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ORIGINAL PAPER

Life as an Intelligence Test: Intelligence, Education, and Behavioral Genetics

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Abstract Using the large datasets available with new gene sequencing and biobank projects, behavioral geneticists are developing tools that attempt to predict individual intelligence based on genetics. These predictive tools are meant to enable a 'precision education' that will transform society. These technological developments have not changed the fundamental aims of a program with a long history. Behavioral genetics is continuous with previous attempts to match personal characteristics to heredity, such as sociobiology and evolutionary psychology, and threatens racial and other forms of bias. From these older paradigms, it inherits an understanding of intelligence as informational processing shaped by mechanistic and computational metaphors as well as a view of society and education organized around competition. Because of these influences, these models misdescribe fundamental aspects of human engagement with the world and disregard other concepts of intelligence, which creates problems for the precision education that researchers hope to construct using genetic knowledge.

Keywords Behavioral genetics · Intelligence · Ethics · Precision education · Eugenics

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Introduction

"Life is an intelligence test," asserts a recent review of the genetics of intelligence (Plomin and von Stumm 2018:148). The results of this test are largely predetermined, according to the co-author Robert Plomin and his collaborator, in the sense that achievement in society is based on intelligence, which itself comes largely from heredity. Plomin is at the forefront of the burgeoning field of behavioral genetics, which seeks to find the source of our traits, dispositions, mental illnesses, intelligence, and achievement—basically all of that which differentiates people—in our genes (for popular overviews, see Pinker 2002; Plomin 2018; Wade 2014). Behavioral genetics is not the first field to engage in this quest. For 130 years, the role of heredity in achievement has been one of the most contested issues in genetics. The heart of the conflict, however, has not been the claim that heredity influences our characteristics; everyone agrees on this point to some extent (coupled with the converse statement that environment plays an important role). Rather, the conflict is over how this claim should be understood and how it ought to affect our practical goals. Despite new rhetoric and technological methods, behavioral genetics recapitulates the fundamental aims and, thus, the dangers of prior hereditarian frameworks.

This article examines the problems of this hereditarian program through two terms from that initial quote, 'intelligence' and 'test,' by investigating how the particular meanings given to them by behavioral geneticists might affect social practices. According to Plomin, 'intelligence,' when not defined simply in terms of tests, is the "ability to learn, reason, and solve problems," which are the cognitive instruments of pragmatic success (Plomin and von Stumm 2018:149). In the broader field of behavioral genetics, these abilities are framed in terms of metaphors of mind derived from computer science: thinking is machine-like information processing shaped by genetic blueprints. Yet, as I will argue, this cannot be an adequate picture of thought. It eschews the lived world filled with meaning and tacit knowledge. This framework, therefore, leaves behavioral geneticists with a deficient model of intelligence.

'Test' here is taken in the sense of "a battery of diverse cognitive tests scores" from which intelligence can be inferred (Plomin and von Stumm 2018:148). These tests are predictive, indicating the future capacity of an individual. More specifically, they predict ability for competitive achievement. This framing points to the broader sense of test, a test of fitness. Life in this model is a competitive struggle among individuals, where success is based on intelligence, which is also correlated with many valued traits, such as health, happiness, and income (Deary 2011). While not reducing IQ to achievement, Plomin notes that they are closely related (Asbury and Plomin 2014:92). Unlike earlier eugenicists or market-centric theorists, who were frequently ready to accept any inequities resulting from genetics, behavioral geneticists want to use their tools to help make education a better preparation for this competition. Yet this aim narrows the scope of education to only a few skills, eschewing a richer formation of the student as a person or citizen. Moreover, it would subject students to powerful forms of technologically mediated managerial oversight, with curricula matched to their genotype.

Heedless of these problems, with new DNA sequence and computer processing power available, behavioral geneticists feel that they are on the cusp of proving their theories, enabling social intervention. It is thus essential to examine the presuppositions and projected implementation of their research program. This paper begins by exploring the continuities of behavioral genetics with previous attempts to link heredity and achievement, such as a competitive understanding of the person. One of the most important continuities, it will show, is behavioral genetics' understanding of intelligence as merely pragmatic and as understandable through technological metaphors. Intelligence, in this view, is operationalized through intelligence tests. The paper concludes by outlining how this conceptual framework translates into practical policy recommendations in the field of education.

Behavioral Genetics and Its Precursors

The debate over the genetic basis of intelligence and personality traits spans almost 150 years.[1] In the early 2000s, there was evolutionary psychology, which purported to show that the genetically encoded tendencies of our Pleistocene ancestors on the savannah governed social problems like rape, divorce, and aggression. The 1990s saw the *The Bell Curve*, a book that argued that racial and class differences in achievement were genetically determined, which would limit the effectiveness of social programs for closing the achievement gap (Herrnstein and Murray 1996). The 1970s witnessed sociobiology and Arthur Jensen's IQ research, the intellectual precursors to the ideas found in evolutionary psychology and *The Bell Curve* (Jensen 1969; Wilson 2004). The forebearer of all of these frameworks was the eugenics movement (Kevles 1995). Eugenicists sought hereditary sources for unfitness of various sorts—pauperism, criminality, and feeble-mindedness. They tested the population in regard to various characteristics, such as intelligence, which was tested for every draftee in World War I, and then tried to intervene to prevent future social ills caused by 'low-quality individuals.'

The criticisms of these positions have been largely consistent. First, critics attack the science: sampling methods are problematic; traits are poorly defined (this is most obvious for something like pauperism or feeble-mindedness); the tests used are questionable (the ongoing criticism of the IQ tests is a case in point); and the hypotheses lack the basic scientific characteristic of falsifiability (they are 'Just So' stories of how our hunter-gatherer ancestors behaved). More important for this article are two further sets of criticisms aimed at the social effect of this kind of

[1] This literature is vast. Important sources of history and defense of a hereditarian outlook include Wade (2014), Comfort (2012), Wilson (2004), Pinker (2002), Herrnstein and Murray (1996), Jensen (1969), Kevles (1995). Influential criticism of this tradition can be found in McKinnon (2005), Gould (1996), Lewontin (1991), The Ann Arbor Science for the People Editorial Collective (1977), Sahlins (1976). For discussion of the impact of a hereditarian outlook and competing psychological and neuroscientific theories on understanding of intelligence and education, see Staub (2018).

research. These studies could lead to devastating programs of discrimination against those deemed ‘unfit,’ a label that was frequently applied to individuals based on their race or class. This danger was shown in its full horror in the eugenics movement, which led to exclusionary immigration policies, miscegenation laws, the enforced sterilization of about 70,000 US citizens, and ultimately the horrors of the Nazi regime (Kevles 1995). More subtly, such research could serve as an ideological justification of the socioeconomic status quo because one of its claims is that wealth and status run in families largely for genetic reasons. Many critics point to the influence of a Hobbesian philosophical anthropology on this literature: life is a war of all against all for reproductive success (Sahlins 1976:93–107; Schwartz 1986:41–43). Framed with evolutionary narratives, society is seen as a competitive struggle among individuals, modeled on competitive market relationships. This social vision reinforces problematic understandings of what it means to be human, ignoring important aspects of the social and cooperative nature of humanity (McKinnon 2005; Sahlins 1976).

While acknowledging a debt to previous movements like sociobiology, behavioral geneticists claim that they are different. First, the scientific tools they are using are much more powerful. Because of past controversies, their methods have improved, which they think vitiates criticisms of prior methods (Plomin 2018:148). The new genetics of behavior draws on a long history of twin and adoption studies that attempt to differentiate the effects of nature from nurture. While earlier hereditarians, such as Jensen, used similar studies, recent ones are larger and more statistically sophisticated than ever before. Such studies examine the characteristics of twins separated at birth versus those raised in the same environment, fraternal versus identical twins, and biological versus adoptive siblings. From these studies, researchers claim that most traits have a high degree of dependence on genetic factors (Plomin 2018:6). With respect to intelligence, these studies suggest that about 50% of the variance in a population may be explained by heritable factors. Other factors, like environmental effects, are either induced by genetics (e.g., affectionate kids induce parental affection), are only transiently influential (Plomin 2018:32–51), or are so idiosyncratic (e.g., your experience of that bully in third grade or that inspiring fourth grade teacher) as to be impossible to study scientifically (Asbury and Plomin 2014:115–125).

Estimates of heritability undergird work in genetics. Over the last 10 years, geneticists have gathered large collections of DNA sequence linked to background information and health records. Such databases include the 500,000 people represented in the UK’s Biobank and the millions of people who have sent their DNA to 23andMe. In general, the databases do not contain entire genome sequences, but rather the small fraction of the genome that differs between individuals. Of the total three billion base pairs in the human genome, these specific sites that are variable in a population, known as single nucleotide polymorphism (SNPs), number in the hundreds of thousands. Statistical tests indicate how much each variant of a SNP is associated with a particular form of a trait. By integrating these data, behavioral geneticists gain the statistical power to determine how much each different gene variant found in a population contributes to the variance of a certain trait.

Such calculations appear to provide predictive power. Behavioral geneticists can look at the thousands of SNPs in an individual's genome, determine how closely correlated each of them is with a trait, add those correlations together, and end up with a polygenic risk score. This score is the relative probability of the person having a certain trait. In the field of intelligence, this means the ability to forecast whether a particular individual is likely to score high or low on intelligence tests or whether someone is likely to have a reading disability or a mental illness. At least, that is the goal.

In fact, these are not deterministic predictions. The scores are merely estimates that a propensity toward a certain trait might be present. They are statistics tied to large populations and so have very little predictive power for any individual.[2] Moreover, genetics so far explains only a small piece of the variance of traits. Currently, the best studies only predict at most 7–10% of the variance in the intelligence of a population (Hill et al. 2019:176; Lee et al. 2018). Still, behavioral geneticists argue, at the population level, such estimates can be useful for administrators, therapists, and educators, allowing for, in their words, precision education tailored to individual needs or at least the needs of individuals as members of stratified risk groups.

The promised social interventions are the justifications for this research, since the actual biological knowledge gained from behavioral genetics has largely been trivial, such as that genes involved in neural development are also involved in intelligence. The new genetics of intelligence is in this way very different from the functional genetics that was popular in pharmaceutical development during the 1990s (Rose and Abi-Rached 2013:25–52). The earlier paradigm sought to find one or a small number of variants that caused a disease or a trait and use that knowledge to address them. For example, scientists sought to find the mutation in the serotonin receptor believed to lead to depression and then develop a drug that would modulate it. Unfortunately, very few of these kinds of mutations have been identified. Instead, traits seem to be influenced by hundreds or thousands of variants with small effects. It would be impossible to manipulate all of these variants, so researchers have turned from using genetics as a resource for developing biomedical therapies or understanding biology to using it as a predictive tool that can then guide social interventions.

Even with their managerial interventions, behavioral geneticists have sought to temper negative social effects criticized in earlier forms of eugenics or sociobiology. They seek noncoercive policy solutions to the problems that they identify, arguing that broadly coercive social policies will have little effect. Parents would not be sterilized nor would there be multigenerational genetic castes because a lineage's abilities tend to regress to the mean (Plomin 2018:102–103). Further, major researchers in the field eschew implicit or explicit racism. Plomin, for example, rarely discusses race. This could be a good sign, in that he is not explicitly making claims about, for example, African American intelligence as found in *The Bell Curve* controversy. Most genetic studies exclude people of non-European

[2] For a more in-depth explanation of these caveats, see the excellent discussion in Box 7 of Plomin and von Stumm (2018:156).

descent in order to make the statistical analysis easier and more powerful. In part this is due to necessity because many minorities, for well-founded historical reasons, have been resistant to participating in this research. These researchers examine a very narrow, constrained environment; most of the subjects of the twin and adoption studies live in middle-class households in Colorado, the UK, and Sweden (see studies discussed in Plomin 2018:12–31). However, these narrow samples create challenges for the validity of these studies. If minorities are underrepresented, none of these findings will apply to minority populations, which makes it difficult to use this research in practical policy. Further, researchers admit that situations of gross poverty or neglect will have large effects, and it is far from clear whether findings from affluent populations are applicable to different social circumstances and groups.

As one moves farther into the popular arena, though, one finds less restrained commentators, such as the former *New York Times* science journalist Nicholas Wade. Wade claimed in his book *A Troublesome Inheritance* that distinctive frequencies of different gene variants among ancestral populations of Africa, Europe, East Asia, Austronesia, and the Americas indicate distinct racial groupings with different behavioral characteristics (Wade 2014). Yet, as others have observed, such groupings are arbitrary; there are many models of clustering the difference genetic variants that would have fit the data depending on how one chooses to cluster the results (Roberts 2011:57–80). The five named were chosen because they fit preexisting biases. Moreover, such data fitting ignores highly mixed populations, such as Middle Easterners or African Americans, as well as the vast diversity within different populations themselves. Despite these and many other problems with the use of race in such genetic research (Marks 2017; Sussman 2014; Teslow 2014), Wade argues for using diverse genetic inheritances to understand social patterns. He claims, for instance, that democracy has had trouble taking hold in Africa and the Middle East because of genetic distributions that favor tribalism in these groups (Wade 2014:173–177). This of course ignores the effects of history, the troubles of nationalism in Europe, and the example of countries like Botswana with well-functioning democracies.

Wade applies this general racial model to intelligence as well—he sees Europeans and East Asians as being of especially high intelligence. In regard to China, he argues that this is the result of the selection process of their long-running systems of qualification exams for the imperial bureaucracy (Wade 2014:165–166). Here a tie between intelligence and testing appears that will be repeated in the examples that follow. While mainstream behavioral geneticists tend to steer clear of such claims, they share a similar form of argument in that genetic propensities are essential to shaping environment and thus culture. As Plomin writes about the home environment, nature makes nurture: genetic propensity shapes both home environment and culture.

Moreover, while there are no concrete plans for coercive, government-run eugenics policies based on this research, there is already the possibility of using it to select what kind of children should be born, a discrimination based on a belief in who is most likely to succeed in the intelligence test of life. A company named Genomic Prediction offers testing that provides polygenic risk scores for parents undergoing in vitro fertilization (Regalado 2019). They provide the risk score of a particular embryo for common health problems, such as diabetes, cancer, or heart disease. This goes beyond classic preimplantation genetic testing, which just looked at single variants causing severe diseases, like the Huntington disease mutations. This new testing is for much lower risk conditions. The company also goes beyond health, providing predictions for height. They only give a warning if tests indicate the child will be very short but that could change in the future, allowing for a selection for height. Another of their tests is a polygenic risk score for intelligence. The company would only tell parents if the embryo has a likelihood of being at the lower end of the intelligence spectrum, but there is no reason that they could not provide more detailed predictions of IQ. Parents could then use the information to decide which embryos to implant. It is, as supporters argue, a liberal eugenics, based in parents' free choice rather than coercive governmental policy (Buchanan et al. 2000). It is eugenic nonetheless. Few scientists thinks that the technology is yet ready for deployment in the way Genomic Prediction uses it, but this is clearly the direction in which it points. Life as an intelligence test begins even before pregnancy. The demons of eugenics are difficult to exorcise. Though behavioral geneticists may not advocate such practices, their research framework lead in this direction.

The third set of criticisms regarding a competitive picture of humanity that supports the status quo are harder to sidestep. Behavioral geneticists assume the justice of our meritocratic society: Plomin claims that the "heritability of outcomes can be seen as an index of equality of opportunity." The high heritability of school achievement in our society, he asserts, indicates that our patterns of school achievement are not "caused by systematic inequalities of opportunity" (Plomin 2018:94–95). That does not mean, however, that behavioral geneticists completely accept the status quo. Most believe their findings can be used to manipulate and improve society. They are basically Rawlsians in outlook, largely supporting fairly progressive political frameworks, rather than market purism red in tooth and claw (Kaye 1986; Pinker 2002:149–151; Plomin 2018:103–105). In a Rawlsian perspective of justice as fairness, defined as a social order anyone would agree to if they did not know what their social position would be, inborn privilege does not rule out income redistribution and melioristic social programs in order to equalize outcomes. Plomin argues for income redistribution and a respect for all kinds of employment. He, like other behavioral geneticists, does not support strictly laissez-faire frameworks. Rather, they advocate for highly managerial interventions into education.

The form of managerial intervention, however, is highly individualistic. According to Plomin, intelligence determines one's success in getting higher levels of education, which determines success in the goal of higher income. These are the stakes in the test of life. Since education serves to maximize human capital for success in this struggle, educational interventions are not designed to reshape competitive social norms.[3] Instead, their goal is a highly individualized form of

[3] These competitive norms are shaped by the dominant order of neoliberalism, an intellectual and social system that aims, in Friedrich von Hayek's thought, not so much at free enterprise as at a competitive

intervention that helps children better fit these norms. The goal, as described in Asbury and Plomin's book *G is for Genes*, is to use the individual's genetic data to shape a personalized plan of education that will increase her competitive ability and slot her into the right pathway for her genes. In Plomin's vision, each child would be assigned a "key worker" who has access to the child's genotype and would help create a unique educational track suited to the child's genetic gifts (Asbury and Plomin 2014:178–187). There would still be choice in this system, but the choices would be channeled and guided by expert genetic interpretation.

There are problems with this vision. Practically, as noted, the actual predictive power of genetics is relatively low. Whatever a person's risk score, it is only a statistical prediction in terms of a population. Any individual will land somewhere on a distribution of a trait. Someone predicted to have a low intelligence score may actually have a high one. Even in the best case, following the genetic data will lead to frequent mistakes in designing educational plans. More importantly though, there are questions as to whether this is the vision of education that we want. It occludes other possibilities for education and other grounds for critique. As Ivan Illich worried, it could merely perpetuate an educational system that prepares children to be consumers and competitors managed by bureaucratic systems (Illich 1971). Other, more important, goals of education are lost. For these reasons, behavioral genetics still fails to meet criticisms of the historical problems with such research. Testing, now in the form of genetic testing, continues to serve the role of a prospective filter leading to discrimination or intensive management that perpetuates problematic aspects of current social systems.

Operationalizing Intelligence

The specific problems of behavioral genetics, and hereditarian research programs in general, arise in part from the understanding of the mind. These problems become apparent in discussions of intelligence. Scientific research is only reliable insofar as the object of study is properly defined, especially when dealing with the large-scale correlational research of genomics. For Plomin, intelligence is a "construct [that] … captures what diverse cognitive tests have in common, which is often referred to as *general cognitive* ability, or *g*" (Plomin 2018:52). This pragmatic operationalization of intelligence goes all the way back to Charles Spearman's 1904 paper that serves as the foundation for studies of intelligence testing and the heritability of intelligence (Gould 1996; Horn and McArdle 2007). Spearman was a disciple of Francis Galton, who coined the term eugenics, and sought to further Galton's hereditarian program in regard to intelligence. He administered multiple cognitive tests, each of which examined some different mental skill, and then tried to find a way of correlating the person's performance on them. Psychometric researchers still use Spearman's factor analysis to infer a source of the common variance across

Footnote 3 continued
order (Hayek 1948:111). For history and analysis of neoliberalism, see Foucault (2008), Mirowski and Plehwe (2009), Dardot and Laval (2014), and Brown (2015).

tests. They name this common factor intelligence (for thorough discussion, see Gould 1996). As psychologist Edwin Boring observed early in the last century, "intelligence as a measurable capacity must … be defined as the capacity to do well in an intelligence test. Intelligence is what the test tests" (Boring 1923:35). It is just the correlation between test performances. This definition of intelligence in terms of test scores then changes social practices in ways that reinforce its use. For example, educational interventions, like Head Start, are evaluated in regard to how they affect IQ, making the tests even more socially important (Staub 2018). This circular tie between operational and conceptual definition that then affects practice is seen in other domains such as spirituality, in which concepts are reshaped in terms of operational measures (Bishop 2013; Hacking 1986). IQ tests have become what Barry Schwartz calls a powerful idea technology, a concept that shapes social reality (Schwartz n.d.).

Defining intelligence as whatever the test measures has struck many as problematic. The claim that there is a common g factor underlying these results is a nonfalsifiable conclusion since the advanced statistical methods of factor analysis can always identify a higher common factor among multiple factors (Kohn 1996). Stephen Jay Gould powerfully argued that the g factor is just a reification of a correlation (Gould 1996:264–350).[4] Though commitment to a single g factor is the dominant opinion in psychometric research, there are many in the field who disagree, who point to other understandings of intelligence like verbal ability or the knowledge of a particular field (Horn and McArdle 2007; Staub 2018:109–138). These experts argue that we would be much better served by thinking in terms of a variety of distinct intellectual abilities, rather than a single factor. Such an interpretation of many kinds of intelligence is just as defensible by the same technique of factor analysis that gives g. It just depends on one's presuppositions and statistical model.

Part of the problem with either criticizing or defending the g factor is that there is no general theoretical definition of what it is beyond its simple operationalization. As one expert writes, "specialists studying different manifestations of intelligence do not present anything like a united front on the meaning of the general factor" (Carroll 1997:42). It is defined entirely in relation to intelligence tests: g is the general factor that explains correlations in performance on intelligence tests of whatever type.

However, one can find a consistent metaphorical understanding of intelligence emerging from the hereditarian camp, an understanding that equates the mind with a machine. Spearman, for instance, thought of intelligence exactly in these mechanical terms. He cautiously argued that "g may be regarded as indicating a 'mental energy,' whereas the variations" of lower level mental operations "represent so many engines into which this may be directed alternatively" (Carr, Wolf, and Spearman 1925:27). In Spearman's vision, intelligence is power or

[4] His analysis has been challenged by many, including Plomin, who argues that SNPs may serve as a causal structure for g factor. This claim is problematic given that the computational techniques giving rise to a polygenic risk score are themselves based in correlations (Scherz 2019).

energy that is directed into the individual machines of mind that carry out different mental operations. People just vary in how much of this energy they generate.

Behavioral geneticists continue to use this technological model of mind, but in the form of metaphors based on the computer (McKinnon 2005:4–6). As one of the leading theorists and popularizers of behavioral genetics, Steven Pinker, states, “Intelligence is a form of information processing,” and “mental life can be explained in terms of information, computation, and feedback. Beliefs and memories are collections of information-like facts in a database” (Pinker 2002:35, 32). By reducing human thought to machine processes, consciousness, an issue that has long troubled scientific analysis of intelligence, is removed from the equation. What remains is a mental information processing program, or rather group of programs, whose functioning is directed by the genes that construct the machinery of mind during neurodevelopment. The genome provides the blueprint for the neural circuitry. Because of genetic diversity, different individuals will end up with slightly different machines and thus different propensities for action based on given data. The g factor becomes something like computer processing power with genetic variation providing more or less ‘smart’ circuitry.

Plomin does not provide his own interpretation of the meaning of intelligence aside from the “ability to learn, reason, and solve problems” indicated by performance on cognitive tests (Plomin and von Stum 2018:149). His writing sticks close to the data of statistical correlation without giving a deeper explanation of his model of mind. By avoiding such deeper explanations, he can sidestep controversies about it. No scientific work can be completely devoid of such an interpretation of intelligence, but in Plomin’s case, it can only be reconstructed from his system of references and other statements. Glimpses of a deeper model appear in his description of his opponents, though, whom he sees as embracing the model of a blank slate. Here, one sees references to Pinker’s popular book *The Blank Slate*, which Plomin frequently cites. Pinker takes his intellectual opponents to claim that the mind is infinitely pliable, unaffected by internal mental structures. He describes critics of behavioral genetics as either leftists embracing a Marxist philosophy of strict economic determinism in which personality can be completely shaped by social structure or naïve behaviorists assuming that all behavior can be modified through psychological techniques (Pinker 2002:103–137). Similarly, Asbury and Plomin lament that “[t]he entire education system is predicated on the belief that children are ‘blank slates.’… [E]nvironmental determinism has become the norm, with all of the smugness and censure that it inevitably entails” (Asbury and Plomin 2014:5). Critics are taken as politically motivated; they oppose behavioral genetics because it would undermine the scientific basis for attempts at the social engineering of behavior, either through social transformation or complex forms of Skinnerian operant conditioning.

The blank slate critique, however, is an overstatement of the critics’ position. Even B.F. Skinner recognized that behavioral conditioning was limited by the biological nature of the research subject. The scientist’s “apparatus exerts a conspicuous control on the pigeon, but we must not overlook the control exerted by the pigeon. The behavior of the pigeon has determined the design of the apparatus and the procedures in which it is used” (Skinner 1971:169). Therefore, behaviorism was an adjunct to evolutionary studies: “The task of scientific analysis is to explain how the behavior of a person as a physical system is related to the conditions under which the human species evolved and the conditions under which the individual lives” (Skinner 1971:14). Behaviorists and sociobiologists interpret both the evolutionary process and mental development through the framework of a competitive process of natural selection (Schwartz 1986), and Howard Kaye sees behaviorism in the thought of E.O. Wilson (Kaye 1986:105–106). For Barry Schwartz, behaviorism serves as the psychological paradigm that best links the sociobiology of the species to the economic analysis of individual rational action (Schwartz 1986). The description of the blank slate is something of a straw man because behavioral genetics itself has a close intellectual kinship with behaviorism.

The point of critics of these hereditarian frameworks is that dispositions, personalities, and drives are only expressed in a context that is already embedded in a symbolic and interpretive cultural order. One cannot ignore this cultural order and reduce behavior to genetic causation. Kinship is perhaps the clearest example (Sahlins 1976:17–61). Whereas geneticists influenced by sociobiology would predict a strict focus on maximizing the fitness of closely related genetic kin, anthropologists have repeatedly pointed out that most societies and systems of kinship do not straightforwardly follow a logic of genetic relationship. Those an individual regards as kin may primarily be identified by whom he lives near and only somewhat through genetic relatedness. Kinship may not even be understood as formed through birth, but through other processes. This distinction between genetics and kinship becomes even clearer in affinal kinship, or in religious systems in which traditional kinship becomes reinscribed in new sets of relationships formed through ritual action. For example, in Christianity, the kinship of all believers as sons and daughters of God is initiated through the ritual of baptism. The difficulty that E.O. Wilson had in giving a convincing sociobiological description of Mother Teresa’s actions in his *On Human Nature* is noteworthy (Wilson 2004:164–166). As Howard Kaye points out, to understand her altruism, Wilson is forced to embrace a concept, group selection, that he had already claimed to have disproven elsewhere (Kaye 1986:126–127; he later came to accept group selection). The transformation of her understanding of familial relations by religious belief is a far more parsimonious explanation.

Behavioral geneticists are unable to engage with the symbolic, expressive, and interpretive nature of culture. They treat culture as just a collection of facts. According to Pinker, culture is “a pool of technological and social innovations that people accumulate to help them live their lives, not a collection of arbitrary roles and symbols” (Pinker 2002:65). Culture is far more than that. It is a conceptual framework of practical and metaphysical meanings that shapes experience; through which one’s engagements with the world are ordered and interpreted. Interpretation, symbol, and meaning have no place in behavioral geneticists’ lexicon because they resist reduction.

The behavioral geneticists’ computational model of mind is the stumbling black. As Hubert Dreyfus and John Searle argued in regard to artificial intelligence, such information processing models fail to explain the data of consciousness, human experience, and human behavior. They have no place for a world in the phenomenological sense, which one engages as purposeful, which one interprets, and in which one finds meaning (Dreyfus 1978; Searle 1980). People do not encounter reality as a discrete body of facts that they then build into a framework. Rather, they meet it as a whole horizon of meaning through which they understand reality. This is one reason why behavioral geneticists and their critics talk past one another. Their very different models of mind make it as difficult for the behavioral geneticists to integrate anthropological critiques as it has been for artificial intelligence researchers to integrate philosophical critiques.[5]

Ironically, as intelligence tests have become less overtly discriminatory, they have been more deeply infused with this computational model of intelligence. Early IQ tests were criticized because they were too culturally specific. For example, multiple choice questions given to World War I recruits asked about common products and entertainment stars of the day. In another variant, test subjects were required to fill in what was missing in pictures. The missing parts, such as the net in a tennis game, for instance, might not be immediately apparent to someone who was then not part of the white upper classes (Gould 1996:230). The questions also required test takers to note what would be appropriate in a specific frame of cultural reference. In one case, a picture of a house was missing something: the appropriate answer was a chimney. But “Franz Boas, an early critic, told the tale of a Sicilian recruit who added a crucifix where it always appeared in his native land to a house without a chimney.” The answer was marked wrong (Gould 1996:230). A high score on the test was only possible with a particular background of cultural knowledge. Clearly these tests were inappropriate, but the alternative has been to strip intelligence testing of reference to any cultural framework or interpretive ability, which holds its own dangers of encouraging a highly limited model of intelligence.

Many psychologists are critical of this model of intelligence based on a simple g factor and identified by speedy problem-solving on tests. These tests examine only the most general problem-solving skills, things that can be tested in 2 min or 1 h for anyone in the population with no need for experience. They test a kind of shallow quickness. Such tests would therefore miss the more substantive, interpretive understandings of intelligence, such as expertise. As two psychologists write:

> The expert is able to construct a framework within which to organize and effectively evaluate presented information, while novices, with no expertise basis for constructing a framework, search for patterns and do reasoning by trial-and-error evaluations—inductive reasoning. The expert … comprehends many relationships among elements of [organized] information, infers possible continuations and extrapolations, and, as a result, is able to select the best path from among many possibilities (Horn and McArdle 2007:239).

This kind of skill is frequently what we understand as mature intelligence, rather than the skills tested by intelligence tests that tend to characterize novices.

[5] This incomprehension may explain the laziness of Pinker’s reply to Sahlins’ critiques based in culture and kinship, in which he zeroes in on a passing parenthetical comment and ignores some fifty pages of careful argumentation (Pinker 2002:109; Sahlins 1976:44–45).

Similarly, the early critic Boring noted that many competent army surgeons scored poorly on military intelligence tests, because speed is the skill that is tested (Boring 1923:36). It is just these kinds of expert skills that stand out in a model of mind that accepts the phenomenological world as the context for thought. It also opens us up to appreciating other forms of intelligence, such as the forms of practical reason that Matthew Crawford has shown operating in crafts like plumbing, cooking, or carpentry (Crawford 2009).

If these behavioral genetics models fail to encompass all of what contemporary society takes to be intelligence, they fail even more completely when related to other cultures or historical periods. Medieval thought, to take just one alternative historical example, noted multiple forms of intellectual excellence: intellect (*intellectus*), the ability to grasp the abstract form of things; wisdom (*sapientia*), the ability to attain to the first principles of a discipline; practical wisdom (*prudentia*), the ability to apply the general to the particular; or shrewdness (*solertia*), the ability to intuit the missing term of a syllogism (Aquinas 1947:I-II.57 and II-II.49a4). The practical aspect of these intellectual abilities is also morally inflected; one can have a false prudence that aims at the wrong ends, for example. Intelligence, on this understanding, allowed one to engage the world by intuiting relations between things and grasping their meaning. None of these forms of intelligence clearly overlaps with the contemporary g factor.

Framings of intelligence are related to modes of scientific or philosophical reasoning and other kinds of cultural values. If we start from different intellectual values, such as contemplation, originality, or esthetic judgment, we arrive at different analyses. Behavioral genetics defines intelligence in light of forms of scientific reasoning dependent on technology, the experimental method, and a culture that values certain aspects of pragmatic success. Other models of intelligence disappear.

Intelligence and Education

With the development of large genetic databases, even standard intelligence testing has become too cumbersome for the research enterprise. Intelligence tests tend to be long, and the best ones require specialized administration. The very power of scale has made such focused testing impossible (Plomin and von Stumm 2018:151). The UK's Biobank has 500,000 participants and the US's All of Us program aims at one million. At these scales, it is difficult to find enough research participants willing to engage in lengthy tests. The actual intelligence test used for the UK's Biobank intake screening was only 13 questions and 2 min long (for questionnaire, see https://biobank.ctsu.ox.ac.uk/crystal/field.cgi?id=20016). Direct-to-consumer genetic testing companies like 23andMe, another source of large datasets, extract such information through short, "fun" quizzes and questionnaires. For behavioral geneticists, increasing the predictive accuracy of polygenic risk scores requires ever larger databases. This will demand another approach to intelligence testing.

A correlation between education and testing has led to a solution to this problem in another surrogate measure for intelligence: educational attainment. Educational attainment is generally defined as the number of years of schooling (or it can sometimes be described as the highest degree obtained). Studies have found that certain gene variants correlate with educational attainment, with the most recent published study able to predict up to 12% of the variance of educational attainment in the population (Okbay et al. 2016; Lee et al. 2018). That may not sound like a much, but for institutional decisions, like deciding who among tens of thousands of applicants to admit to college, it could make a difference. Interestingly, polygenic risk scores based on educational attainment can be more predictive for intelligence than many scores based on intelligence testing (7–10% vs 3.6–6.8%). This odd result makes sense once one understands that the definition of intelligence is based on those abilities that allow students to succeed in schools like test taking. The regime of intelligence testing was built in concert with the educational system, which was itself built on achievement testing. Definitions and social structure are interrelated. Intelligence as success on intelligence tests correlates well with our educational system based on competitive achievement testing.

This inadequate definition of intelligence itself may lead to problematic policies. As geared toward an understanding of intelligence shaped by computer problem-solving, it limits what education can be thought to achieve. It aims merely to give tools. Asbury and Plomin think education should aim at two goals: first, providing a skillset consisting of reading, writing, math, and technological competence; second, providing more specific skills that benefit the economy (Asbury and Plomin 2014:4). Goals beyond that are fine, but they are more like icing on the cake. These further goals should be chosen in consultation with a counselor to fit the child's genetic abilities and interests. Gone, in this vision, is any hope of a shared background provided by education, a shared set of knowledge foundations that all can bring to public discussion, creating a shared world. No longer can education focus on developing interpretive abilities, narrative skills, or expertise. Behavioral geneticists' own dependence on testing and problem-solving prevent them from engaging criticisms emerging from defenses of liberal arts which argue that the focus on testing, grades, and utilitarian skills is degrading the rich formation of the citizen and person that education once sought to inculcate.

As focused on individualized problem-solving power, behavioral genetics removes all of the shared aspects of education. Education becomes heavily focused on technology, as one might expect with a computational model of mind. Gone is most classroom interaction, as, by necessity, most of the teaching will be provided by educational software (Asbury and Plomin 2014:150–153). One cannot expect teachers to personalize instruction for the genetic make-up of each student in a class, so technology is necessary. Individualization drowns out shared knowledge or even intersubjectivity. Other goals that education might have disappear: preparation for citizenship, induction into a longer tradition of knowledge, engagement with other minds. Everything becomes tailored to this vision of optimized individual problem-solving. Already the goal is inherent in the presumptions of the research.

Conclusion

This paper has argued for many possible problems with contemporary behavioral genetics. The central one, though, is that it misdescribes human experience through its definition of intelligence in terms of general problem-solving ability framed in metaphors derived from computer science and through its understanding of human society as fundamentally a competition between individuals, a test. Educational initiatives based on this framework would aim at enabling success in a competitive culture, precluding other ends. Behavioral genetics, as in previous paradigms of eugenics or sociobiology, assume the current order and cultural values, reading them into biology rather than seeing them as the historically contingent form of engaging intellectual ability that they are. Systems of individual management based in such research will attempt to shape children to it or even eliminate before birth those who are deemed unfit for the competition.

What is needed is a new paradigm for understanding the relationship between genetics and intellectual endeavors. Such a paradigm would need to fully recognize the genetic complexity revealed by the Human Genome Project, understanding that many individuals will be poorly served if their futures are shaped by population-level risk scores. There is neither an easy nor just way to translate probabilistic predictions into the life of an individual. More deeply, such a paradigm would need to be more adequate to mental phenomena, better capturing the diversity of intellectual abilities. It must recognize the forms of genius that surround us in the practical, esthetic, and contemplative life. Only then could such a science shape an education that would foster a richer intellectual and social life that could aim beyond mere technical problem-solving toward some form of wisdom.

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