## Early Child Development and Care

# Recent advances in the theory and measurement of intelligence

Hans Eysenck [a]

[a] Institute of Psychiatry , London
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# Recent advances in the theory and measurement of intelligence

HANS EYSENCK

*Institute of Psychiatry, London*

The measurement of intelligence has been both the pride and the despair of psychology. Hailed for many years as an example of how mental traits and capacities can be measured, and of immense practical importance through its applications in schools, industry, and the armed forces, the measurement of intelligence has recently come under great critical fire. Critics have maintained that not only is there no such thing as "intelligence", and that even if it existed, it could not be measured; they have also thrown doubt on the whole notion of applying scientific criteria to psychological constructs, preferring some kind of idiographic framework for psychological theory. Last but not least, it has been suggested that because there is no universally accepted theory of intelligence, the concept cannot be admitted to have any scientific value.

In spite of its obvious absurdity, this last argument has impressed many people ignorant of the tradition of the hard sciences. Scientific discovery never begins with clear-cut and widely accepted definitions and theories; these are the end product of a long process of research, if they are ever achieved at all. Newton already grappled with the problem of finding a causal theory for gravitational phenomena, ending up with the quite unsatisfactory notion of *action at a distance*; modern physics and astronomy are equally far from reaching agreement, with Einstein's theory of gravitation as a distortion of the space-time configuration, and the

quantum mechanic theory of particle exchange (gravitations) the main contenders. If we had to wait for agreement on fundamental theoretical issues in science, no advance would be possible.

The major problem in any discussion of intelligence is the differential meaning of the term, depending on context and user. Broadly speaking we must distinguish three types of intelligence, traditionally labelled Intelligence A, Intelligence B and Intelligence C. Intelligence A is the *dispositional* basis of cognitive activity, presumably physiological and neurological in nature, and largely genetically given. Intelligence B is the problem-solving activity in the cognitive field which is found in every day life situations. This, presumably, is largely based on Intelligence A, but in its expressions very much influenced by experience, teaching, personality, cultural and socio-economic factors, and hence much more complex than Intelligence A. Intelligence C, lastly, is intelligence as measured by IQ tests, and not identifiable directly with either Intelligence A or Intelligence B, but obviously attempting to measure the one or the other.

Figure 1 will illustrate the relationship between these three concepts of intelligence. Intelligence A is the most central and also the most restricted of the three; it is basic to Intelligence B and the IQ measurement of Intelligence which we have called Intelligence C. Intelligence C is largely identical with Intelligence A, but also contains learned material, strategies of dealing with problem solving and other environment-produced methods and knowledge bases which are inevitably associated with both the verbal and the nonverbal problems contained in IQ tests. Intelligence B is even more inclusive than Intelligence A, because IQ measurement at least attempts to cut down to a minimum the extraneous features which prevent IQ tests from being perfect measures of Intelligence A. Thus for instance the psychologist using an IQ test will attempt to reduce anxiety in the subject to a minimum, as otherwise it might interfere with his measurement. In ordinary life situations, however, anxiety may play an important part in interfering with a

person's ability to show his true Intelligence (Intelligence A). As an example, consider the famous studies by Terman in which he followed up some 1500 high IQ children over a period of 30 years and more. Most of these did very well educationally and professionally, but a small group failed to do so. Nearly all of these had been found, according to the teacher's ratings, to have been highly emotional and anxious at the time of the original IQ testing. Thus the neuroticism interfered with the application of their high intelligence to everyday life problems, and made it impossible for them to do themselves justice in their professional lives.
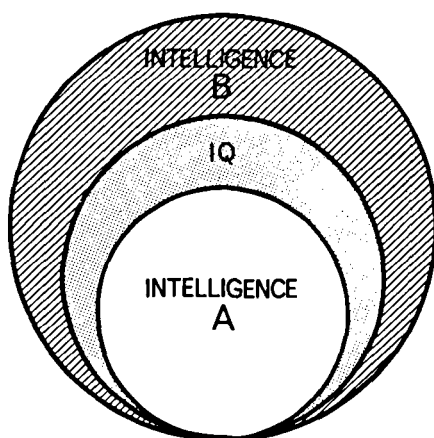


FIGURE 1    Relations between Intelligence A, Intelligence B and Intelligence C (IQ).

It might be thought that the existence of three "types" of intelligence was unusual in science, and might be considered to disqualify intelligence altogether from scientific investigation and discourse. However, we can observe exactly the same phenomena in relation to heat. As in the case of intelligence, the investigation of heat started out with observable phenomena, such as the different feelings on the skin of snow, on the one hand, and the proximity of

fire, on the other. Experienced heat (heat B) is very complex and depends only in part on the actual temperature of the air. Heat B is determined by such things as humidity, the chill factor (movement of air), previous intake of food and particularly drink, exercise, fever, and many other factors. A famous experiment illustrated the point. The subject puts one hand in a bowl full of hot water, the other in a bowl full of cold water, after 5 minutes he transfers both hands into a third bowl full of lukewarm water. This now feels hot to the hand that had been immersed in cold water, and cold to the hand that had immersed in hot water! Clearly Heat B (felt heat) is very different from Heat A, which, following the kinetic theory of heat, we may identify with and define as a movement of molecules.

Heat C constitutes a measurement of heat by means of mercury-in-glass thermometers, constant-volume gas thermometers, resistance thermometers, thermo-couples and many other means. These do not by any means agree on the actual temperature of the object that is being measured. The thermal mercury-in-glass thermometer registers 300°C, when a platinum resistance thermometer will register 291 °C! There is no "objective" temperature; the choice between these values is purely arbitrary, just as would be the choice between an IQ given by the Wechsler and one given by the Binet test.

In any consideration of intelligence, it is vitally important to keep apart Intelligence A, Intelligence B and Intelligence C; confusion results if this distinction is not borne in mind. We may usefully employ it in order to consider the two major paradigms of intelligence and intelligence testing that have divided the field, right from the beginning, namely the paradigms due to Sir Francis Galton and to Alfred Binet. These authors differ on three major points. For Galton, intelligence was a unitary mental capacity, underlying all learning and problem solving activities. Binet, on the other hand, thought of intelligence only as the average of a

number of relatively independent capacities, such as verbal, numerical, and memory ability, in adition to such rather more odd-seeming factors such as suggestabilty, etc. Strictly speaking Binet should not have used the term "intelligence" at all, because as an artifical statistical average it would have no psychological meaning. However, like most pioneers he was not very consistent in his use of terms. Correlational and factor analytical studies overwhelmingly support Galton's position, and among modern psychologists only Guilford, with his model-of-intellect, supports a Binet-type position. Guilford's model of Intelligence posits some 120 independent intellectual abilities, resulting from the interaction of 5 different operations, 6 different products, and 4 different types of content. Psychometrically the model is a monster, which has been severely criticized by all competent psychometrists. In addition, all the allegedly independent factors correlate quite highly with each other, and with ordinary IQ tests, disproving Guilford's contention.

On one point Binet was right, however, namely the fact that in addition to general intelligence we also need to postulate special abilities, such as the verbal, numerical and other abilities he discussed. Thurstone and his many followers have established this point conclusively, and for practical issues these so called "primary factors" can be of great importance.

The second point on which Galton and Binet differed was with respect to the importance of genetics. For Galton, general intelligence was largely determined by genetic factors. Binet, as an educational psychologist, was more concerned with environmental factors, and hence, while not dismissing genetics as the main cause of individual differences, was more concerned with possible changes in intelligence produced by teaching, training and other environmental manipulations. Here again Galton was very largely correct; the evidence on the genetic determination of individual differences is now very strong, suggesting that something like 80%

of the total variance in IQ differences is due to genetic factors, and only 20% to environmental ones.

There has been much debate in recent years about the actual proportion of the variance contributed by environmental and genetic factors, but much of this debate is sham. It should always be remembered that heritability is a population statistic; in other words, it characterizes a given population, at a given time. Heritability is not absolute value, like the speed of light for instance, which is invariant. There is no reason why the heritability of IQ in England at the present time should be identical with that in the United States of America; given that there are greater inequalities of wealth and education in the United States, it is perfectly possible that heritability would be greater in the United Kingdom than the United States. Heritability in the Scandinavian countries might be different again. The changes from one country to another would not be expected to be very large, but they might account for some of the observed differences. A recent study in the U.S.S.R. showed a heritabilty of 78%, which is very close to that found in the United Kingdom, suggesting that differences in political and social organization may not affect the value very much. However, it is quite unknown what the heritability of IQ might be in China, or in Japan, or in Africa.

It should also be noted that precisely because heritability is a population statistic, it cannot be used to refer to individual people. It is meaningless to say that for a given person 80% of IQ inherited, 20% environmentally determined; we are throughout dealing with variances, and these must always refer to a population, not an individual. The fact will illustrate why certain criticisms of the concept of heritability are nonsensical.

Thus it is sometimes said that partitioning the total variance of IQ into genetic and environmental portions is as meaningless as saying whether the length or the width of a field contributes more to its size. Clearly the comparison is quite mistaken; the single field

has no variance, and does not present a proper analogue. If we had a thousand fields, varying in size, in width and length, then it would be clearly possible and indeed easy to say which contributed more to the differences in size observed.

The third point of difference between Galton and Binet follows from the other two, and relates to the optimum method of measurement of intelligence. Galton was clearly more interested in Intelligence A, and hence suggested physiological indices, such as reaction time. Binet was more concerned with Intelligence B, and hence suggested tests involving problem solving, learning, memory, etc. Psychologists have almost universally followed Binet, and practically all existing IQ tests are of the Binet type, although some are more measures of crystallized ability, others of fluid ability. Even those of fluid or "culture-fair" ability, as Cattel has called them, still depend on a good deal of learned knowledge, acquired strategies, and other environmental factors. It is the adoption of the Binet-type method of measuring the IQ which has led to the grave difficulties that have arisen in applying intelligence measurement to social issues, such as sex differences in ability, age decline in intelligence, cross cultural comparisons, class differences in intelligence, etc. Inevitably the Binet-type measurement of IQ is only partly a measurement of genetically determined differences, (Intelligence A) and partly a measurement of culturally, educationally and socially determined ones.

It is interesting to speculate why psychologists rejected Galton's suggestions, and so enthusiastically accepted Binet's. It would seem in retrospect that the Zeitgeist had a great deal to do with this choice, which does not seem to have been based on any sound reasoning or good experimental evidence. The crucial factor seems to have been an article published in 1901 by Clark Wissler, who worked at Columbia University and claimed to have found no correlation at all between reaction time and intelligence. This conclusion has been widely quoted ever since, and persuaded

psychologists not to investigate the area any further, in view of this highly unsatisfactory result. It is difficult to understand why Wissler's work was ever taken seriously as it contains at least three major errors of design, any one of which would have led an alert editor to reject the manuscript. In the first place, Wissler did not use an IQ test at all, but used the grade point average of the students he was testing. This is known to correlate very poorly with IQ tests, particularly in such highly selected groups, and does not constitute a proper criterion of intelligence. In the second place, students being rather uniform with respect to intelligence, in view of the selection process they have undergone, produce a range of abilities so restricted as to lower drastically any correlations between different measures of intelligence that might be applied. A proper test of Galton's hypothesis would require a population with a standard deviation of fifteen, rather than of four or five! And as a third point, the measurement of reaction times was faulty. It is well known that reaction times are rather variable, and hence between fifty and a hundred measures are necessary to obtain a useful and reliable average. Wissler only used three to five measures, obtaining hopelessly unreliable data as far as the measurement of reaction times was concerned. Together these three elementary errors disqualify the study from being taken seriously, and one can only wonder how it is that such a truly incompetent study was accepted, and misled workers into believing that reaction times had no relation to intelligence.

In recent years there have been advances in this field, showing that Galton was right, and that indeed reaction times correlate quite significantly with IQ. The first to suggest new ways of looking at the problem was a German psychologist, P. Roth, who made use of Hick's law to derive a rather new variable from reaction time measurement. As Hick had shown there is a linear relation between the length of reaction time, and the number of alternative stimuli presented, taken as bits of information. Usually we would have one

stimulus, a choice between two stimuli, four stimuli, or eight stimuli, corresponding to, o, one two or three bits or information. When reaction times are averaged and plotted for individuals or groups, they lie on a straight line, and Roth suggested using the *slope* of this line as a measure of intelligence. He argued that for intelligent people the increase in complexity (i.e. in bits) of a test should lead to a relatively *lesser* increase in times than it would for relatively dull people, in other words, the slope would be steeper for dull as compared with bright subjects. He demonstrated experimentally that this prediction was in fact borne out by the data.

Figure 2 illustrates the results reported by Roth. On the ordinate is given information in bits, on the abscissa reaction times in msecs. The different regression lines corresponding to different IQ's are shown on the main part of the figure, and it will be seen that steeper slopes are associated with lower IQ's, very much as predicted by Roth.
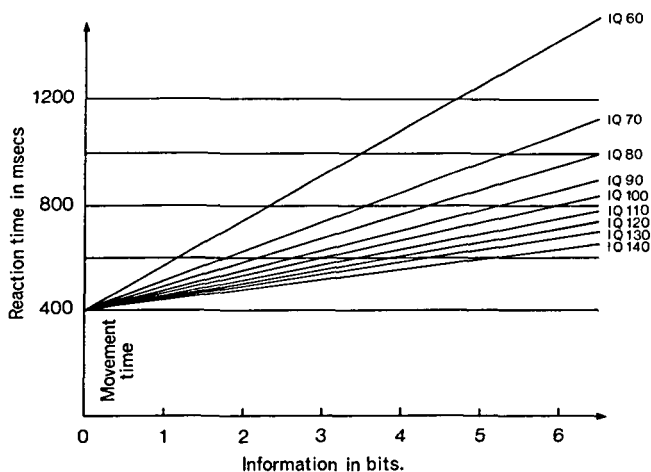


FIGURE 2    Reaction time in milliseconds, and information value (in bits) of the stimulus, as related to IQ of subjects.

Many people have since taken up the measurement of reaction time as an index of intelligence, particularly Arthur Jensen, and it may be useful to summarise the information now available. We find that: (1) Simple reaction times correlate between .3 and .4 with IQ in normal groups. (2) The more complex the experiment, i.e. the larger the number of stimuli between which the subject has to choose in order to respond, the higher is the correlation of reaction time with IQ. (3) The slope of the Hick regression line correlates with IQ in the predicted direction. (4) The variability of an individual's reaction times is inversely proportional to his IQ; in other words, the higher the IQ the less variable are the reaction times that are being averaged. (5) There are day-to-day variations in reaction time which act in such a way as to lower the observed correlations on any given day; if this variability is corrected for statistically (e.g. by averaging two or more days), or experimentally, higher correlations with IQ can be obtained.

Much of the work done on reaction time and intelligence has been carried out by contrasting retarded with normal subjects, or normal subjects with students; in looking at reported correlations it is always important to consider the range of talent which has been employed and to make necessary corrections for attenuation. The negative correlations between reaction times and intelligence are probably not particularly surprising, except to psychologists who took Wissler's results seriously; what is interesting is the observed correlations between slope of the regression line and intelligence, on the one hand, and the correlation between variability and IQ, on the other. These demand a causal explanation.

Various rather novel paradigms have been used to try and get high correlations between reaction times and intelligence, such as for instance the so-called *inspection time* paradigm. According to this, the subject is presented on a tachistoscope with two parallel lines, one clearly much longer than the other. The lines are presented for very short periods of time, and the subject has to say

whether it is the right or the left line which is the longer. Thresholds are established on the basis of his being 97.5% correct in his judgements, and this threshold has been found to correlate quite highly with intelligence, high IQ subjects giving lower thresholds. The test has also been adapted to auditory presentation, with similar results.

Other paradigms that have been used are the *Sternberg paradigm*, which incorporates short term memory into the procedure. Subjects are shown three, four or five letters or digits; this is followed by a probe letter or digit, and the subject has to decide whether this probe letter or digit was contained in the original set. He has to press a "yes" or "no" *button*, and the reaction time is found to correlate again quite highly with intelligence. The *Posner paradigm*, on the other hand, makes use of long term memory as an ingrediant in the design. Letters are presented which may be physically or semantically identical or different, and the subject has to press a button to indicate identity or difference. Again reaction times are taken, and found to correlate quite highly with intelligence. These variants indicate that the inclusion of short term memory, although theoretically expected to increase the correlation with IQ does not in fact materially do so; thus increasing the cognitive content of the test seems to make little difference to the correlation between reaction time and intelligence.

In the strict sense, of course, reaction times are not direct measures of physiological variables, and when Galton suggested them as such he could not have predicted the emergence of EEG and other types of direct studies of physiological brain processes. It is, however, in this areas that most recent attempts have been made to find a biological substrate for IQ and that the effort has been most successful. In relation to the EEG as such, little positive can be said; while possibly correlating with IQ (or more particularly with mental age) in retardates, little correlation has been found in

normal children and adults, and it is doubtful whether this is a promising area of research. Much more promising has been the study of event-produced potentials, particularly that so-called A.E.P. (averaged evoked potential). The experiment is a very simple one, in that the experimenter produces a number of auditory and visual stimuli (usually sounds delivered over earphones, or flashes of light), which in turn produce a flurry of waves superimposed on the ongoing EEG. These waves last for about 500 to 750 msec, but it is usually only the first 250 msec which are analysed, and are relevant to IQ. It is suspected that these waves indicate neuronal activity related to the processing of information through the cortex, although no universally agreed theory as to exactly what is happening has been arrived at. Evoked potentials have to be averaged over a series of evocations because the signal-to-noise ratio for each particular trial is rather poor. Hence fifty to a hundred timelocked evocations are necessary in order to get a meaningful trace.

Figure 3 shows roughly in diagrammatic form what is happening when, at point A, a sound is introduced into the ongoing EEG activity preceding the point! Negative (N) and Positive (P) pulses follow each other and gradually die away; it is customary to number these $N_1$, $N_2$, $N_3$ etc.

A Canadian psychologist, J. Ertl was the first to claim correlations between IQ and some aspects of the A.E.P. trace, namely *latency* and *amplitude*. High latency, slow waves are indicative of *low* IQ, and so was small amplitude of the waves. The correlations were not very high, ranging from .2 and .3, and many people had difficulty in replicating Ertl's work. Some of these difficulties, at least, were due to the fact that replications used methods other than those pioneered by Ertl, and also the quality of the research was not always very high. It is now recognised that by the use of proper parameters (intensity of stimulus, placement of electrode, type of electrode, proper interstimulus intervals, etc.) it is possible

to get correlation of between .3 and .4 with IQ, but of course this is not high enough to be of any practical importance, although it is interesting theoretically.
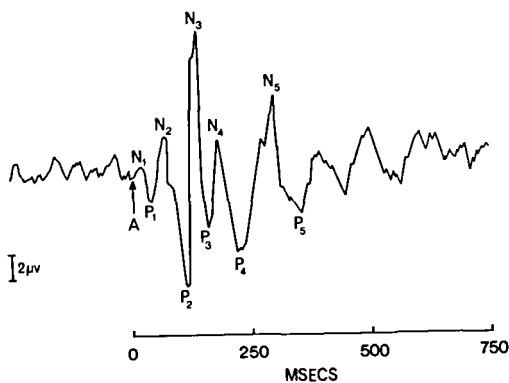


FIGURE 3    Diagrammatic representation of the evoked potential, with ordinary EEG activity preceding point A.

Another variable that has been found correlated with IQ is *variability* of the evoked potential. We have fifty to a hundred timelocked replications of the experiment for each subject, and we can look at the degree to which one of these differs from the other. The general finding has been that the *lower* the IQ, the *greater* the variability, very much as in the case of reaction times. Indeed, it might be said that variability is probably more fundamental than latency or amplitude, because high variability inevitably *decreases* amplitude and *lengthens* latency. The point may not be quite obvious intuitively, but consider amplitude for a moment. Assume that you have a series of one hundred waveforms, so variable that there is no correlation between one wave and the next, i.e. a trough may be superimposed on a peak etc. and peak and trough will only coincide accidentally. Under these conditions the most likely result is a straight line, i.e. zero amplitude! The

closer the correspondence of peaks and troughs between successive replications, the greater is the chance of obtaining respectable amplitudes.

Result of this kind are interesting, but they lack a theoretical substructure. This has recently been supplied, and indeed we now have several different types of theories, leading to rather different types of measures. It cannot be said at the moment that one or the other of these theories has clearly established its superiority, and we are in the interesting position of being able to design experiments to decide between theories. Here we will only consider two theories, namely that of the Henricksons, and that of Schafer, an early collaborator of Ertl's.

What the Henricksons are suggesting, essentially, is that there is a degree of isomorphism between the information that is passing through the neurons of the CNS, and the shape of the evoked potential. It is also proposed that in the transmission of the message, *errors* may occur, probably at the synapse, and that these errors are responsible for lengthening the time of reaction, make learning and problem solving more difficult and hence are responsible for low IQ performance. In other words, the greater the number of errors, the smaller the IQ.

It is possible from this hypothesis to deduce two ways of measuring IQ which should be superior to the usual latency and amplitude measures. The first of these is, as already pointed out, the *variability* of the averaged measure; the second is the *complexity* of the trace. Here again we can argue that the greater the variability, the less must be the complexity, as, in exactly the same way as with amplitude, smaller peculiarities of the averaged trace will only appear if peaks and troughs are appearing at the same time, i.e. under conditions of low variability. The Hendricksons have work out a combined measure, using both variability and complexity, and have correlated this with Wechsler IQ measures for over two hundred children constituting a reasonably random

sample as far as intelligence is concerned. The correlation they report between these two measures is .83, which is truly astonishingly high! It should be remembered that the correlation between the Wechsler and another, rather similar type of IQ test, namely the Binet, is only about .75; in other words, the AEP measure correlates more highly with Wechsler IQ than does Wechsler IQ with Binet IQ. We shall come back to the interpretation of this result presently.

Figure 4 shows the differences between high IQ and low IQ children; the evoked potential waves have been recorded for 6 children in each group, and it will be obvious that the waves of the high IQ children are much more complex than those of the low IQ children, high complexity being a function of low variability. These differences are obvious to the eye, and hardly need statistical analysis.



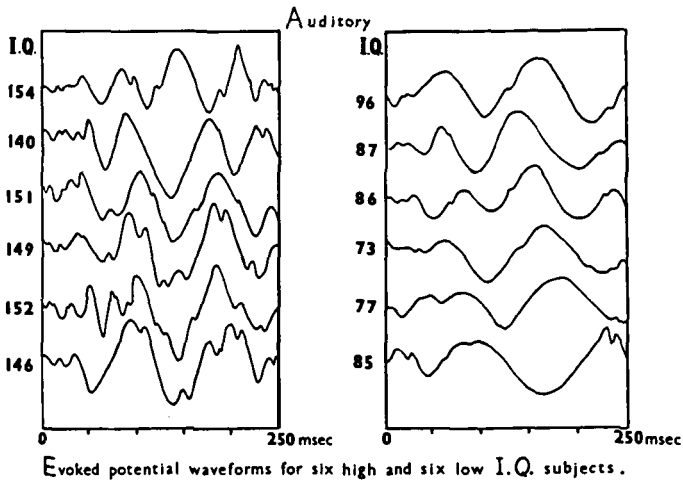Evoked potential waveforms for six high and six low I.Q. subjects.

FIGURE 4   Evoked potential wave forms for 6 high and 6 low IQ subjects.

The Schafer paradigm is quite different. It is argued that for an intelligent person reactions to an unexpected stimulus should be *greater* than reaction to an expected stimulus. Hence, Schafer measured the amplitude of response to unexpected stimuli, and compared them with response to expected stimuli. The latter were in fact stimuli produced by the subject himself, so that he knew perfectly well exactly when the stimulus would occur. Taking the difference in amplitude between these two measures, he correlated these differences with IQ, and also came up with a correlation in excess of .80, in the expected direction. It is not necessary to postulate that one or another of these theories is correct; both might of course be correct as the paradigms are rather dissimilar and the measures taken are quite different. It is also of course possible that both theories may be wrong, and that the observed high correlation cannot be taken as direct evidence of the correctness of the theory. At the moment, it is impossible to say. With the theory of the A.E.P. still in a rather early stage, and with our general theory of intelligence being even less highly developed, it would be impossible to arrive at any kind of definitive statement. All we can say is that the empirical results are favourable to any hypothesis linking A.E.P.'s and intelligence in a very direct kind of fashion.

It is obvious that these results, even more than those derived from reaction time investigations, cause great problems for the cognitive type of theory which has been woven around the Binet-type IQ. It is often claimed that learning and experience, cultural factors of various kinds, the acquisition of strategies practice effects and many other environmental variables account for the greater part if not the total of the variance observed in IQ measurement. None of these factors can be claimed to be active, in relation to reaction time measurement and even less in relation to the averaged evoked potential. Neither can motivation, nor attention; EEG measures related to attention have not been found to

correlate with intelligence, and indeed A.E.P. measurement is more successful in correlating with intelligence when circumstances are such as to minimize attentional variables. Making the necessary statistical corrections for attenuation, we may say that the A.E.P. accounts for something like 80% of the total variance of the Wechsler IQ suggesting that all that is left for these various cognitive parameters to account for is a 20% of environment variance contributed to the Wechsler IQ, leaving the A.E.P. as an almost perfect measure of genetic variance. The possibility that this may be so is all that is being suggested; obviously the evidence at the moment does not begin to prove such a view to be true, in spite of the fact that A.E.P.'s have always been found, in investigations of MZ and DZ twins, to have a high degree of heritibility. However, there are ways and means of testing the hypothesis, and it is being stated merely in order to suggest that such tests are urgently in need of being carried out, in order to come to a reasonable conclusion on this important point.

As a regards the practical implications of this work, it may be useful to state at once that it is very doubtful whether the ordinary IQ tests will for most educational, industrial and other purposes be displaced by the A.E.P. The very imperfections of the IQ, i.e. its contamination with social, educational, and other environmental factors, make it particularly useful for making educational, industrial and other predictions, because the criterion in each usually involves the same environmental factors! Hence the use of a pure measure of genetic intelligence (assuming that the A.E.P. is something of the kind) might actually *lower* correlations with external criteria which are more likely to resemble intelligence B than Intelligence A. Hence for most practical purposes present-day IQ tests are perfectly adequate, and are in any case very much cheaper of course than are A.E.P.'s.

However, there are many cases where ordinary IQ tests are inappropriate. Obvious examples are cases where there are cul-

tural or socioeconomic differences between individuals, too large to make the application of traditional IQ tests feasible. Traditional IQ tests are also often inapplicable in psychiatric patients, whether for reasons of high states of anxiety, depression, schizophrenic thought disorders, or what not. In these and many other cases, including also geriatric patients and patients with brain damage, the A.E.P. may provide a very useful item of additional information on which to base diagnosis and possible recommendations for therapy.

The new methods open up important paths for research. It should now be possible to trace the growth and decline of intelligence, by testing neonates or very young children, on the one hand, and older people on the other. Ordinary IQ test are not applicable to children under five years or so, and similarly the decline of intelligence after the age of sixty or seventy has only been poorly documented, different types of IQ tests giving different results, and leaving the actual amount of decline still in doubt. Indeed, it may perhaps be said that for most if not all experimental purposes, where the question is concerned with scientific truth rather than practical applicability, the new tests are very much preferable to ordinary IQ tests, being apparently much purer measures of Intelligence A than are Wechsler, Binet, progressive Matrices, or other widely used tests. It is to be hoped that through the use of the A.E.P. and reaction time in such research much more will be learned about the nature of intelligence, and the degree to which A.E.P.'s and reaction times can be integrated with our general knowledge of experimental psychology. It may be said that this new work is causing a revolution in the rather stagnant world of intelligence testing; only the future will be able to tell us how successful this revolution has been in advancing our scientific knowledge of intelligence.

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A detailed discussion, with full references, of the problem of the definition, meaning and inheritance of intelligence will be found in H. J. Eysenck, The Structure and Measurement of Intelligence (New York; Springer, 1979). The most recent studies on the averaged evoked potential are discussed in H. J. Eysenck (Ed.), A model for Intelligence (New York; Springer, 1982). Work on reaction times, inspection times, and the Posner and Sternberg paradigms are discussed by A.R. Jensen, and C. Brand and I. Deary in "A Model for Intelligence". Modern version of the Binet-type models are discussed in R. J. Sternberg (Ed.) Handbook of Human Intelligence (London Cambridge Univeristy Press, 1982).