The Future of Individual Differences

CARL BEREITER, *The Ontario Institute for Studies in Education*

Professor Bereiter concurs in Jensen's re-emphasis of the heritability of intelligence, but he draws different conclusions about the probable future. Because most intellectual tools which can be learned act as amplifiers rather than equalizers of basic differences in problem-solving ability and because our complex society increasingly emphasizes intelligence rather than other abilities, Bereiter believes that the kind of educational effort recommended by Jensen may in fact only increase the consequences of individual differences. Nevertheless, he suggests that this pessimistic projection may be open to revision in the light of ongoing work in early remedial education.

I have read Dr. Jensen's paper as an essay on the subject of what lies beyond attainment of equal educational opportunity. He does not deny that educational inequities exist and should be rectified, but he is concerned that people seem to expect the removal of such inequities to eliminate effectively the great spread of individual differences in intelligence, with its host of social concomitants. Dr. Jensen expects that in reality the removal of these inequities will have little effect on the spread of individual differences and he proposes that we start developing educational approaches that accept this spread of abilities as hard fact.

My own view of the future of individual differences and their social consequences is even less optimistic than Dr. Jensen's. The heritability of intelligence is unquestionably high, but what is more to the point is that with further social progress its heritability can only increase, because of the elimination of such sources of environmental variance as differences in the quality of education, nutrition, and medical care. One's view of the future beyond equality of opportunity

must, therefore, be of a future in which differences in intelligence are virtually one hundred percent determined by heredity.[1]

The magnitude of these differences then becomes a crucial question; however, it is not magnitude in terms of IQ points that counts, but magnitude in terms of differences in effective problem-solving capability.[2] These are not the same thing, even if they are perfectly correlated. We may expect that through continued scientific progress, through the continued development of intellectual "tools" such as language, logic, thinking machines, and scientific techniques, man's ability to solve problems will increase at an accelerating pace, even though his IQ changes not a jot. There is nothing paradoxical in this. Through the development of mechanical tools man's ability to lift weights, hurl objects, and so on, has been multiplied manyfold, independently of any increase in his basic muscular strength.

Tools, then, may act as amplifiers or equalizers with respect to basic human capabilities. A lever, for instance, amplifies force. If it triples the force Smith and Jones can exert, it also triples the *difference* between the forces Smith can exert and Jones can exert. An electric hoist, on the other hand, is an equalizer. So long as they both have what it takes to operate the hoist, both Smith and Jones can lift the same weight, regardless of their differences in muscular strength. Technology has generally been moving toward tools of the latter type, thus giving rise to the spectre of a future automated world in which individual human differences will no longer count for anything, having been obliterated by the uniformity of machine performance. I would edit this vision in only one important respect: in this future world the overwhelming variable of individual differentiation will be that of intelligence as manifested in the ability to use those tools that make other individual differences irrelevant. This statement rests on the following arguments:

1. The equalizing effect of sophisticated tools is gained by having intelligence take over the function of other abilities. Whereas the photographer once needed the ability to judge depths and levels of illumination accurately in order to take a clear picture, he can now be quite deficient in these abilities providing he is intelligent enough to use his equipment properly. This is not to say that sophisticated tools always require more intelligence to operate than primitive ones;

[1] This eventuality is in no wise to be forestalled by individualized instruction or any more libertarian tactic; on the contrary, such approaches should allow inherited differences to reach full flower, as advertised in the slogan, "enabling each child to realize his fullest potential."

[2] Another way of saying this is that it is surface traits rather than source traits of intellectual ability that count socially (Cattell, 1950). Both, of course, are phenotypes.

they may require less. The point is that the sophisticated tool requires only intellectual ability, whereas the primitive tool required intelligence plus physical strength, manual dexterity, sensory acuity, etc.

2. Intellectual tools, by which I mean algorithms, principles, systems, and devices that are used in processing information, appear in the long run always to function as amplifiers rather than equalizers of intelligence and, thus, to magnify rather than nullify individual differences in ability. The class of tools called mathematics furnishes the clearest examples. Using only arithmetic, people will differ considerably in the complexity of problems they can solve with it, as shown for instance by their performance on the Arithmetic Reasoning Test of the Wechsler Adult Intelligence Scale. Using elementary algebra, the less capable person will be able to accomplish little more than he could with arithmetic, whereas the more capable will be able to use it to solve problems of quite a high level. Using analytical geometry and calculus, the less capable person will again show little gain, except for being able to solve integration and differentiation problems that are clearly set up for him, whereas the more capable person will now be able to solve problems that the duller one cannot even conceive of.

Even when a new tool serves as an equalizer with respect to ability to solve a certain kind of problem, its overall effect seems to be that of an amplifier. Computer programs for the rotation of factors in factor analysis and for the simplification of electrical circuit designs have taken over tasks that used to require considerable art and intelligence. But the ultimate effect of such a development is simply to take out of the hands of specialists and to make available for more general use tools which the intelligent person can use intelligently and the unintelligent person can use unintelligently, thus increasing their manifest difference.

3. Every tool requires certain minimum abilities of a person in order for him to use it at all. Accordingly, each new tool drives a wedge between those who can learn to use it and those who cannot. The more powerful the tool the wider the wedge. An enormous effective gap, for instance, separates those who can learn to read from those who cannot. The social importance of such gaps seems, however, to depend not only on their size, but on where they occur in the distribution of abilities—on whether they separate a small minority at the top or bottom of the distribution or whether they separate the population more nearly into halves.

The direction of progress in the development of intellectual tools and of methods for teaching their use is generally toward lowering the level of intel-

lectual ability prerequisite to their use. Thus, I do not see Dr. Jensen's proposal, that educators look for ways to make school learning less dependent on intelligence, as a very radical one. This is what efforts at curriculum improvement, remediation, and improvement of teaching methods all try to do, whether successfully or not.[3] Bringing intellectual tools within the reach of more people does not necessarily have a leveling effect, however. To replace a method of reading instruction in which fifteen percent of children fail by one in which only five percent fail would tend to make for more social equality; but to take some powerful intellectual tool that could be mastered by only one person in a hundred and to make it so that half the population could master it would be a divisive influence. One such possibility is suggested by the oft-mentioned prospect of household computers. Presumably, such computers would be so simple in their routine operation that all but the most incompetent could manage them. But being general purpose computers, they would lend themselves to all sorts of non-routine applications and thus would provide an intellectual tool of enormous power and versatility to the person who could program them—and this is an ability that might well be put within the reach of about half the population, and yet remain unattainable by the other half. Thus, a sharp and conspicuous split in effective problem-solving ability would arise where none exist at this time.

The magnitude of individual differences referred to in the above arguments is, of course, a subjective matter, a matter of what people make of perceived differences rather than of objective magnitude. There is no absolute sense in which one could say that individual differences in problem-solving ability are greater than, say, individual differences in perceptual abilities; yet as a statement about the recognized and pragmatically significant differences among people in modern societies, it is obviously valid. We are sharply aware of differences among our fellow men in problem-solving ability; such perceived differences figure in countless decisions, with the result that a person's problem-solving ability enters prominently and complexly into the determination of his social fate. Differences in perceptual abilities, on the other hand, come to our attention only rarely and in special circumstances and for most people play little part in determining the course and character of their social lives. It is easy to imagine a world in which the tables would be turned.

[3] Even when new mathematics and science curricula demand more intelligence of the students than old curricula, if one considers what the new curricula are actually trying to teach, it will be seen that they are trying to bring within the reach of a wider population concepts and tools that were previously reserved for a more advanced or gifted minority.

Dr. Jensen has noted that there are societies in which differences in *g* do not count for so much. Presumably, there is a level of description at which it may be said that individual differences in intelligence are of about the same magnitude in those societies as they are in ours, but the level of description is assuredly not that of manifest effectiveness in solving real-life problems or of differentiation of social status on the basis of competence. A common interpretation of this anthropological fact is that, for one or another creditable reason, some other societies do not "value" intellectual abilities as we do. Another interpretation is that these societies lack the intellectual tools that would amplify differences in problem-solving abilities to the point where they are as conspicuous as they are in our society.

Either way, as one moves from relatively primitive to relatively advanced societies, individual differences in intelligence become at once more conspicuous and more consequential in manifold ways. What I have been proposing is simply that this trend will continue into the future at a rapidly accelerating rate, as differences in intelligence take the place of more and more other, formerly compensating, differences in ability and as more and increasingly powerful intellectual tools become available to magnify differences in effective intellectual ability.

We may now hasten to the denouement of this pessimistic story. The prospect is of a meritocratic caste system, based not on arbitrary distinctions of privilege as in traditional caste systems, but on the natural consequences of inherited differences in intellectual potential. These consequences, however, could be expected to extend well beyond differences in occupational status, to include associated differences in attitudes, interests, and ways of life. Assortative mating could be expected to intensify under these conditions, thus leading to further augmentation of inherited differences and rigidification of the caste hierarchy. Such a caste system would be far more resistant to democratizing influences than imposed caste systems of the past. It would tend to persist even though everyone at all levels of the hierarchy considered it a bad thing. The already high level of assortative mating on intelligence, which according to Dr. Jensen is higher than on any other trait that has been investigated, is perhaps the strongest single piece of evidence that progress toward this caste system is already well advanced.[4]

[4] Michael Young's otherwise compelling fictional account of *The Rise of the Meritocracy* (1958) misses the mark, I believe, in focussing on the tyrannical use of IQ tests to fix people's places in the meritocratic hierarchy. Testing is a red herring in this discussion, for it could at best be used only to facilitate discriminations that would be made anyway. The great improvements in intelligence testing that Young saw as necessary to the fullest development of meritocracy are not only unnecessary but also unlikely. The validity of intelligence tests has not increased appreciably in thirty years, and there is little prospect that they will ever account for more than about half the variance in non-test criteria of achievement. Improvements in instructional tech-

In this futuristic context, and in light of the failure of education to date, it may seem gratuitous to raise the question of whether education can do anything to equalize effective intelligence (once it has accomplished the still far from realized goal of giving everyone equal access to intellectual tools). I am encouraged to keep the question open, however, if only because of the results of early education experiments that I have had a part in. The approach that I and my co-workers have taken to early education of disadvantaged children has been rather close to that which Dr. Jensen advocates. We were not trying to "stimulate the growth of intelligence," but rather to teach academic skills directly in ways that did not demand of the children abilities they demonstrably did not possess (Bereiter, Engelmann, Osborn, and Reidford, 1966; Bereiter and Engelmann, 1966). As judged by achievement tests, the efforts have been quite successful (Bereiter, 1968), and I think they lend support, at least as far as the early stages of subject-matter learning are concerned, to Jensen's conviction that "all the basic scholastic skills can be learned by children with normal Level I learning ability, provided the instructional techniques do not make *g* ... the *sine qua non* of being able to learn" (p. 117).

Nevertheless, in spite of the fact that the program was never intended to raise IQ and that two-thirds of it was devoted to reading and arithmetic instruction having little or nothing to do with the skills called for on IQ tests, significant IQ gains have been regularly obtained. Over the last four replications they have averaged about 15 points. This seems to be too much of a gain to write off to test-wiseness and things of that sort, especially since the children's IQs were in the middle nineties to begin with and thus rose to substantially above average.

However, we never entertained any illusions that the instruction was improving the children's brains. The most reasonable interpretation had seemed to be that the IQ gains merely reflected the accelerated learning of some kinds of conceptual content sampled by the IQ test (in all cases the Stanford-Binet). This interpretation has received something of a blow, however, from a recent and as yet unpublished study in which we tried out a new curriculum generated by working backward from the Stanford-Binet to create a universe of content for

---

nology, which would make instruction continuously adaptive to variations in level, rate, and style of learning, are foreseeable, however, and would render IQ testing irrelevant. They would also have the effect of streaming people into different levels of the meritocratic hierarchy without the least hint of coercion. By imagining a tyrannical system, Young imagined one that could be overthrown by the oppressed. The currently high level of assortative mating on intelligence demonstrates how little meritocracy need depend either on IQ-branding or on official control.

which the Stanford-Binet could be considered a content-valid achievement measure. Going at it in this bald-faced manner, we expected to obtain enormous but, of course, psychologically meaningless IQ gains on the Stanford-Binet. As a check on non-specific effects, we also used the WPPSI as a pre- and post-test, without its content's being known during the experiment either to the curriculum writers or to the teachers. Contrary to expectation, the gains on the Stanford-Binet were not large compared to those regularly obtained with the academically-oriented curriculum—about 12 points, and the gains on the WPPSI were exactly the same as those on the Stanford-Binet.

Tracking down what is actually learned in order to account for IQ gains is likely to prove an arduous and perhaps ultimately thankless task. Our unpublished study does not point to any answer but does suggest that there may be more to educationally-induced IQ gains than meets the eye, whereas we, along with Dr. Jensen, had been inclined to assume that there was less.

Here is one possibility: thinking, as even the behaviorists are coming to admit, must surely consist of very long strings of actions or responses, most of which are never directly subjected to corrective feedback. Thus learning to think, to the extent that it occurs, must occur under less than propitious circumstances. This would constitute a situation in which inherited differences in functioning of an otherwise trivial nature could have profound effects. Slight differences in immediate memory, alertness, etc., could spell the difference between learning and not learning some of the cognitive behaviors involved in thinking, or between learning them early and learning them late. Yet with a little help they might be learned—help of a kind that is not regularly provided by the feedback conditions of either normal or school life. Educational programs that produce substantial IQ gains may have inadvertently managed to teach such behaviors. The temporary character of IQ gains doesn't negate this possibility. Most likely such programs, operating blindly in this regard, could do no more than teach early what would be learned later anyway, so that IQs eventually return to their expected levels.[5]

[5] Whether this will be altogether the case with children educated in our program remains to be seen. It was so for the children in the original pilot group. By the end of second grade their IQs had gone back down to their original level. However, the mean IQ for that group had only risen 10 points after treatment. The second wave, on the other hand, showed a 25 point IQ gain in two years of preschool treatment. By the end of first grade their IQs had declined 11 points, but this still left them with a net gain of 14 points and a mean IQ of 110. A randomly equivalent control group given one year of Head Start-like enrichment gained approximately 8 points and remained at the end of first grade with a net gain of 5 points and a mean IQ of 101 (Karnes, 1969).

In order to achieve any lasting neutralization of the inherited tendencies leading to lower IQ, it would be necessary to discover cognitive behaviors which duller people will never learn at all and to find ways of teaching them. I will not pretend to specify any such behaviors, even speculatively, but I will suggest a couple of areas where they might lie. One is an area that may be called preliminary information-processing—what you do with incoming information when you don't yet have enough other information to make intelligent use of it. I would suggest that the dull person doesn't do anything with it most of the time, so that he is said to have an attentional deficit (Zeaman and House, 1963), whereas the intelligent person has learned a number of provisional information-processing moves which at least have the effect of preserving the pieces of information in a form so that they can be assembled later (Payne, Krathwohl, and Gordon, 1967). Another is in the construction of solution models for problems (Gagne, 1966), which even some college students seem to do not merely poorly, but not at all (Bloom and Broder, 1950).

Remedial education, along with remedial genetics and remedial biochemistry, might conceivably have some appreciable effect in reducing the spread of individual differences in intelligence. I see no prospect whatever, however, for a reversal of the tendency for intelligence to take over the function of other human abilities. That tendency is intrinsic in the entire progress of science and technology. The domain in which other human abilities are significant becomes increasingly limited to sports and to arts where the scope of intelligence is arbitrarily restricted (through restrictions on the kind of equipment that may be used, for instance). Thus Dr. Jensen's closing appeal for diversity of aims in education inspires more nostalgia than hope, recalling the nearly vanished era when blacksmith, watchmaker, woodcarver, gardener, and a host of others could attain some measure of distinction on the basis of special abilities little related to general intelligence. Special abilities will continue to have a place, of course, but as adjuncts rather than alternatives to general intelligence.[6] If we are to

[6] Throughout this discussion I have followed Dr. Jensen in using the terms *g*, intelligence, and IQ interchangeably. I don't believe that either his argument or mine would be materially altered by dropping the notion of *g* and adopting a multifactorial view of intellectual abilities, as in Guilford (1967). The main difficulty would be the shortage of relevant data on separate intellectual abilities, compared to what is available on general intelligence. A special drawback to approaching the problem multifactorially is the lack of data on hereditary and environmental contributions to the *correlations* between mental abilities. According to Thompson (1966), this matter has never been studied, although the methodology is available and has been applied to other problems. If we regard *g* as an unrotated first factor (Rimoldi, 1951), its composition would naturally change with change in the selection of tests, as Dr. Jensen notes, and preferred

make something of the "untapped reservoir" of learning ability that Dr. Jensen finds among the disadvantaged, it would seem that we must look—as educators and psychologists have really only just begun to do—for ways to marshal this learning ability to the task of learning to think.

---

selections of tests might change as cultural conditions changed. For instance, there could be a shift toward greater emphasis on creativity measures. Such shifts would have implications for who ranks where in a meritocratic hierarchy but not, foreseeably, of such a radical kind as to require serious qualifications in any arguments presented here.

References

Bereiter, C. A non-psychological approach to compensatory education. In M. Deutsch, I. Katz, and A. R. Jensen (Eds.), *Social class, race, and psychological development.* New York: Holt, Rinehart & Winston, 1968.

Bereiter, C. and Engelmann, S. *Teaching disadvantaged children in the preschool.* Englewood Ciffs, N. J.: Prentice-Hall, 1966.

Bereiter, C., Engelmann, S., Osborn, J., and Reidford, P. An academically-oriented pre-school for disadvantaged children. In F. M. Hechinger (Ed.), *Pre-school education today.* Garden Hills, New York: Doubleday, 1966, pp. 105-135.

Bloom, B. S. and Broder, L. J. *Problem-solving processes of college students.* Chicago: University of Chicago Press, 1950.

Cattell, R. B. *Personality: A systematical theoretical and factual study.* New York: McGraw-Hill, 1950.

Gagne, R. M. Human problem solving: internal and external events. In B. Kleinmuntz (Ed.), *Problem solving: Research, method, and theory.* New York: Wiley, 1966.

Guilford, J. P. *The nature of human intelligence.* New York: McGraw-Hill, 1967.

Karnes, M. B., Teska, J. A., Hodgins, A. S. A longitudinal study of disadvantaged children who participated in three different preschool programs: Traditional, direct verbal, and amelioration of learning deficits. Paper read at American Education Research Association, Los Angeles, February, 1969.

Payne, D. A., Krathwohl, D. R., and Gordon, J. The effect of sequence on programmed instruction. *American Educational Research Journal,* 1967, 4, pp. 125-132.

Rimoldi, H. J. A. The central intellective factor. *Psychometrika,* 1951, 16, pp. 75-102.

Thompson, W. R., Multivariate experiment in behavior genetics. In R. B. Cattell (Ed.), *Handbook of Multivariate Experimental Psychology.* Chicago: Rand-McNally, 1966, pp. 711-731.

Young, M. *The rise of the meritocracy.* London: Thames & Hudson, 1958.

Zeaman, D., and House, B. J. The role of attention in retardate discrimination learning. In N. Ellis (Ed.), *Handbook on Mental Deficiency.* New York: McGraw-Hill, 1963.