# *Environment: The Cumulation of Effects Is Yet to be Understood*

ARTHUR L. STINCHCOMBE

*University of California, Berkeley*

*Professor Stinchcombe deals with the Jensen article from the point of view of an "environmentalist" but not from the simplistic stance that Professor Jensen attacked in his original article. Stinchcombe argues that deprivation does more than prevent children from learning simple skills at an early age—that cultures or social conditions must operate consistently and sequentially to produce successively higher levels of cognitive functioning. Environments, he argues, are cumulative, and until researchers can account for the complexity of environment, statements about the proportional effects of heredity and environment are premature. Thus extrapolations from twin studies limited to a single social group to estimates of the genetic capabilities of a different group are particularly suspect.*

This essay is divided into two broad parts. First I want to make several comments about what Jensen's evidence shows, taking the evidence at face value. In general, Jensen conceives the evidence he presents to have a single obvious interpretation. I think the singularity of interpretation is often the result of a kind of systematic naivete about how the environment works.

Second, I want to develop the outlines of a theory about how the environment determines the abstract cognitive structures people have to deal with the environ-

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ment—especially the symbolic environment—which are measured by IQ tests. The basic argument will be that many of the findings in Jensen's article fit into a pattern that would be produced if rural and oppressed cultures were inefficient in teaching advanced cognitive structures at later ages. Jensen assumes that if environment works harm, it will do so in the learning of simple cognitive skills at earlier ages. This might be called the "Headstart" environmental theory. When he gives arguments against this theory, he thinks he is arguing for a genetic theory. But he is also implicitly arguing for a "civilization" theory of environmental determination of thought, which says that cultures differ most at the most sophisticated levels. My purpose will be to use his evidence in favor of a different theory of environmental impact on IQ.

*What Do the Kinship Data Show?*

The most impressive argument for the heritability of intelligence is clearly the data on correlations among kinsmen in IQ. The basic finding is that if you take pairs of kinsmen that are genetically more closely related (*e.g.,* identical twins) and pairs of kinsmen that are farther apart (*e.g.,* fraternal twins), then the correlation between the IQs of the closer pairs will be greater than the correlation between the IQs of the more distant pairs. That is, if you know the IQ of one identical twin, you can predict the IQ of the other very well. If you know the IQ of a fraternal twin, you cannot predict the IQ of the other nearly as well. By combining genetic theory about *differences in genetic closeness* of different types of relatives with knowledge of the *differences in correlations* between pairs of different types of relatives, one can estimate how much effect genetic closeness has. From this estimate of the effect of genetic closeness, one can estimate the *size* of the effect of genetic constitution, even though one cannot measure genetic constitution itself. This seems to me a valid procedure for what it is designed for, though subject to the risks of any attempt to get at unobserved variables from the pattern of manifest variables.[1]

But if we look at Jensen's estimates of environmental effects for IQ (p. 51), we find that the difference *in environment* between one twin and another is the same size as the difference *in environment* between one family and another. That is, if

[1] One assumption it does make is that if two people are born in the same family they have the same father. This is, of course, a theory of the frequency of extramarital affairs or of extramarital contraception. It has been estimated that a fourth of all married women in the U.S. have extra-marital affairs, but I know of no studies of their contraceptive practice in such affairs. One could estimate the frequency of such fruitful affairs by studying some clearly inherited characteristics, such as blood types.

you pick out two brothers at random, the chance that one of them will be in a "deprived environment" while the other is in an "advantaged environment" is the same as the chance that one out of a pair of randomly picked families is a "deprived environment" while the other is advantaged. This clearly is not the notion most people have of variations in environment.[2]

This peculiar fact of as much environmental variation within families as between families is illuminated if we look at the samples. The one described for London is more or less typical. To summarize briefly what is going on, if you and your cousin both live in London and both are still in school, then the difference between your father's family and your uncle's family is about of the same order of magnitude as the difference between your family as you grew up in it and your family as your brother grew up in it. That is, the environmental variations we are talking about are variations *within* an endogamous group, a group that intermarry and exchange children by adoption. If we want to generalize across endogamous groups (groups that intermarry among themselves), for instance across races, we have to ask whether there is more variation in environment between a white and Negro family than there is among kinfolk living in London. If there is, then the between-families variance in environmental factors would increase, and the relative role of genetic factors would decrease. Also, the relative role of within-family variation in environment would decrease relative to between-family variation.

What is really needed to apply such kinship research to the problem of racial differences are pairs of identical twins, one of whom is a Negro, and pairs of fraternal twins, one of whom is a Negro.

*Regression Effects*

Another apparently impressive piece of evidence is the larger regression effect for Negroes rather than whites (pp. 83-84). Briefly the data are mean IQs of children, subtracted from the mean IQs of parents in each of three, four, or five social classes. (Roughly speaking this is what is going on—the actual calculations

[2] Incidentally, it may confuse some readers of Jensen's article that he takes correlation coefficients as measures of variance explained at this point in his argument. He does not explain why, and most people learned to treat correlations as the square root of variance explained. But Jensen is right here. The key is that the estimate of the correlation between the *unmeasured* genetic variable and the manifest variable is estimated by the square root of the correlation between two manifest variables assumed to have the same correlation with the unmeasured variable. When this square root is then squared to give the variance explained, it gives back the manifest correlation. In psychometric language, the reliability of a test is an estimate of the square of its validity, *i.e.*, the "variance explained" of the test by the variable it measures.

do not seem to be as adequate to the purpose as I described.) The differences are larger for Negro middle class children than for white middle class kids. The argument here goes as follows. The difference between childrens' and parents' IQ measures the difference between the particular set of genes that are manifested in the parent and the average of the total set of genes which the parent carries. That is, out of the total pool of genes that the parent carries only one subset are the ones that he gives his children. If the manifested subset is very different from the pool, then the children will be very different from their parents. So the size of the difference between parents and children is supposed to measure the distance *for the parents* between the genes they manifest and the genes they carry without manifesting. If Negroes of high intelligence show more regression effect than whites of the same intelligence and environment, that is supposed to show that the pool of genes from which exceptionally talented Negroes come is farther from them, on the average, than the pool from which exceptionally talented whites come.

Now the key to this inference is actually equating the environments of the children. For if the children of talented Negroes are actually exposed to a less cognitively rich environment than are whites, even though they are in the "same" social class as measured, then we would expect a larger regression effect even if the pool of genes were the same distance from the parents. What we have to do then is to examine the equation of parents' status first, and then whether the equation of status equates environments. Briefly the argument will be that Jensen has not in fact equated statuses, and that even if he had he would not have equated environments.

First, let us assume that the indicator of status in the studies that Jensen quotes were a perfect measure of status. Then what he has done is to pick out three (or four, or five) cutting points on a continuous variable, and equated all people above the top cutting point as middle class, and so forth. Now as Jensen so carefully shows for IQ, if one distribution has a lower mean than the other and the distributions have the same shape, the more extreme values are more underrepresented on the lower distribution than the more moderate values. The same is true of status. Rockefellers, Mellons, and du Ponts are more underrepresented among Negroes than are $20,000 a year men; $20,000 a year men are more underrepresented than $10,000 a year men, and so forth. So if you take a given cutoff point for middle class, those few Negroes that are middle class will be mostly very near the cutoff. Many of the whites will be quite far from the cutoff. Thus actually the mean class position for middle class Negroes is likely to be much lower

than the mean class position of middle class whites. Thus even if the class measures were perfect, the groups would not be equated.

But of course the actual situation is that the measurement of social status is much more unreliable than the measurement of IQ, and Jensen is always careful to take account of measurement error for IQ. Merely to take occupation as an example, at a given point in time when the census reinterviews people about their occupations, they get 17 to 22 per cent giving a different occupation (Blau and Duncan, p. 15). Of course the census uses trained interviewers who know what is required to classify an occupation. Most school studies ask children to describe their parents' occupation. Census studies of the reliability of occupational scales recently reported give figures in the eighties, somewhat lower for Negroes than for whites. Questionnaires, especially from children, must have a great deal more measurement error than census interviewers.

Furthermore, the environment of a child is a cumulative matter, consisting of so and so many months in a middle class family when his father had a good job, so and so many in a welfare family when he was unemployed, and so forth. Thus even if we had a perfect measure of the status of a family at a given time, it would be a poor measure of the cumulative environment of the child if peoples' status changes much over their lives.

Perhaps this will be more understandable with an example. Suppose one truly has 10 per cent of middle class Negroes and 90 per cent working class, while whites are 50 per cent middle class and 50 per cent working class. And, also, assume that the likelihood of misclassification is the same for both races and both social classes. Now apply a measurement that misclassifies 10 per cent of all people. Applying this to Negroes, we get

| | *Classified as Middle Class* |
|---|---|
| 90% of the 10% Truly Middle Class = | 9% |
| 10% of the 90% Truly Working Class = | 9% |
| Total classified as Middle Class = | 18% |

Percentage of Negroes Measured Middle Class Who are Truly Workers = 50%

Applying the same measurements to whites, we would get

| | |
|---|---|
| 90% of the 50% Truly Middle Class = | 45% |
| 10% of the 50% Truly Working Class = | 5% |
| Total Classified as Middle Class = | 50% |

Percentage of Whites Measured Middle Class who are Truly Workers = 10%

Thus we would expect that many more of the Negroes Jensen calls middle class are truly working class (either at present, or in the cumulative environmental sense) than are the whites. Hence because of measurement error he has not equated the environments. Actually in most of the studies he reports on, the most important environmental variable, the IQ of the parent, has not been equated at all.

Finally, of course, children associate with other children as well as with their parents. With a highly segregated society, this means that Negro children associate with workers' children, while white children associate with middle class children. Consequently even were the status of families equated, the status of interpersonal environments of children would not be equated.

On all these grounds, then, the different regression effects cannot be taken as evidence that talented Negroes are farther genetically from their gene pools than are talented whites.

*How Big is a Big Environmental Effect?*

The difficulty Jensen has in thinking about environment as cumulative shows up again in his evaluation of the size of environmental effects. Jensen would like to have environments change once and for all from one environment to another, as genes do, and then stay that way. We might call this the spurt conception of the environment. Environmental change in this conception comes in a spurt, and any time after that we can measure the effects of the spurt. Genetic variation does come in spurts; environmental variation does not.

The difference between Negro and white measured IQ scores in the U.S. is about one standard deviation, or 15 IQ points. Jensen observes that by decreasing the fear people have in the testing situation, so that they feel they control the situation and can keep from getting hurt, one can often increase poor children's IQs by 5 to 8 points, or about one-third to one-half of the distance between whites and Negroes. Now this seems to him to be evidence of a small environmental effect, since most *other* changes in environments only produce about the same effect. But this is only because he regards taking fear out of social situations as eliminating measurement error. If he regarded it as changing the environment, he would conclude that taking fear out of the relations of Negroes to their environment might, by itself, decrease the difference between Negro and white performance.

Then Jensen goes through a set of studies which show that by changing the environment of children for six, or nine, or three months, one can change their IQs by 5 to 10 points. That is, a short period of environmental enrichment can

apparently wipe out a third of the difference between whites and Negroes. Furthermore, this is change in only 25 or 30 hours a week of their environment.

Finally, we quite often find that naturally occurring variations in environments cause variations of this order of magnitude in IQ or mental ability scores. Jensen himself quotes a study which estimates that a standard deviation of environmental variation within a white group can cause two-fifths of a standard deviation in IQ. To explain the variation between Negro and white IQ on this enironmental basis, we need to find determinants of IQ on which there is a difference of two and one-half standard deviations between Negroes and whites, assuming a linear relationship between the variables. This is a difference such that, for a normally distributed variable, about one per cent of Negroes would be above the average of the whites. It does not seem to me outrageous that a well-measured variable of oppressiveness of conditions of life and cultural deprivation might show such a difference.

Besides this estimate of Jensen's, we can get a notion of the size of the environmental variation by observing variation between Negroes whose environment approximates that of whites from those whose environment approximates that of Negroes. Clearly if Negroes go to nearly all-white schools, they are exposed for 30 hours a week to the same environment most whites are. If they go to all Negro schools, the 30 hours a week are like those to which Negroes are exposed. James S. Coleman's estimates of the correlation between proportion white and Negro mental abilities indicates that by changing this part of a child's environment one makes about a half a standard deviation difference. This is of course also a non-cumulated score. A Negro child in an all-white school is much more likely than a white child in the same school to have spent part of his life in an all-Negro school.

The estimate of the effect of variations among white families in the kinship studies comes to approximately the same conclusion. If the correlation between adopted children and their parents in IQ is taken as a measure of the effect of environment, environmental variation between families who adopt each others' children explains about 24 per cent of the variance. That means that a standard deviation of environmental variation in families that adopt each others' children would cause about a half standard deviation variation of IQ.

What we have then is a large number of environmental variables, many of them occupying a small portion of children's lives, that explain between one-third and two-thirds of the difference between races. Equalize the amount of fear between races, put Negroes in all-white schools, or schools with the same conditions, improve the standards of Negro families by a standard deviation, then

(if the effects are additive) the IQs would be equalized. Jensen thinks that each such variation is small because it only explains half or two-thirds of the racial difference. But environments cumulate.

Because Jensen thinks of environment in spurts rather than in hours per day, he is "surprised" when an equalizing spurt does not equalize IQ. He translates this surprise into an argument that the spurt that created the genetic differences is more important. Suppose that we have a difference in environment which gives one group a rate of improvement in cognitive skills of 5 per cent a year, while another group advances at 3 per cent a year. The ratio of advance would be 1.05/1.03, or about 1.02 per year. If the two groups start equal, the more advantaged group will be about two per cent ahead after a year. If this environmental difference is maintained for, say, the first 20 years of life, the cumulated effect is about $(1.02)^{20}$, or about 1.5. The effect of a given year's enriched environment, which equalizes the increase for one year, is about a fifth of the disadvantage at 5 years of age. But it is about one-twenty-fifth of the disadvantage at 20 years of age. Jensen seems surprised that equalizing a single year results in an effect which disappears in a few more years. He would not be so surprised if he had thought a bit about a compound interest table.

*The Cognitive Environment of the Individual*

So far I have let Jensen get away with his conception of intelligence, and of the environment, because most of his arguments can be undermined even if we allow him his conception of his own business, and require only elementary elaboration of his conception and measurement of environment. It seems to me that the rest of his argument stands up at its own level, and requires some more fundamental thought about cognition and the sociology of cognition. What I will try to do now is to develop a theory of what intelligence, as measured by the usual IQ tests, is, and then on this basis develop a notion of what kind of environmental variables might determine it. Then I will try to derive the remainder of Jensen's results from this alternative theory. The combination of his genetic spurt conception of intelligence and his Headstart theory of environment makes it hard for him to think about cognitive functioning appropriately.

First, to intelligence. The central fact about intelligence among children is that older children have to be able to do *more* than younger children in order to stay at the same level of intelligence. Jensen notes that Negro children's capacities go down from a slight superiority to whites at early ages to inferiority at later ages. That does not mean, of course, that Negro children forget by five years old

what they knew how to do at three. It means instead that the time between mastery of one task or test and mastery of a more complex task or test is longer for Negro children than for white children.

That is, from the point of view of an individual child's biography, his intelligence is a measure of the time between being able to manage one type of task and being able to manage the next. Thus tasks are arranged more or less in layers with one group of tasks or intelligence test items being a layer which is normally learned after the "simpler" ones and before the more "complex" ones.

What seems to be behind each layer of tasks is one or more *cognitive structures,* or styles of abstraction and reasoning. Once a child learns to manage a given general cognitive structure or style of abstraction and reasoning, he can usually solve or answer most of the tasks or test items using that cognitive structure. The cognitive structure may involve perception, operations on perceptions, combinations of perceptions with previous knowledge, and so forth. There is a fair amount of evidence that such structures are well ordered, so that a five year old average IQ score is rarely made up of a hash of questions at a four year old level and a fifteen year old level. Instead the normal five year old answers four year old and five year old questions. The six year old answers 4, 5, and 6 year old, etc. The classic work here was done by Jean Piaget. The funny scatter diagram at p. 114 in Jensen seems to be evidence in Piaget's favor. (The subtitle of these diagrams is mixed up with something else). If we think of intelligence as such a layer-cake type of phenomenon in the individual, rather than as a manifestation at the present time of his constant IQ "dispositional property," then we can ask what sorts of environmental features would be most likely to affect it. Probably the most important characteristic of the environment is the frequency with which the *next developmental type* of cognitive structure is used in a child's environment. Most of us at breakfast use grunts and groans and expressions of displeasure whose cognitive content is easily mastered, if not enjoyed, by a three year old. During the day we vary in intellectual level, returning just before sleep to the same level of grunts and groans, if we are lucky. The same variation is true of a child's playmates—they mostly function below their capacities, and only occasionally reach their limits. Although Jensen sometimes seems to subscribe implicitly to the Education School Fallacy (that anyone is smart enough to teach kids something),[3] the same variation in intellectual level is characteristic of classrooms.

[3] Jensen, for instance, wonders why experimental programs, when made mass programs, very often have less effect. Perhaps the mass of teachers are dumber than those involved in experimental programs.

What we would like, then, as an environmental measure of development pressure, is a measure of the density of interaction of the child with someone who, in the interaction, leads him up one cognitive structural level from where he is, solves his problem, then restates it at the level where the child is (Compare the account of language learning in Roger Brown, *Social Psychology* pp. 292-297). Since most people most of the time function with structures much less complex than they manage in their finest hour, a person's cognitive behavior is probably distributed with different intensities at different levels below his highest capacities. These intensities or densities are probably determined by various influences, such as the intelligence of people around him, the complexity of the problems in his work, his amount of education, and so forth, as well as being limited by his upper limit of cognitive structures (his IQ). It is well known, for example, that professional men's IQs do not decline with age as rapidly as do the IQs of manual workers. Presumably this is because they keep the highest levels of mental functioning in better shape by more practice.

Thus there should be two main causal forces which would determine the mean level and variations of the cognitive functioning of a man—his *capacity to abstract* (his IQ) and his socially and psychologically induced *inclination to abstract* (determined by his education, his occupation, the intelligence of his wife and friends, and their educations and occupations, etc.). Thus we would expect to find correlations between people's IQ and the rate of development of children with whom they come in contact. For instance, there should be correlations between the IQ of foster children and the IQ of their foster parents (reported by Jensen, p. 52), between the IQ of teachers and the achievement of children in their schools (reported by Coleman pp. 317-318—the effect is stronger at higher grades), between the IQ of peers and the rate of advance of the IQ of peers (difficult to isolate, but fairly clear in some Coleman data, e.g. at p. 307).

Given the proportion of a person's cognitive functioning which just strains the child, the next question is the *hours of attention* he gives to the child, and the *attentiveness of the child* during those hours. We have very few estimates of these things, but we suppose that mothers spend more time with children than fathers (hence there should be higher correlations with mothers' IQ), that parents spend more time with only children than with many children (hence only children should be smarter generally and have less regression from parents' IQ), and so forth. The hours of attention received by and paid by children at different levels of cognitive tasks are ordinarily not measured in educational experiments. If the change from small to large programs changes the level of atten-

tiveness of teachers, or students, or both, then we would expect less change in cognitive functioning in the expanded programs.

*Civilization and Intelligence*

We could now define the level of civilization of a group by the average level of cognitive function used to solve its problems. That is, an "advanced" civilization would be one whose average man at the average moment was using, say, a third grade level of abstraction. There would be a wide distribution around that level, of course. A "backward" people would be one which did not ordinarily use the cognitive structures (e.g. mathematical reasoning, experiments, etc.) of which it is genetically capable. In general, more complex cognitive processes require reading and writing. Few people can solve mathematical problems in their heads that they solve easily on paper. Probably a good surrogate indicator of the level of cognitive functioning of a group is hours per day spent in reading and writing.

Ever since a famous sociologist of cognitive affairs in 1848 spoke of "the idiocy of rural life," evidence has been accumulating that farm life has not provided the practice in symbolic analysis of the environment that a city did. Civilizations grow in cities. In some rich agricultural areas (e.g. Iowa, New Zealand) civilization has more or less completely spread to the countryside.

If we suppose that the definition given above of civilization is something like the same thing that we ordinarily call civilization, then it will come as no surprise to find that rural people when tested have regularly turned up less intelligent on IQ tests. Furthermore groups imported for plantation labor and not allowed to develop their own civilized institutions (schools, churches, publishing houses, newspapers, political parties, trade unions, welfare groups, community governments, etc.), show the most IQ disadvantage compared to urban people. They also show the most gains in IQ when moved to the more civilized environment of an urban slum. They show still further gains as the hours per day of reading and writing increase in the group.

What this suggests then is that one of the legacies of slavery in the Negro community is a dearth of institutions that function routinely at advanced cognitive levels. There are too few Negro colleges, too few professionals, newspapers and book publishers, and so forth, to fill the environment with a rich variety of cognitive levels. But it might be that as Negro children grow older, after starting to learn with the same capacity as white children, their environment is progressively less rich in the frequency of use of the next developmental cognitive structure.

If this were the case, we would expect that Negro IQ would appear to decline,

as it took them longer to learn each successive cognitive structure. This is what Jensen reports (e.g. pp. 86-87; p. 77 gives the same for social class). We might also expect there to be stability of IQ disadvantage, even though this looks as if it might be evidence for genetic determination of IQ.[4]

The purpose of these last two sections has been to develop a more serious environmental theory of intelligence than the Headstart theory, to suggest how research might be done on such a theory, and to explain why we might expect on the basis of such a theory that an oppressed rural group from a backward section of the country might show a progressive deficit. Instead of defining environment in a way borrowed from other fields, an environmental theory of determinants of cognitive capacity needs to define the environment in intellectual terms.

In particular, we need to know the proportion of time a child focusses attention on cognitive structures at the next level of development above his own. Various results that we already have can be interpreted in the light of such a conception of the environment. For instance, the correlation of children's achievment with the mean vocabulary scores of their teachers makes sense if we think that smarter teachers will strain their students' capacities a little more.

The idiocy of rural life, the cognitive consequences of growing up in urban slums, the disparities of achievement among ethnic, religious, and social-class groups begin to make sense if we define civilization in terms of the densities or frequencies of use of intellectual structures at different levels.

[4] An I.Q. deficit of 15 points, or one standard deviation, is approximately equivalent to the amount of development that an average child has gone through in the last sixth of his life. That is, for a child of six, an I.Q. of 85 means he can do approximately the things a normal 5 year old can. For a child of 15, it means he can do approximately the things a normal 12 year old can. Thus a constant deficit of one standard deviation means functioning at progressively more years behind others.

## References


Blau, Peter M. and Duncan, Otis Dudley. *The American Occupational Structure.* New York: John Wiley and Sons, 1967.

Brown, Roger, *Social Psychology.* New York: The Free Press, 1965.

Coleman, James S., and Others. *Equality of Educational Opportunity.* Washington: U.S. Government Printing Office, 1966.

Jensen, Arthur R. How Much Can We Boost IQ and Scholastic Achievement? *Harvard Educational Review,* 39, (Winter 1969), 1-123.