He will share their conversation and acquire their vocabulary Father or mother will help him with his homework, and take an encouraging pride in his educational progress In the illiterate home all this is reversed Among lower manual classes of today it is the intellectual poverty of the family rather than the material poverty which stands out as the important environmental factor, and, what commonly goes with it, an unfavourable and even at times a hostile attitude on the part of the parents towards school, education, and even the teachers themselves

Matthew Arnold in his reports as Inspector of Schools, repeatedly commented on 'the incredible scantiness of the vocabulary possessed by the

children in our elementary schools, and the correspondingly narrow circle of their ideas ' Nor do the kinds of film and television programmes such children nowadays prefer to watch do much to enlarge their store of information On applying tests of vocabulary and of general knowledge my co-workers and I found that in both respects the scores of the average child from the manual classes was less than half those of the average child in the clerical and professional classes Even when the comparison was restricted to two groups equal in average intelligence, there was still a wide difference Mr Pidgeon (14) has maintained that recent researches during the past five or ten years have shown that 'much of the difference in measured intelligence between "privileged" and "disadvantaged" children may be due to the latter's lack of appropriate verbal stimulation and the poverty of their perceptual experiences ' But here, I venture to suggest, there are two misconceptions First, the importance of the two causes mentioned is by no means a recent discovery, other educationists and psychologists besides myself drew attention to them more than forty years ago Secondly, as I pointed out at the time, these two causes affect, not the intelligence of the child as properly assessed, but rather his intellectual progress in the school room Mr Pidgeon is evidently thinking of the marks obtained in current types of group test for intelligence which are predominantly verbal in character But all such tests are quite inappropriate for assessing the intelligence in the case of children thus penalized

The group tests that are still in regular use are strongly biased in favour of particular types of children Their great attraction springs from the fact that they are so cheap and easy to administer short problems, couched in verbal form, each calling for a single clear-cut answer, can be readily constructed in large numbers and automatically marked with a simple key But the consequence is that highly intelligent children with intuitive rather than analytic ways of thinking, who may be relatively inarticulate when it comes to expressing their ideas in words, usually fail to do themselves justice There is a pressing need for including non-verbal, open-ended types of problem, which will detect pupils whose abilities have developed in a technical or an inventive direction rather than along strictly conventional or academic lines

Since there are plenty of children with quite low IQs who have been brought up in good middle-class homes, where both economic and cultural conditions are beyond reproach, many educationists are now more inclined to fix the blame on 'old-fashioned teaching-methods and on out-of-date school organization ' With modern 'progressive methods' and 'compensatory education,' we are told, the school can also make amends for

the shortcomings of the underprivileged home, and both attainments and intelligence will be greatly enhanced after a couple of years in the hands of a good primary school teacher, even the disadvantaged child should achieve a normal degree of intelligence But all too often, so it is alleged, the shy child from a shiftless and illiterate home, so soon as he enters school, finds a low IQ hung round his neck He is promptly relegated to a C-stream There the low-grade instruction he receives dooms him to incompetence for the remainder of his school career Re-tested at a later stage, he naturally obtains much the same low IQ as before

All these speculative assertions, however, rest solely on the critic's *ipse dixit* No cases are cited to show that this kind of injustice is a matter of frequent occurrence, and the argument seems grossly unfair both to the school psychologists and to the teachers Let us, however, look at the actual facts so far as they are discoverable ' "Progressiveness" in school organization and teaching methods,' says Professor Wiseman in his book, *Education and environment* (18, p 159), 'made its full impact on the English educational scene in the years between the wars ' Its inspiration came from America, and underlying it were the 'activity theory' of Dewey and the theory of 'conditioning' promulgated by Watson and other behaviourists With a more democratic organization of schools, and more progressive methods of teaching, it was argued, the average intelligence and attainments of the whole school population would be rapidly increased

One undeniable outcome of this policy has been a pronounced improvement in educational methods in the infants school, particularly in regard to the rudiments of reading and number In some of the primary schools remarkable results have also been achieved by a few devoted and enterprising teachers There are shining examples in the Yorkshire schools The classroom is no longer a mental treadmill, it has become a happy place And this is no small gain provided work and self-discipline do not suffer Nevertheless, when we turn to the average accomplishments of the school population as a whole, we search in vain for evidence of any marked improvement either in the basic educational subjects or in general ability

On my appointment in 1913 as Psychologist in the London schools, I commenced, with the aid of the teachers, regular surveys by means of standardized tests both of intelligence and of school attainments They were repeated at intervals of three years and later on at intervals of about ten years The tests and sampling methods we adopted were described in *Mental and scholastic tests* (1) Since the war similar studies have been carried out by my own research students and by various other investigators Many of them have used the same standardized tests others have preferred those

of Schonell, Vernon, Weschsler, or the National Foundation for Educational Research In these latter cases the results recorded can readily be translated into terms of the earlier norms When checking the standards for the latest edition of my book (1) in 1962, I collected a good deal of fresh data, and was surprised to find that in many respects the changes seemed comparatively small Certainly there were no signs of any superior attainment in the fundamental subjects, such as several enthusiasts had claimed Accordingly, I asked two or three of my former research-students to attempt a systematic comparison of the available data for the last fifty years

What are the results? Let us glance first of all at the findings for intelligence In spite of the vast improvement made in social conditions during the last fifty years and the alleged improvements in educational methods, there are no signs whatever that the average level of intelligence has been raised Nor has there been any discernible levelling up of the intelligence of the duller children The mean IQ has remained at about 100 and the standard deviation at about 15 or 16 on the revised Binet scale, with minor fluctuations well within the margin allowed by the standard error The proportional number of dull and mental defective children has certainly not diminished, and that of the brighter pupils—those formerly described as 'up to junior county scholarship standard' has certainly not increased, this has been confirmed by setting old scholarship examination papers, which include tests of intelligence as well as of English and of arithmetic, to representative samples of children from the same social levels Among the moderately gifted, particularly those coming from the manual classes who formerly would have suffered from the handicaps of their homes, there has been a considerable improvement both in the level and in the variety of attainments, thanks to grants now awarded, far more of them now go on to a university or college But the potentialities of the most highly gifted are still blindly ignored

It is much to be desired that similar surveys should be carried out in other areas besides London For intelligence, individual tests, such as the revised Binet and standardized performance tests, must be used, and that, it is commonly assumed, renders it impossible to examine more than a hundred or so The difficulty, however, can be largely circumvented by adopting what I termed the method of median sampling The school inspectors can usually be relied on to select average or median schools, and in each of these the investigator then picks out the median pupil in the age-group under consideration How this is to be done I have described in detail in the volume already cited (1, pp 14-15) Actual trial shows that by

testing about 20 or 30 children thus selected (often even less) one can get a much better estimate of the average of the general population than if one attempted to test all the children in what was designed to be a genuinely random sample

For a comparison of school attainments I am indebted to a study carried out by Miss M G O'Connor She has compiled data from various surveys and reports from 1914 onwards, based on tests applied by teachers or research students They relate to the last year of the primary school (age 10 to 11) The data are presented in Table 1 The figures in the table are medians, those obtained in 1920 (the year of the survey reported in

TABLE 1

COMPARISON OF SCHOOL ATTAINMENTS, 1914-1965

Year	Intelligence	Reading		Spelling	Arithmetic	
		Accuracy	Comprehension		Mechanical	Problems
1914	100 3	101 4	100 1	102 8	103 2	101 3
1917	100 1	95 3	96 5	94 7	91 1	92 5
1920	100 0	100 0	100 0	100 0	100 0	100 0
1930	98 6	100 7	105 2	100 8	103 4	94 7
1945	99 3	90 8	91 1	89 5	88 9	93 2
1955	99 8	95 1	96 9	93 8	91 4	95 5
1965	99 5	96 7	99 4	94 6	95 5	97 6

Mental and scholastic tests) are taken as 100 The most striking feature that emerges is the zig-zag fluctuation in each of the subjects tested, never very large, and due mainly, it would seem, to the effects of the wars and the subsequent recovery in each case As the Plowden Report (9) and other investigations have amply demonstrated, there has been, since the end of the last war, a substantial improvement in the basic subjects—most of all in comprehension of reading Yet even so, especially where accuracy is concerned, the level reached in each of the three R's is still below that which was attained in 1914, when teachers concentrated almost all their efforts on these fundamental processes If we took the medians for that year as standard, then the decline would be still more obvious the figures for spelling would be only 91 1 and for mechanical arithmetic 92 5 A comparison of essays written by average school children in 1914 and fifty years later reveals yet more obvious signs of decline, at least so far as the

formal aspects are concerned Certainly the later specimens are, on the whole, more imaginative, more amusing, and (as one of my colleagues puts it) 'freer from inhibitions ' But judged from a practical and prosaic standpoint, there is a marked falling off in clarity, factual accuracy, and respect for evidence and logic For this, I fancy, psychologists themselves are partly to blame Piaget and his followers have led many teachers to accept the traditional notion that reasoning does not develop until the age of eleven or later (a view which I hold to be quite contrary to the experimental evidence) and that during the primary stage the chief aim should be to develop imagination, self-expression, and what it is the fashion to call 'creativity '

All such comparisons are admittedly precarious But the figures I have quoted appear to be the best we can get in the way of objective data And there is in addition a cumulative mass of vaguer evidence pointing in the same direction In connection with the 'preliminary examination' (preceding the annual scholarship examination) which the LCC instituted for a while, booklets of group tests for intelligence, English and arithmetic, were carefully prepared These have since been published, and are still used by teachers and examiners on a fairly wide scale in different parts of the country Here too the results bear out what I have already said Quite independently a number of other investigators have reached somewhat similar conclusions, based on studies of their own

Commenting on 'the alleged decline in educational standards over the past fifty years' Professor Vernon rightly notes the difficulty of procuring samples which can be safely regarded as comparable This caution applied equally to the figures set out above Yet, even if we make the most liberal allowance for this and other sources of inaccuracy, we must at least acknowledge that they present a strong *prima facie* case against the unverified claims so often advanced for large-scale improvements during the last half century Viewed as a branch of applied science—as a 'practical art'—educational psychology has made nothing like the progress achieved during the same period by the sister arts of medicine and surgery treating the infirm body is now a far greater scientific success than training the immature mind Not for a moment, however, do I wish to deprecate the invention and trial of new classroom techniques, least of all those that claim to be 'progressive ' But all such innovations must be considered as experiments, until their value has been objectively proved Meanwhile, the main conclusion I myself would draw from the figures just quoted is that, as has so often been surmised, a definite limit to what children can achieve is inexorably set by the limitations of their innate capacities, and no improve-

ments in the quality of their education can affect the genetic composition of a large and stable population

Quite recently, however, a group of educational critics—among them several well-known psychiatrists—have been advocating a change of standpoint Instead of devoting all our attention to the period of schooling, we should, they say, concentrate on the pre-school period They willingly agree that wide differences in intelligence are already discernible when children first enter school, and that the degree of intelligence exhibited by each one remains relatively constant throughout the years that follow, even after the teacher has striven his utmost to 'boost the dull child's IQ ' But this demonstrates, so they maintain, not that the teacher has failed, still less that the differences are inborn, but rather that the diversities we note in the classroom are nothing but the effects of the vast cultural differences to which different children are exposed during the really formative period, namely, the first four years of life In this, as in most other criticisms, there is an undeniable grain of truth But what I would repudiate is the 'nothing-buttery ' Dogmatic generalizations of this kind are in my view sufficiently refuted by the occurrence of highly gifted children born and brought up in homes where the 'cultural' level can only be described as a condition of ignorance and illiteracy

Far more important, as our studies of the backward child have shown, are the effects of the infectious diseases to which children in the first few years of life are peculiarly prone It is sometimes impossible to say in later years whether or not the apparently poor intelligence of a dull youngster may not be due to early damage to the central nervous system caused by some early bout of feverish illness, until his medical history has been carefully scrutinized And of course, it has long been recognized that various pathological disturbances before, during, or just after birth may produce gross mental deficiency Accordingly, if in the more conspicuous cases grave defects are the result, in less obvious instances it is conceivable that minor degrees of subnormality may ensue However, all these types of causation are exceptional and in recent years they have become increasingly rare Moreover, as a mere smattering of biography suffices to show, there have been numerous examples of outstanding genius, born with poor bodily health and weak physique resulting from adverse conditions of pregnancy and delivery, who have nevertheless made good, and my own case-histories of gifted children include many similar instances, clearly disproving that physiological factors of this kind play more than an occasional and a minor role

PRACTICAL CONCLUSIONS

We seem therefore compelled to accept the theory of innate mental differences To suppose otherwise is to suppose that the human brain is a unique organ, exempt from the genetic influences that affect every other tissue of the body That being so, several obvious corollaries follow for those of us who are engaged in the practice of education

In England the issues that arise have of late been canvassed chiefly in reference to their bearing on school organization, and it seems widely assumed that those who subscribe to the hereditarian view are wholly at variance with the establishment of comprehensive schools That is by no means an inevitable inference As I have argued elsewhere, the question of school organization must be decided on administrative rather than on psychological grounds There is no one universal scheme equally suited to every type of educational area Recent inquiries, undertaken by the National Foundation for Educational Research, have demonstrated that so-called comprehensive schools differ far more from one another than is commonly imagined, and the various types of organization are constantly being revised We should therefore suspend our judgment as to the relative efficiency of different kinds of school until the Foundation's investigations have been completed

The paramount need is not equality of educational opportunity, but diversity According to his own innate potentialities, each child should, in an ideal system, be provided with the peculiar types of opportunity that can best minister to his needs Inevitably that must entail some kind of segregation or selective streaming A year or two ago a questionnaire circulated to a number of practising teachers indicated that the majority of the older (and therefore presumably the more experienced) favoured relatively homogeneous classes as being far easier to teach 'The dull pupil,' said one, 'when working in a class with pupils of average intelligence quickly becomes disheartened by the daily evidence of his own inferiority, the exceptionally able soon get bored and restive' And this appeared to be a pretty general view But unless the teacher is prepared to sift and sort he cannot secure the intellectual homogeneity that he wants 'Promote by attainment rather than by age, and ability rather than by attainment' That appeared to be an oft-repeated maxim

But intelligence is by no means the only factor determining the child's educational progress There are the special abilities and disabilities that emerge and mature during the years of growth, there are his qualities of temperament and character—the ambitions that he cherishes and the aims

that he forms. These, like general intelligence, are also largely influenced by the child's inborn constitution; but they are far more liable to be swayed by the conditions and events of his daily life, at home, at school, and wherever he meets his boon companions. Hitherto, our notions about the kind of school, curriculum, and teaching methods best fitted to this or that type of child have been for the most part decided by purely theoretical deductions. What is most urgently needed therefore are systematic experiments, deliberately planned and conducted, in order to secure first-hand empirical evidence as to the merits and the limitations of the various alternatives now proposed.

REFERENCES

1. BURT, C. *Mental and scholastic tests*. London: King, 1921.
2. BURT, C. *The backward child* (5th ed.). London: University of London Press, 1961.
3. BURT, C. The genetic determination of differences in intelligence: a study of monozygotic twins reared together and apart. *British Journal of Psychology*, 1966, *57*, 137-153.
4. BURT, C., and HOWARD, M. The multifactorial theory of inheritance and its application to intelligence. *British Journal of Statistical Psychology*, 1956, *9*, 95-131.
5. BUTCHER, H. J. *Human intelligence: Its nature and assessment*. London: Methuen, 1968.
6. FISHER, R. A. *Statistical methods for research workers* (13th ed.). Edinburgh: Oliver and Boyd, 1958.
7. FULLER, J. L., and THOMPSON, W. R. *Behavior genetics*. New York: Wiley, 1960.
8. GALTON, F. *Hereditary genius*. London: Macmillan, 1869.
9. GRAHAM, C. Ability and attainment tests. *Education*, 1967, *129*, 902-903, 948-949, and 1000-1002.
10. GREAT BRITAIN: DEPARTMENT OF EDUCATION AND SCIENCE. *Children and their primary schools*. A report of the Central Advisory Council for Education (England). London: HMSO, 1967.
11. HEIM, A. W. *The appraisal of intelligence*. London: Methuen, 1954.
12. HUNT, J. McV. *Intelligence and experience*. New York: Ronald Press, 1961.
13. JENSEN, A. R. How much can we boost IQ and scholastic achievement? *Harvard Educational Review*, 1969, *39*, 1-123.
14. PIDGEON, D. Intelligence: A changed view. *Educational Research News*, 1969, no. 6, 1-2.
15. PIDGEON, D. *et al*, Paper read at Symposium on the concept of intelligence, Conference of Educational Psychologists, 1966.
16. VERNON, P. E. What is potential ability? *Bulletin of the British Psychological Society*, 1968, *21*, 211-219.
17. VERNON, P. E. *Intelligence and cultural environment*. London: Methuen, 1969.
18. WISEMAN, S. *Education and environment*. Manchester: University Press, 1964.

CORRIGENDA

Page 78, line 5 *for* (16, p. 214) *read* (17, p. 214).
Page 81, line 34 *for* (cf 5, sect. 40) *read* (cf 6, sect. 40).
Page 83, line 7 *for* (12) *read* (13).
Page 88, line 1 *for* Weschsler *read* Wechsler.
Page 89, line 14 *for* (9) *read* (10).

APPENDIX

COMMON AND SPECIFIC GENETIC AND ENVIRONMENTAL FACTORS

The table below is a correlation matrix constructed according to the procedure described in the text The following abbreviations are used IT, identical twins, S, sibs, P, parents, GP, grandparents, C first cousins, U, unrelated children, t, children reared together, a, children reared apart, CG, common genetic factor, CE, common environmental factor, SG, specific environmental factor

The correlations are ordinary product-moment correlations, not intraclass correlations One member of each pair of twins who had been reared together was chosen by chance (the toss of a com), and taken to form the first group (IT), the other members were taken to form the second group (ITt), and the same procedure was adopted with the sibs The 'unrelated children reared together' are groups reared together with some of the twins or sibs In the rows or columns marked ITa, Sa, P, GP, and C they represent unrelated children reared apart from twins, sibs, parents, grandparents, or cousins Without further information it is impossible to separate specific factors except in the case of the identical twins

	IT	ITt	ITa	S	St	Sa	P	GP	C	Ut
IT	1 00	93	81	57	61	45	54	22	28	20
ITt	93	1 00	75	51	55	41	48	29	31	11
ITa	81	75	1 00	43	51	36	31	25	26	- 15
S	57	51	43	1 00	57	39	41	27	23	16
St	61	55	51	57	1 00	43	49	20	21	24
Sa	45	41	36	39	43	1 00	36	26	18	08
P	54	48	31	41	49	36	1 00	48	24	09
GP	22	29	25	27	20	26	48	1 00	11	- 10
C	28	31	26	23	21	18	24	11	1 00	·06
Ut	20	11	- 15	16	24	08	09	- 10	·06	1 00
FACTOR LOADINGS										
CG	66	66	64	65	65	61	66	38	32	00
CB	38	38	00	36	36	00	—	—	—	41
SG	56	56	60	—	—	—	—	—	—	—
SE	26	26	54	—	—	—	—	—	—	—