Simplicity and complexity: Is IQ ready for genetics?

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The study of genetic contributions to intelligence has been one of the longest-standing controversies in modern science. Although discussions over this issue can be traced back in one form or another to earliest times, the advances in biology in the 19th century, Darwin 's theory of evolution and the re discovery of Mendel's Laws of inheritance at the dawn of the 20th century add ed weight of apparent scientific authority to the claims of the IQists.

Capron et al. show how the types of evidence considered acceptable with in this field of research have undergone constant revision. The field has progressively become more sophisticated in areas such as statistics, in consideration of the role of environment in the development of intelligence, and in modifying the earlier more deterministic representations of genetic influences. It would appear that we have come a long way from Galton's 19th century simplistic descriptions of famous successful families to current efforts to detect quantitative trait loci in the search for intelligence genes.

Nevertheless, it is clear that the debate is still far from over. While most of those who are involved in research on this issue, largely trained in psycho logy, assert that there is consensus for a large heritability (40-80%) of IQ (Neisser et al., 1996), the claim is received with considerable skepticism in other branches of psychology, among many geneticists and even by the once unquestioning media.

One of the major reasons for the failure of IQists to convince is what, to many of us, appear to be the unwarranted simplifying assumptions that underlie their research. Yet, parsimony is often considered as a virtue and even essential in the evolution of new scientific fields. As philosophers of science such as Richard Boyd put it, "one of the features of the scientific approach is the methodological preference for simplicity or parsimony [which] scientists often call elegance (or, perhaps, beauty)…" (Boyd, 1995). Boyd goes on to point out that logic al positivists have offered a "pragmatic" explanation for the focus on parsimony: that it is more rational and efficient to first investigate the less complex theories.

Simple theories with strong explanatory power appeal to the scientific community and can even catalyze revolutionary changes in direction of a science. Simple theories may eventually be found wanting in their Commentary/Misconceptions of biometrical IQists -2- ability to explain all relevant phenomena, and are either modified and made more complex or are overthrown by novel theories (Kuhn, 1970). In much of science, the new or expanded theories do not vitiate the successes of their predecessors, but appear necessary in the face of new information or newly perceived problems.

If simplification at least at the outset of a field is no vice, it has to be pointed out that choices of how to simplify are not unbiased. These choices reflect assumptions about which are the important facts to consider and explain in building the theory. So, while parsimony in the evolution of a scientific field is accepted, the simplifying assumptions offered or implicit in a field may well doom it to failure. I will argue that simplifying assumptions have created enormous problems for the field of IQ and genetics research.

Challenges to these assumptions have forced a continuous thorough rethinking of the approaches. The problem persists today and raises questions about whether, for such a complex issue, parsimony really works.

In this commentary, I will describe some of the simplifications inherent in IQ studies over the last century and how they have influenced conclusions. While Capron and coworkers, themselves, give a number of examples, I will focus on other aspects of the twin studies, which have provided the core of the data. Some of these examples will be quite familiar to readers of this article, but putting several of them together demonstrates a problematic pattern in this scientific field.

Separated twins and their placement

The idea behind studies on genetically identical twins that have been separated at an early age is that they provide an ideal experiment for separating the contributions of genetics and environment to intelligence. So the argument goes, identical twins raised in their biological family experience the same environment, whereas such twins placed in two different families experience different environments. The differences in correlation of scores on IQ tests between the two classes of twins should allow an estimation of the relative contributions of environment and genetics to intelligence. But, importantly, the success of this analysis depends on situations in which the separated twins are placed in truly different environments.

Psychologist Leon Kam in, recognizing this issue in the 1970's, reexamined the major studies that had been done up until that time and discovered that three of the four studies were severely flawed (Kam in, 1974). The twins had often been placed in homes with very similar environments (e.g., the homes of relatives of the biological parents). Sir Cyril Burt, the director of the fourth study, clearly recognized this problem and reported that his twins subjects were mostly placed in very different environments (e.g., one of a pair in a wealthy family and the other in a poor family). However, Burt's reports are no longer considered reliable, in part, because the data could not be recovered after his death, and, in part, because of charges that there were fraudulent aspects to the studies (MacKintosh, 1995).

Kamin's critique played a large role in forcing a more sophisticated look at the environments in which twins were placed. Because of Kamin, behavior geneticists had to sharpen the ir arguments, design new, more careful studies, obtain fresh evidence" (MacKintosh , 1995, p. 142). Th us, in recent years, researchers report attempts to be more quantitative in their evaluation of home environments into which adopted twins are placed. In some cases, they quantify the number of books in the home, parental vocabulary, nutrition, and other such factors (Rowe, 1994). The study of Thomas Bouchard and his coworkers evaluated the availability of household facilities such a s "power tools, sailboat, telescope, unabridged dictionary, and original artwork". They also took into account retrospective impressions of family environment by separated twins (Buchard et al., 1990).

While this new quantitative app roach might b e considered an advance over the earlier more simplistic analyses, one can certainly ask whether it is sufficient. Do w e know what combination of factors both in the home and outside environment may provide the appropriate mix for the development of the complex capabilities being measured? Further, by focusing on those features of the environment that are easily Commentary/Misconceptions of biometrical IQists
-3- quantifiable, the less tangible features o f such environments are left out. So, while research has moved from the most simplistic approaches to these more sophisticated studies, I would argue that we do not understand enough about the development of intelligence to be able to measure the factors in the home or cultural environment that nurture it.

Comparing monozygotic and dizygotic twins

Another area where increasing recognition of complexity is confounding issues in IQ research is the study of twins that are raised within their biological families. Many of the conclusions concerning inheritance of intelligence come from comparisons between these monozygotic and dizygotic twins. A fundamental simplifying assumption underlying these studies is that the environment in which each member of a twin pair develops and grows up, from conception on, is essentially identical (Scan & Carter-Saitzman, 1979). The degree to which twins are considered to experience the same environments is thought to be the same for either monozygotic or dizygotic pairs. Thus, according to the argument, the difference in concordance for any trait between the two classes of twins can be ascribed to genetics. This "equal environment assumption" is based on the fact that such twins develop in the same womb and are raised together by their biological parents a t the same time in the history o f the family an d in the history of their society. This assumption did not encounter serious criticism until the early 1960's (Joseph, 19 98).

One of the major problems with this assumption is that the physically identical nature of monozygotic twins could contribute to making their environments much more similar than that of dizygotic twins (Billings et al., 1992). This consequence of genetic identity could result from the ways in which both family and the larger society treat or deal with individuals who are know n to be identical and physically present as identical. In addition, the known closer bonds between monozygotic twins as compared to dizygotic twins can contribute to greater behavioral similarity. Studies designed to respond to these criticisms have yielded conflicting results. The research suffers from the same problems of defining quantitatively those factors that could be considered to influence behavioral development in a family and social setting. Furthermore, contrary to the original simplifying assumptions, the studies have revealed that there are differences in the shared environments between the two classes of twins (Joseph, 1998). In a review of these studies, Joseph claims that, in the case of studies of inheritance of schizophrenia, "the evidence suggests that the classical twin method ... is [based] on the fallacy of the equal environment assumption" (Joseph, 1998).

Several recent papers cast further doubt on the equal environment assumption as it relates to early stages of development. Dr. Bernie Devlin and co workers showed that conditions with in the womb may have substantial effects on the concordance of subsequent scores on IQ tests for identical twins (Devlin et al.,1997). They estimated that including the effects of maternal environment reduces the estimate of the heritability of IQ from 60% to 48%. Although the approaches used in this study are criticized by Capron and colleagues, the appearance of this work still underscores the un settled nature and wildly varying estimates of IQ heritability that depend on input assumptions. In addition, Devlin et al. note that their analyses do not "preclude other, unmodelled factors, such as cultural inheritance and interaction between genes and the environment, from having important effects on IQ". This is a rather remarkable commentary on the state of the field. What this comment highlights is that the statistical analyses used by most researchers in the field have excluded the more complex aspects of human behavior, presumably because they are more difficult to model or because they have been dismissed a priori as unimportant factors.

Further complications arise in the evaluation of twin studies from recent findings on environmental and genetic factors that affect the presumed identity of identical twins. Drs. Elisabeth Spitz and Michêle Carlier found that identical twins who develop in a single chorionic sac in the womb (monochorionic MZ twins) show different concordances for certain aptitudes when compared to identical twins who develop in separate sacs (dichorionic M Z twins) (Spitz & Carlier, 1996). When the calculations are corrected for the Commentary/Misconceptions of biometrical IQists -4- high

proportion of monochorionic MZ twins, genetic differences could no longer account for the differences in performance on an IQ-type test.

Daniel O'Loughlin and coworkers observed that the greater incidence of premature births among twins makes it difficult to extend specific conclusions drawn from the study of twins to conclusions about the role of genes in behavior in the overall population (Ainshe et al , 1987) The resultant lower birth weights and other complications associated with prematurity could result in enhanced similarities in twin development compared to ordinary siblings Because of these and other developmental factors peculiar to twins (Machin 1996), some of which may differentially affect dizygotic vs monozygotic twins, it may be unwarranted to conclude anything about the role of genes in behavior from genetic studies of identical twins These issues have been said by one researcher, Geoffrey Machiu to "strike at the heart of twin studies..." (Machin 1996)

Complexity without end

One last and perhaps most important point about the complexity of making arguments about genetics a trait or behavior can be highly correlated with genetics, but, in fact turn out to be largely due to environmental factors As an example, consider a study that examines an essential aspect of IQ research the tests of cognitive ability What is beyond debate is the fact that scores on tests of cognitive ability are on average correlated in this country with genes for skin color But a recent study by Steele and Aaronson (Steele & Aronson , 1995) high lights the complex interaction between social psychological historical, and other factors that mix into the achievement of scores on such a test These researchers administered tests of cognitive ability to mixed groups of B lack and White college students. In some cases they told the students that the tests would measure their abilities and in others that these tests were simply problem solving tasks that were "nondiagnostic" of ability. To quote their conclusions: "Blacks underperformed in relation to whites in the ability-diagnostic condition but not in the non-diagnostic condition." They attributed this striking finding to what they called "stereotype vulnerability" the fears that result from years of being exposed to an environment in which Blacks are considered intellectually inferior to Whites.

The main reason for including this example is to highlight the primitiveness of our real knowledge of the mix of factors that influence how human behavior and human aptitudes are manifested. There are unexplored realms influencing the development of human behavior and of human capabilities, some of which we probably cannot even imagine at this point. The likely intricate interplay of so many societal and familial and genetic factors with the ultimate score that is achieved on a test by an individual will not be usefully reduced to the specification of the location of a gene on a chromosome. Attempts to quantify these factors will usually reflect the biases or the limited knowledge that we bring to such an analysis.

Given the examples I have provided here, Capron et al.'s statement that, in such studies, "... not all environmental factors may be known..." appears a gentle understatement of the extent of the problem.

Contemporary genetics and complexity

Recent research in genetics of human disease facilitated by the Human Genome Project has enhanced our appreciation of the complex nature of the development of what might in the past appeared to have been even relatively simple genetic traits physical diseases. This is occurring because the new DNA technologies allow detection of anybody who carries a mutation known to be associated with various health conditions.

The surprising findings are that individuals who carry mutations thought to be deterministic for many conditions such as Gaueher' s Disease, cystic fibrosis and even Huntington's Disease never exhibit symptoms of the disease (Beckwith, 1999).

This substantial variability could be due to the effects of other genes within each individual on the expression of the trait or environmental factors, including prenatal conditions, diet, and even the actions of individuals themselves in directing their own lives. These findings with relatively simple human traits may Commentary/Misconceptions of biometrical IQists -5- also explain the continuing difficulty in identifying genes for human behavioral traits (Riseh & Botstein, 1996).

From simplification to complexity: lessons from the IQ controversy

What the history of IQ research shows is that fundamental assumptions or mind-sets that permeate the field reflect attitudes toward the relative importance of environment in the development of human behaviors and aptitudes. While the avoidance of dealing with these assumptions may also reflect the difficulty in measuring environmental factors, a scientific problem with such difficulties is usually put aside until they can be dealt with.

While simplification is integral to the evolution of scientific fields, its use (or overuse) in the field of IQ research raises special problems. First, moving from simplicity to complexity in many realms of science often does not vitiate all previous conclusions, but rather expands upon them increasing knowledge.

However, in this field, the results of recognizing oversimplification and the moves toward greater sophistication in analysis, rather then advancing knowledge, appear to many of us to have returned the science back to its starting point.

Second, most science which utilizes simple starting assumptions is not used to promote social agendas. In contrast, IQ research, from the eugenics movement to "The Bell Curve" has repeatedly been used to influence social policy. The social implications may be fostered by scientists themselves, by the media, or by other interest groups within society. What is most striking about this state of affairs is that the simplifying assumptions practically dictate the conclusions. The research field appears to have been imbued with a social perspective from its outset to its presentation to the public.

Jon Beckwith is a geneticist at Harvard Medical School. This article originally appeared in Current Psychology of Cognition (citation enclosed in article, the pagination is different from the original). This is the first of many articles from the Genetic Screening Study Group that we intend to publish here. The study group is an offshoot of Science for the People an important radical/progressive science formation from the '60s and '70s.

These articles are of particular importance since confusion over what science really can and does say about the capabilities of human beings figures heavily into social policy at all levels of human societies. It is still being used in a variety of ways to justify class, race, ethnic and gender stratification. These articles expose not only the political implications of genetic determinism, they also lay bare the unscientific nature of these claims that have been with us every since Spencer coined the phrase "survival of the fittest". This article is available in PDF format.

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