Nature *and* Nurture

The Complex Interplay of Genetic and Environmental Influences on Human Behavior and Development

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9 Instinct and Choice: A Framework for Analysis

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Birds do not need to be taught how to build nests. Evidently the behavior is largely instinctual. Humans need to be taught nearly everything they do (or at least need to learn through other means, such as imitation). Further, our experience of our own behavior is that we make conscious choices—that we are the masters of our own ships. It thus comes as a shock to many people that genetic differences have been shown to be an important determinant of variation in a wide range of human behaviors.

Besides a number of psycho-pathologies,[1] a large and growing list of behaviors—including major measurable aspects of personality (Loehlin 1992), political conservatism (Eaves et. al. 1997), religiosity (Waller, Kojetin, Bouchard, Lykken, & Tellegen, 1990), occupational attitudes (Lykken, Bouchard, McGue, & Tellegen, 1993), social attitudes (Martin et. al. 1986), marital status (Trumbetta et. al. submitted), and even television viewing (Plomin, Corley, DeFries, & Fulker, 1990)—have all been shown to be heritable.[2]

If a trait is heritable, then we know that it is subject to genetic influence. But the vast majority of physical characteristics that are genetically programmed are *not* heritable and the same may be true for behavioral characteristics. Heritability is defined as the fraction of the variance of a trait in a population that is due, directly

[1] See Plomin, DeFries, McClearn, & McGuffin (2001) for a review.
[2] This list is incomplete. See Plomin et. al. (1997) for a longer list.

or indirectly, to genetic variation. More precisely, it is the fraction of the variance of a trait in a population facing a particular environment that is explained in a statistical sense by genetic variation. If there is no genetic variation, there can be no heritability. Nearly every human has two hands and five fingers on each hand. This structure is genetically determined, but the traits of having 2 hands or 10 fingers have virtually zero heritability, because the small amount of variation in these traits is due mainly to accidents or developmental defects.

While behavioral geneticists have been documenting the role genes play in behavioral differences, evolutionary psychologists have been developing a research program exploring what role genes may play in determining universal human behaviors.[3] It has been suggested that aspects of our ability to cooperate (Cosmides & Tooby 1992), sexual behavior (Ellis 1992), child rearing (Mann 1992, Fernald 1992), and even aesthetics (Orians & Heerwagen 1992) may result from the operation of specialized evolved psychological mechanisms. Psychologists working in this field have shown that often startling predictions made from theories of this nature can be validated and tested with experimental data (e.g., Cosmides 1989).

So what? What difference does it make to us in how we conduct our lives or structure our institutions; if our TV viewing habits are somehow subject to genetic influence? What significance should we ascribe to the evolutionary psychological finding that we are particularly good at solving logic puzzles when they are posed as problems in detecting cheating in ancient social exchange problems? A great deal of heat has been generated around discussions of nature vs. nurture, but when we critically scrutinize this debate, it is not clear what we should be concerned about.

In this chapter, we want to accomplish three things. First, we will argue that most of the reasons why people have believed the nature/nurture controversy to be important are wrong. Given the current understanding of evolution, saying a behavior is genetically influenced is dramatically far from an ethical justification of such behavior. Further, the notion that if a behavior is genetically influenced, it is unchangeable is also wrong—even if the basis for saying so is a very high heritability. We believe that it is confusion about this last point that leads people to think that whether or not group differences have a genetic source is relevant to discussions of whether or not they are just. Second, we want to develop a framework for thinking about the influence of genes on behavior that is consistent with our perception of ourselves as rational decision makers. We submit that the economist's model of human behavior as the result of rational choice is a good point of departure for such a framework.[4] Third, another advantage of the rational choice model of behavior is that it can be used as the basis for an elaborate normative theory of institutions—it can serve not only as a guide to how people will behave but also how they should behave and how they should structure their institutions to improve their well-being. Thus, this model of behavior is also a vehicle for understanding what the real implications of genetic influences on behavior for social policy and well-being might be.

[3]See for example Barkow, Cosmides, & Tooby (1992).

[4]For a description of the economic method see Frank (1997, pp. 63–92).

Here we explain why we think that people have been drawing the wrong conclusions from what some have interpreted as the triumph of nature over nurture in the long war between their advocates. From there we move on to describe the economist's model of behavior in which people are seen as making optimal choices given their preferences and constraints. In the third section, we discuss the relevance of genetic research for public policy when genetic influences are imbedded in the rational choice model. A far more important application of the study of how genes influence behavior may be in providing better theoretical foundations for the emerging field of behavioral economics. Later in this chapter, we argue for developing such a research program.

WHAT GENETIC INFLUENCES ON BEHAVIOR DO *NOT* IMPLY

In this section, we consider the mistaken policy inferences that people have drawn from evidence of genetic influences on behavior. Many of the arguments we present here have been made before, but we feel obliged to restate them because the errors we are highlighting persist in popular and scientific writing. We begin by pointing out that showing that a trait is genetically influenced is a far cry from showing that it can't be changed or even that it is difficult to change. Then we contend that if arguments that natural equals good or right ever had any appeal, they shouldn't in light of evolutionary theory. Finally, some believe that whether or not group differences have genetic origins bears on the justice of their existence. We suspect this view exists because it confuses genetic origins with inevitability. We present a few examples that we believe illustrate that the source of group differences (environmental or genetic) has little to do with whether differences are just.

Genetic Does Not Mean Unchangeable

Most people assume that if something is genetically influenced it is inevitable, or at least very difficult to change. The message that many people took from Herrnstein and Murray's *The Bell Curve* (1994) was that there is a strong and unbreakable link from genes to IQ to poverty and social deviance, and because nothing can be done to break this link, nothing should be done. In particular, Herrnstein and Murray railed against affirmative action and antidiscrimination efforts as having pushed the drive for equality too far. In the 1970s, critics of sociobiology were concerned that if people didn't conclude that genetically dictated sex roles were good or right, they might nevertheless conclude that they were unavoidable.[5] Why pass the Equal Rights Amendment if sexual inequality is in our genes?

[5]See *The Economist*, January 1, 1977, p. 44, for a description of the controversy around sociobiology.

People's tendency to view genetic as synonymous with unchangeable probably arises from two mistaken impressions about how genes shape behavior. People may assume that if something like IQ is "substantially genetically determined," that must mean that it has a proximate biological cause and that one's IQ is the inevitable result of possessing a particular combination of genes—as inevitable as having two arms and two legs. However, no such link has ever been demonstrated. Further, geneticists can provide many examples of even physical traits that are clearly coded in the genetic structure but that are only expressed in particular environments.[6]

Of course, at *some* level genes must have *some* physical manifestation if they affect behavior, but how remote the physical manifestation of those genes is from a particular behavior is an empirical question. A circuitous route from biological cause to social effect seems necessary to any explanation of at least some behaviors that have been shown to have genetic influences. But just because a cause is circuitous or contingent does not mean that in any practical sense it is less important. We want to look further into why people may falsely equate genetic influence with inevitability, but first we need to clarify what we mean when we say that a behavior is genetically influenced.

Does it make any sense to distinguish between genetically influenced behavior and socially influenced behavior? At least at one level the answer has to be "no." We are biological organisms, and all our behavior is conditioned by our physical make-up. The fact that speech is nearly universal and sign language rarely used is in part a consequence of how our bodies are constructed. The nature of the shelters we build for ourselves is affected by how we are built. Doors would be wider if we were wider, or we might be more concerned with keeping our shelters cool if we had heavy fur. There are an infinite number of ways we can imagine how our behavior would be different if our genes were different. On the other hand, as the examples just given illustrate, genes aren't destiny. If we need wider doors to accommodate cars instead of bodies, we build them. If we live in a warm climate, our houses don't have big heaters if any at all. If people like wide doors or a cold house, they can build them to suit their tastes. So what is all the fuss about?

Controversy seems to arise concerning the two most common types of evidence cited to show that a particular behavior is subject to genetic influence. The nature of the evidence suggests to some that the gene-outcome link is inescapable. The first is a trait's heritability. Heritability is defined as the fraction of the variance of a trait within a population that is due to genetic differences. A common mistake is to conclude that if a trait is highly heritable, then there is little role left for environment. Examples of this mistaken reasoning are Jensen (1998, pp. 445–458) and Herrnstein and Murray (1994, pp. 298–299) who present formal arguments that

[6]For a summary, see Gottlieb (1998). Recently Rowe, Jacobson, & Van den Oord (1999) and Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman (2002) have demonstrated some interaction between genes and environment in the formation of IQ. Additional interaction effects could be very hard to detect (Turkheimer and Gottesman [1996] and Turkheimer [1997]).

the high heritability of IQ virtually precludes environmental explanations for Black-White IQ differences. A second approach to discerning genetic influences on behavior has been to find a behavior that is nearly universal, to look for explanations as to why the behavior would be evolutionarily advantageous, and then to look for other implications of the hypothesized evolutionary cause and check to see if they can be confirmed. The facts that the behavior is universal (or nearly so) and that it can be explained as being a product of biological evolution may give it the sense of inevitability. But in neither case is inevitability inevitable.

Consider first traits that are highly heritable. Recall the definition of heritability—the fraction of population variance explained by genetic differences. Heritability is not a characteristic of a trait, it is a characteristic of a trait in a particular population facing a particular environment. Take a group of genetically diverse organisms and put them all in an identical environment and in theory heritability will be 100%.[7] Put a group of genetically identical organisms into a wide range of different environments and heritability will be zero. This has enormous practical importance. There are genetic diseases such as phenylketonuria (or PKU—a metabolic disorder that can produce mental retardation), the symptoms of which in another era would have been 100% heritable. But because we have learned how to treat PKU with diet, those with the gene for the disease need never develop the advanced symptoms so that today the heritability of those symptoms is virtually zero in populations screened for the disease. Heritable does not mean inevitable.

But this observation is small solace if we want to influence a trait that is highly heritable in a population despite considerable variance in the environments of the members of the population. This is the case that Jensen, and Herrnstein and Murray, consider. To make their formal arguments simple, they argue that if all the environmental variance we observe in our society explains so little of the variance of a trait such as IQ, how can we expect to find environmental interventions that could change IQ?

It has been clear for a while that there must be something wrong with this argument. It implies that large environmental effects on any highly heritable trait are impossible without huge differences in environment, yet there has long been evidence that large environmental effects on IQ are possible. This point was driven home with the discovery of huge IQ gains over time. Evidence now demonstrates gains in more than 20 different countries, with data going back in some cases to the earliest IQ tests.[8] Until recently, the juxtaposition of this evidence with high heritability seemed paradoxical. But Dickens and Flynn (2001) presented a formal model of the process generating IQ that explains why high heritability not only does not preclude large environmental effects but may be an indicator of the presence of strong reciprocal effects between environment and phenotype that produce both high heritability and the possibility of large environmental effects.

[7]In fact, measured heritability would probably be less than 100%, because there may be aspects of an organism's development that are essentially random even with a tightly controlled environment.

[8]See Flynn (1998) for a summary.

Briefly, the Dickens-Flynn argument is that those whose genes give them a slight edge in those aspects of intellectual performance measured by IQ tests will tend to find themselves in a better environment for the development of those talents. For example, those who do well on tests are more likely to get into more intellectually stimulating schools or get more challenging jobs. This in turn will lead them to develop greater ability that may lead to further improvements in their environments. An initial environmental advantage could seize control of the process of reciprocal causation with similar effects, but though our genes are always with us, those aspects of our environments that are not a response to our genes are relatively fickle. Thus, most variance appears to be due to genes when looking at a cross section of the population—even though variance in the trait would be considerably smaller if good genes weren't being matched with good environments. But if something comes along and makes a consistent change in the average environment, the process of reciprocal causation can magnify the effects of the initial change several times over. Therefore, relatively small initial differences in the circumstances of different generations (or different ethnic groups) can be magnified into large induced environmental differences in a behavioral trait. Any change that produced the same sort of small consistent change in the circumstances of a large group of interacting individuals could realistically produce similarly large changes in the most heritable trait.

But what about the claim that there are evolved human universals? Suppose that sex roles are in some important sense programmed in our genes. Does this mean that Bill can't cook and Jessica can't do math? Hardly. Doors have pretty much the same shape around the world, and as we described earlier, that is in some sense a genetically influenced behavioral trait of the human population. Our height and width may well have evolved to make us efficient hunter-gatherers in the environments in which our ancestors lived long ago, so how we build doors can be described as resulting from evolutionary adaptation. But that doesn't mean we can't or shouldn't bother trying to build larger doors if we need them. This example illustrates yet another point we will expand upon in the following sections. Unless we know how genes influence a behavioral trait, we know nothing about how easy or hard the trait is to change. Simply knowing that it is genetically influenced tells us nothing about how responsive it might be to changes in the environment.

Natural Does Not Mean Good or Right

One fear often mentioned by opponents of genetic approaches to behavior is that saying something is evolved or natural in some sense justifies or rationalizes it. This was a common criticism of the writing by sociobiologists on sex roles in the mid 1970s. Many saw sociobiology as an attack on the progress women had made toward equality in the job market and in personal relations that aimed to make the traditional sex roles seem natural and right and thus change seem unnatural and wrong.[9] We think such concerns are misplaced. Taking this perspective may have

[9]See footnote 5.

done more harm than good by making the misinterpretation seem more reasonable than it is. Critics might have done better to point out that the sociobiologists' views of how sex roles arose completely undermine the claim that those roles have any moral authority today. Civilization is too new to have had much impact on our evolution. To the extent that our behavior has evolutionary roots, they can be found in the survival demands put on Pleistocenian hunter-gatherer tribes. If that is the source of the modern sexual division of labor: (a) why would anyone think that "natural" meant "right," and (b) given the rather substantial change in our circumstances since then, shouldn't this be an appropriate time to be consciously considering some changes?

This last point anticipates one of the arguments we will be making later. As beings who can make conscious choices about our behavior, evidence that a particular behavior is genetically influenced may in some cases indicate that we are not fully aware of why we do what we do. That means we may not have thought carefully through the individual or social costs and benefits of the behavior. Thus knowing that a behavior is genetically influenced may provide a motivation for critically reconsidering it. Knowing how it is influenced could not only provide motivation for reconsidering the behavior but also for thinking about what sorts of alternatives might be preferable. For example, some have suggested that xenophobia or ethnocentrism may have an evolved basis (Reynolds, Falger, & Vine, 1986). If true, we certainly would not conclude that xenophobia was natural and therefore good. To the contrary, it might help people understand their feelings as anachronistic and inappropriate in modern society. Further, it might help us anticipate the nature, causes, and consequences of unconscious racism, and the circumstances in which it is likely to arise. Such information might help us design social systems to mitigate the undesirable effects of such behavior.

Genes and Justice

The most pernicious application of arguments for genetic influences on behavior has been the rationalization of unequal treatment of different groups—sometimes as horrific as slavery or extermination. The use of genetic theories of group differences to support legal discrimination against ethnic groups and for restricting women to traditional roles has been justifiably condemned. We do not expect much of value to come from studies of group differences in genetic influences on behavior. Knowledge about the extent and malleability of developed differences in ability among groups can inform us about the costs of pursuing equality in economic and social outcomes. Knowledge of whether group differences have genetic origins is not informative on either point.[10] Direct measures are more salient on the extent of differences, and the existence of a genetic role in determining group differences tells us almost nothing about the malleability of those differences, as we have already argued. Understanding how genes influence individual behavior

[10]Though knowledge of a trait's etiology, genetic or environmental, could be, as explained earlier.

could help us design solutions for social problems, but we do not see how information on group differences could be used for this purpose.

Some have suggested to us that knowledge of how group differences arise could influence reasonable judgments about social justice—particularly if the differences are genetic in origin. For example, some argue that a just society need only give everyone equal opportunity to use whatever talents they are born with and need not endeavor to equalize outcomes (Nozick, 1974). Thus, group differences that arise from differences in talents would be acceptable, whereas those that result from unequal treatment by others would be unjust. In fact, most Americans do not seem to consider it unjust that a few exceptionally talented sports stars get a far larger share of society's rewards than everyone else, nor do they consider it unjust that mentally retarded adults typically don't have the resources to afford $300,000 homes. We accept that knowledge of the origins of group differences could be informative about their justice, but we do not believe that genetically induced differences would necessarily be judged just while environmentally induced differences would be judged unjust. Two examples should suffice to make this point.

Consider the children of a religious group that eschews machinery that is neither human nor animal powered. The group might very well live in conditions that would be considered extreme poverty and their children would have no choice but to accept their circumstances, but few if any would see the children's deprivation as unjust even though their circumstances resulted from environmental deprivation that was imposed upon them.

Alternatively, suppose that we were to discover that many people's low IQs were caused by a genetic disorder that could be treated with a single very expensive dose of some drug during a child's first month. Suppose that this drug was so expensive as to be effectively out of the reach of families with incomes in the bottom third of the distribution of incomes. Even though this form of low IQ was genetic in origin, we suspect that few, if any, people would consider it just to allow children with this disorder to go untreated. This example suggests that if we knew how to raise the IQs of low IQ groups or individuals, and doing so was easily within our means, it wouldn't matter at all what the source of the differences was, their continued existence and consequences would be viewed as unjust. We suspect that people who think that group differences in economic and social outcomes that are due to genetic differences are just are implicitly assuming that initial genetic differences could never be overcome. But, as the previous discussion has shown, this need not be the case.

The social implications of genetic influences on behavior can't hinge on mistaken notions that natural equals good or that genetic means inevitable or just. But it is still possible that research on the role genes play in shaping behavior could help us improve society. But as the discussion of this section indicates, we need a framework for understanding the complicated ways in which genes may influence behavior to realize this potential. We turn now to a model of behavior that we feel is a good starting place for such a framework.

THE MODEL OF RATIONAL CHOICE

Over the last 50 years, the boundaries of economics have come to be defined more by the methodology of the discipline than by its subject matter. At the core of that methodology is the rational actor model of behavior.[11] That model is unique among models of human behavior in providing both a positive description of behavior that is quite analytically powerful and a normative standard by which to evaluate social choices. If we want to be able to evaluate the implications of genetic influences on behavior in the context of a model of behavior that fits our understanding of ourselves as making conscious choices, this seems like a good place to start.

Constrained Optimization (the Positive Model of Behavior)

Central to the economist's analysis of behavior is the theory of constrained optimization. That model of behavior takes as given peoples' preferences for different states of the world and the constraints they face and assumes that they will act to achieve the most preferred state of the world given those constraints. For example, a person might prefer consuming one orange to consuming only one apple, and consuming two oranges to consuming two apples or only one of either. A complete statement of the person's preferences with respect to apples and oranges would involve a rank ordering of all possible combinations of apples and oranges. The constraints a person faces in satisfying these preferences could be the money available to purchase apples and oranges together with the prices of apples and oranges. The behavioral assumptions are that such a preference ordering exists and that individuals will choose the most preferred combination of apples and oranges they can afford. The model assumes that individuals are (typically) fully informed and perfectly strategically rational in this decision and can thus choose the optimal behavior out of all possible strategies.[12]

Sometimes it is assumed that peoples' preferences can be summarized by a utility function—a mapping from all possible states of the world into the real number line where states of the world that correspond to higher values for the utility function are preferred to states corresponding to lower values.[13] In such a framework, we can view tastes as the parameters of such a function. That is, a taste is the relative weight we put on apples versus oranges, being comfortable versus being cold, or being with people we like versus those we don't like, in deciding whether one state of the world is preferred to another. But, more generally, preferences are the result of a process of evaluating different states of the world. We will use the term "tastes" (in a nonstan-

[11] See Frank (1997, pp. 63–92) for a description of this methodology.

[12] We discuss criticisms of these assumptions later.

[13] Utility functions are also assumed to be such that if the utility of one state of the world is twice that of another, there is a meaningful sense in which the first is twice as good as the second. Specifically, a person will be indifferent between the certainty of one outcome and a 50% possibility of each of two outcomes with utility values equally above and below that value.

dard way) to represent only one input into that process—the relative extent to which a particular mental or physical state produces pain or pleasure.

In our previous example, constraints were the limits imposed by budget and prices, but the concept can be expanded to include everything from the laws of a society to physical limits on movement. Most generally, the constraints facing individuals are the limitations on the resources that they can deploy to adjust the state of the world.

Note at this point that neither tastes nor constraints determine behavior alone. A person may prefer one apple to one orange, and two apples and one orange to two oranges and one apple, but that doesn't mean that that person will necessarily consume more apples than oranges. If an apple costs five times as much as an orange, and a person has enough money to buy two apples, then that person's preferences might very well lead this person to buy and consume five oranges and one apple even though, in some sense, this person prefers apples to oranges. In fact, if the price of apples was high enough, someone who prefers one apple to three oranges might still end up consuming only oranges. This discussion reinforces what we said above about how genetic influence doesn't mean that a behavior is inevitable. In the rational actor model, no one factor always (i.e., under all circumstances) determines behavior. Change one of the other inputs to the choice process and you can get a different choice.

Explicit or implicit in the optimizing model of behavior are a number of assumptions about the information available to people and their ability and desire to process that information to make the best possible choice. Specifically, individuals have complete knowledge of all possible opportunities available to them and how they would feel in each possible state. If the outcomes of their actions cannot be predicted with certainty, they know the probabilities of all possible outcomes. They are able to consider the entire range of possible actions and decide which of these maximizes their welfare. Not only are individuals fully informed and able to apply rationality universally, but it is also often assumed that it is costless for them to do so (e.g., people don't need to pay to acquire information necessary to make a decision either in terms of time or money).

These behavioral assumptions are unrealistic. After all, we don't always make carefully, thoroughly weighed, and fully rational decisions in which we have considered all possible options. Decisions that approach this standard are the exception rather than the rule, and most behavior seems habitual. The rational actor model has not gone unchallenged in economics. In fact, behavioral economics—a subdiscipline that focuses on the contributions that psychology, sociology, and other social sciences can make to the economic model of behavior—has become a much more active and accepted area of research in the past decade (Rabin, 1998). Still, the rational actor model, even in its strongest and unrealistic form, has a number of important uses.

The most famous defense of the model was made by Milton Friedman (1953) who argued that models, by their very nature as abstractions, are necessarily unrealistic and that they should be judged not by their assumptions but by the accuracy

of their predictions. Friedman has been criticized for the argument that models should never be judged by their assumptions, but he made an important point in his essay; even if people don't behave exactly the way economists assume they do, the model could still provide a good description of their behavior. He gave the example of how an expert billiards player's shots could be modeled using spherical trigonometry whether or not the person taking the shots understood the model. Similarly, people may not be the omniscient calculators that economists assume they are, but if they generally try to do things to improve their well being, if they experiment and learn from their mistakes, and if they have plenty of opportunities to learn, then much behavior may be well described by a model that assumed perfectly informed hyperrationality. Such a model might also be an analytic convenience and that consideration may be decisive in those cases where the deviations from the model are minor.

Normative Analysis

It's not a big step from the assumption that people are always choosing to make themselves as well off as they possibly can to what is called the fundamental welfare theorem of economics. Without going into details,[14] under a set of assumptions about what people know, how trades are made, and the nature of peoples' preferences, it is possible to show that if actors behaving according to the rules of constrained optimization engage in trade so as to exhaust all possibilities for individual welfare improvement, the resulting distribution of goods is Pareto efficient—that is, no one can be made better off without making someone else worse off.

Given this result, a particular global outcome can be criticized on two grounds: One may argue that the conditions necessary for Pareto efficiency don't exist and that some institutional changes are necessary to improve efficiency. Alternatively, one can criticize the distribution on grounds of equity even if the allocation is Pareto efficient.[15] Ethical arguments can be made for preferring more equal distributions over less equal distributions, particularly if more equal distributions are achievable without an efficiency cost. But social policy aimed at reducing inequality will frequently involve some loss of efficiency. Economics can describe this trade-off but has little to say about how to compromise between these competing interests. This is why normative economics generally focuses on the question of

[14]For the proof of the fundamental welfare theorem, see Arrow and Debreu (1954); for a more accessible treatment, see Varian (1987). Frank (1997, pp. 564–565) provides a yet more accessible treatment.

[15]This is because there is not necessarily a unique Pareto efficient allocation of goods. Suppose that person 1 starts off with four left shoes and no right shoes, and person 2 starts out with four right shoes and no left shoes. That is not a Pareto efficient allocation if they both wear the same size shoe and neither likes to wear the wrong shoe on one foot. If the two trade two left shoes for two right shoes, both now have two pairs of shoes and that could be a Pareto efficient allocation. But suppose that person 1 is a very hard bargainer and holds out for three right shoes in exchange for one left shoe. Person 2 tires of haggling and agrees. Person 1 now has three pairs of shoes, and person 2 has only one. That too is a Pareto efficient allocation. No trade would make one of either better off without making the other worse off. See Frank (1997, pp. 564–565) for a discussion of the concepts of equity and efficiency.

the efficiency of a set of institutions and how changes to them will either increase or decrease efficiency.

Economists have identified a number of categories of reasons why ideal efficiency might not be obtained by the free interaction of agents, each corresponding to either a violation of the assumptions of the behavioral model described earlier or a failure of one of the other assumptions of the fundamental welfare theorem. For example, lack of perfect information can lead to failures in insurance markets.[16] The inability to exclude some people from being affected by your consumption can lead to a number of problems with the allocation of goods that can be cured by changing institutions.[17] For example, if people don't take into account the environmental damage done by the exhaust from their cars, a tax on cars based on the amount of pollution they produce can make everyone better off by leading each individual to choose a car that produces the socially optimal level of pollution (the level at which the cost of additional abatement exactly equals the total gain in social welfare from the abatement, and additional abatement would cost more than the welfare gain that would result).

The pollution example is a special case of a general problem for the fundamental welfare theorem called external economies or externalities. In most examples in economic textbooks, externalities are due to the nature of the technology of production or consumption (e.g., sparks from train wheels setting fires, loud music that is audible beyond the site of an outdoor concert, a well-maintained house or yard that can be enjoyed by all those in the neighborhood). However, external economies can also result from the nature of people's tastes. If one person's welfare is directly affected by that person's perception of the welfare of others, then an externality exists and the fundamental welfare theorem may not apply. Empathy, jealousy, and hatred are all examples of emotions that people feel that seem to make their welfare depend on the perceived welfare of others—sometimes positively and sometimes negatively. Such emotions are thought to be very important in explaining collective action which otherwise appears irrational from the perspective of individual welfare maximization (Bowles, 1998; Fehr & Gachter, 2000).

If the assumption of complete rationality is not satisfied—for example, if people do not understand probability theory and must make decisions about very low probability events with little opportunity to learn from mistakes—the outcome can be suboptimal as well. Dickens (1986) used observations from psychological decision theory to argue for regulation of occupational and product safety on these grounds.

What does all this have to do with the importance of genetic influences on behavior for social welfare? We intend to argue that a good first step toward incorporating genetic influences into a reasonable model of behavior is to view them as influencing people's tastes or constraints and to analyze their consequences using rational choice theory. We further argue that unless genetic influences on

[16]See Frank (1997, pp. 189–190, 207–208) for a discussion of how information problems cause adverse selection and moral hazard and the effect on insurance markets.

[17]The original article making this point is Samuelson (1954). See Frank (1997, pp. 576–577) for a simple presentation of the concepts.

behavior create other-regarding tastes or cause the decision-making process to be less than fully rational the importance of genetic influences on behavior for policy analysis is limited. This is because whether tastes are genetically determined or not and whether or not genes impose limits on the types of behavior that can be undertaken doesn't matter for the assumptions of welfare analysis in the model we have just described. If however, genetic influences give people other-regarding tastes or affect the decision-making process itself—that is, they affect the ability to choose the optimal behavior—then the implications for the analysis of policy could be quite profound.

GENES AS A POTENTIAL SOURCE OF TASTES AND CONSTRAINTS THAT AFFECT BEHAVIOR

In the model of behavior just described, people choose to do what maximizes their well-being given their tastes and their constraints. If we want to understand genetic influences on behavior in the context of such a model, a natural place to start is with tastes.

Where Do Tastes Come From?

We all experience hunger pangs (which are sometimes quite specific), desires to be warm when we are cold, and sexual desire, and it's not hard to imagine that these feelings and impulses arise in part because of some genetic programming. On the other hand, certainly not all of our preferences are rooted in our genes. Though some aspects of aesthetic judgment are conceivably inherited, what art we find appealing evolves far more rapidly than our biology. Many of our preferences are developed or learned in some significant sense. Nonetheless, if we are looking for ways in which our behavior as self-conscious organisms might be shaped by genes, tastes seem a promising place to start.

There is another reason to think that genetic influences on behavior may come largely through this channel. Selection has pushed our genetic programming toward fitness—an important component of which is the efficiency with which traits are coded in our genes. In giving instructions there is a clear trade-off between giving detailed step-by-step contingent plans and giving more general information and the goals to be attained. Humans have extremely highly developed general-purpose problem-solving ability.[18] It makes sense that it would be more efficient for fitness-improving behaviors to be encoded in our genes by giving us

[18]In the next section, we consider the implications of arguments that in addition to a general purpose problem-solving ability, we have genetically programmed highly specific problem-solving abilities as well. However, we see no contradiction in believing that our conscious mind has access to both powerful specialized modules as well as a general purpose cognitive mechanism. The demonstrated ability of humans to design solutions to an enormous range of problems virtually on demand is evidence for what must certainly be seen as a general purpose cognitive ability. Evidence discussed later provides strong support for the view that we have relatively specialized abilities as well.

general goals and letting us figure out the specifics of how to implement those goals in these different environments.[19] By making certain things pleasurable and others unpleasant in a state contingent manner, our biology can influence our minds in a way that takes greatest advantage of our most developed capabilities.

Can Genetic Influence on Tastes Account for Differences in Behavior?

We have already discussed the long list of behaviors that seem to vary to some degree due to variation in genetic make-up. It is also often the case that genetic differences explain more variance in traits than family background (Turkheimer, 2000). Here is a real challenge to our images of ourselves as conscious actors with similar biological make-up. How could genes be so important for describing such a wide range of behaviors? How could evolution have anything to do with how much television we watch?

Suppose there is some variance between us in how much discomfort we feel when engaging in rigorous physical activity in the cold outdoors. Someone who had the gene or genes for a rather extreme lack of discomfort might choose to spend more time playing outdoors from an early age—even in extreme weather. Such a person might develop abilities in winter sports to a greater extent than the typical person in a self-reinforcing cycle of more practice meaning better performance meaning more enjoyment and more opportunity for improvement leading to still more time spent in the pursuit of such activities. As a result, such a person might not spend much time watching television. Such a person also might not spend as much time reading or in the company of people whose conversations typically involve a high degree of cognitive sophistication. Thus, the person might underdevelop certain cognitive skills. Through a roundabout path, a gene for how much pain one feels from muscle ache in the cold could also be contributing to TV watching and perhaps be even one of many for IQ.

We are not claiming that this is the mechanism that explains why genetic differences account for so much variation in TV viewing, but the story is illustrative of what might be the nature of many genetic effects on behavior. As such, it is not hard to imagine that there could be a genetic component to the type of cars we drive though the path from tastes for such things as tolerance for cold to make and model could be quite circuitous. The cascading effects of multiple adjustments of choice of lifestyle to accommodate even one difference could lead to genetic influence on an enormously wide range of behaviors.

Implications of Genetic Influences on Tastes

Economists give considerable deference to individuals' preferences (as reflected in those individuals' actions) in judging costs and benefits. Whatever assumptions of the fundamental welfare theorem may be called into question in a particular

[19]See Robson (2001).

analysis, it is almost never the case that well-informed people are assumed to make choices that are not in their best interest.[20] Thus, the ultimate touchstone of what is to be socially preferred in economic analysis is what well-informed individuals would choose in a world free of the limitations imposed by failures of the assumptions of the fundamental welfare theorem. But why give such deference to genetically imposed tastes in determining what is good or right? Isn't this just a repetition, once removed, of the fallacy that natural is good? We don't think so. A host of arguments can be advanced for respecting individual choice, none of which involve appeals to the natural origin of those preferences.

Therefore, if we choose to respect individual preferences, if the effects of genes on behavior come by affecting our tastes (but not by giving us interdependent preferences), and if people make the best use of the resources available to them to satisfy those tastes, then the analysis of a particular policy is completely unaffected by the knowledge that a relevant behavior is highly heritable or the result of some evolutionary imperative. The question of how much a behavior can be affected by incentives remains an empirical one that may be informed by knowledge of a genetic source but is not prejudiced by such knowledge. From the perspective of welfare economics, the question of whether we want to change a behavior still depends on the presence of market failures that prevent society from achieving an optimal allocation of time and resources or a desire to change the distribution of resources to make it fairer. But our first cut is not our last. We can think of three ways in which the knowledge that a particular behavior was the result of a genetically induced taste might affect how one would think about public policy.

Despite the need to respect individual preferences, knowing the etiology of a particular taste, knowing that the behavior can be altered, and knowing that it is in some sense an evolutionary anachronism might help both individuals and policymakers make better choices. Respecting individual preferences can be rationalized on the grounds that they are the product of a critical, self-conscious process. More precise knowledge about the source of preferences could help inform that critical process. It might also inform public dialogue about public values. For example, suppose that we were to identify an anachronistic genetically programmed fear of heights as the reason for an excessive concern about airplane safety relative to other forms of travel. Doing so might allow individuals to appreciate and tame their own impulses in such a way as to make them better able to identify and attain important goals. As a matter of public policy, we may decide to put less weight on air safety than we would if we took consumers' willingness to pay for it as the sole indicator of its true value.

Second, someday it may be possible for people to manipulate their children's (or even their own) tastes through genetic engineering. This possibility raises many seri-

[20]This does not need to be only selfish interest: the rational actor model can accommodate altruistic as well as fully-selfish preferences, and says only that people seek to maximize their own welfare, defined in terms of their own preferences. Thus those who feel very strongly about charity, for example, may be maximizing their welfare through altruistic behavior and this is well within the bounds of the rational actor model.

ous ethical questions—particularly if parents are making choices about things like the personality of their children. Because we can imagine many potentially beneficial uses of such technology (eliminating phobias for example), identification of how genes influence behavior for the purpose of genetic manipulation impresses us as a good motivation for research on the links between genes and behavior.

For discrete behaviors caused by a single gene, the manipulation of behavior may be close at hand. Linkage techniques can reliably identify genes associated with traits when the association is simple and the degree of association is very high. However, we suspect that many, if not most, genetic effects on behavior are complex and polygenic (involving many genes), because very few seem to follow Mendelian laws (Plomin et. al., 2001). The identification of specific genetic causes of specific behaviors then becomes extremely difficult. Reliably identifying genetic causes becomes an enormous problem if one cannot narrow the search to specific areas of the genome using prior knowledge of the physical structures involved. Huge samples are required to allow sufficiently high threshold p values to preclude false positives.[21]

Third, knowledge that a certain behavior results from one or more genetically programmed tastes could only come along with some understanding of the route by which that taste affected behavior. Knowing that route might suggest several different ways to modify the behavior besides changing the incentives for the target behavior directly. This is the third way in which we can imagine that knowledge about the genetic origins of a behavioral trait could be important for policy. It is possible that research on genetic influences on behavior could help us identify important causal paths given the importance of genetic differences for explaining behavioral variance. It could be particularly important if the behavior we were trying to affect was hard to monitor or otherwise difficult to shape with incentives. It is possible that an antecedent to the target behavior could be more susceptible to manipulation. It is also possible that this type of knowledge could save us from folly. Genetic influences on behavior may sometimes account for the correlation of behaviors and their antecedents, and knowledge of this can prevent mistaken imputations that the antecedents are manipulatable causes.

The second and third motivations for interest in understanding the genetic basis for behaviors beg the question of how we would know the path by which a particular behavior and its biological source were related. We have already described why we expect this could be very difficult, but we have one suggestion as to a methodology that might help in identifying chains of causation. The genetic contribution to covariance of traits can be analyzed using similar techniques to those used to analyze the genetic contribution to variance. With more study of the patterns of correlation in the genetic components of behavior, we might be able to get a better understanding of how causation works. For example, if we found that nearly all of the genetic influence on marital status could be explained by its correlation with

[21]See chapter 6 of Plomin et al. (2001) for a discussion of the methods available and an optimistic assessment of what might be possible in the near future.

genetic influence on alcoholism that would be a very different picture of the chain of causation than if we found that IQ, marital status, and income were tied up in a web of correlation. The latter might also make us want to consider the possibility that not all genetic influences on behavior come through their influences on the tastes that motivate our choices. There is also the possibility that genes influence our behavior by affecting the constraints we face.

Genetic Effects on Constraints

If genes influence behavior not through our tastes but rather through the constraints we face, would that change any of the conclusions we have drawn? We argue that insofar as genetic influence on behavior comes through shaping constraints of the type economists typically analyze—such as budget (income) constraints—their presence is basically insignificant for the analysis of efficiency.[22] However, if genetic influence on behavior comes through effects on our cognitive structures, which shape the way we solve problems, constraints and tastes may not be the best way to think about genetic influence. Instead, we may want to consider alternative formulations of the choice process by which tastes and constraints get transformed into behavior. We consider that possibility in the next section. Here we ask whether modeling genetic influences as constraints has different implications from modeling them as tastes.

In the past, health, size, strength, and agility mattered quite a bit in determining how much physical labor one could do and thus how many goods one could obtain by hunting, gathering, farming, and so forth. Still today, genetic influence on characteristics such as strength and health influence how many apples and oranges one will buy, though perhaps a bit more indirectly, for example, through the type of job one selects and, hence, income. Similarly, one's cognitive abilities may influence what work one can do and that also affects what one acquires and consumes.

However, as long as people are doing the best with what they have, most of the analysis of the previous section applies here as well. It is arguably of less consequence for the analysis of economic efficiency where constraints come from than where tastes come from. Evolutionary origins don't raise the question of the relevance of constraints for welfare analysis as they do with tastes, because the legitimacy of a constraint is not an issue for welfare analysis while the legitimacy of a particular taste might be. For this reason, the first motive for identifying the origins of genetic influences on behavior that come through tastes is irrelevant for constraints. Though we may learn about ourselves and better serve our own interests by critically considering the role of our genetic programming in determining our preferences, knowing that a constraint has a genetic origin tells us nothing useful about it as we have argued before. But, both the second and third motives

[22]If we were to tax people on the basis of their genetic potential, there could be an improvement in the efficiency of the tax system, but we doubt that many people would viewing taxing people on the basis of their potential, as opposed to their actual, incomes fair even if it was practical.

are at least as important here as with tastes. Understanding the genetic origins of constraints on our behavior may allow us to modify those constraints either by intervening in the causal path from gene to behavior or by direct manipulation of the genes in question.

There is one very important sense in which genetically influenced constraints on behavior might change how we think about social problems. If our genes limit or shape the way we make decisions in such a way as to make the rational optimizing model of our behavior inappropriate, then we may have a much more important reason for understanding genetic effects on behavior than any we have discussed so far. This will also be true if genes give us interdependent preferences.

A FOUNDATION FOR BEHAVIORAL ECONOMICS

Given the extreme assumptions of the rational actor model (e.g., full information, universally strategically rational behavior), it is easy to imagine how people could fail to make decisions in the way it predicts. As we noted previously, it doesn't necessarily matter if people are truly making decisions in the way economists assume, as long as the predictions of the model closely approximate actual behavior. If people are not always exactly right in their choice of optimal behavior because of cognitive limitations, it may not be a serious problem for the model. However, the nature of cognitive structures become significant for the analysis of social institutions when they cause people to systematically make decisions that the behavioral model would not predict (i.e., those which are, from the standpoint of strategic rationality, not in their best interest). Further, economic analysis of many types of problems is greatly complicated if people care not only about their own welfare but that of others as well.

For at least a decade before mainstream economists became interested in failures of the model of rational choice, researchers in the field of behavioral decision theory were carefully demonstrating consistent failures in judgment—particularly judgments involving probabilistic outcomes.[23] For the past two decades, behavioral economics—a branch of economics that focuses on forms of behavior that deviate from the standard model—has been expanding in scope and influence. Building on behavioral decision theory, behavioral economists employ traditional economic methods, along with new (to economics) experimental methods, to test the behavioral predictions of the rational actor model. Many of the discoveries within this subdiscipline have been extremely important for economic theory, but behavioral economics has not yet been very influential in policy formation. This is in part because the field is still largely underdeveloped, with the many deviations from rationality that have been identified lacking a framework for explaining or predicting them. We propose that evolutionary psychology could provide a framework for understanding behavior that violates the predictions of the rational actor model, and organizing the work of behavioral economists to help extend the influence of this research into the realm of policy analysis.[24] Further, we believe that the tools of behavioral genetics could be used to aid this endeavor as well as providing techniques that could be used more generally in economics to solve problems of sorting out causality in complex systems.

[23]For reviews of this early literature see Nisbett & Ross (1980) or Slovic, Fischoff, & Lichtenstein (1977).

Systematic Deviations From Individual Rationality

Behavioral decision theory researchers and behavioral economists have generated good evidence for some forms of behavior that imply violations of the assumptions and predictions of the rational actor model. We describe some of these phenomena below and suggest how we might be able to understand the foundations of such behavior using an evolutionary psychology approach.

A behavioral phenomenon that has received considerable attention from economists is time preference anomalies. Because I can invest money today, receive interest on it, and have more money next year, I should prefer money today to the same amount of money next year. Because compound interest means that the value of my investments grow geometrically, the normative economic model implies constraints on how I should be willing to trade-off money today versus money a year from now versus money 5 years from now. It can be shown that people's behavior regularly violates these constraints (Laibson, 1997). People seem to value money today far too much based on projections from their willingness to trade money a year from now for money 5 years from now. Alternatively, they value money a year from now far less than they should based on how much they are willing to trade-off money today for money five years from now. People discount the future heavily, but are not very discriminating between different times in the future. Such behavior can have important implications for many aspects of social policy. For instance, people who behave this way may not save enough, or may display other problems with self-control (Laibson, Repetto, & Tobacman, 1998). If we knew with certainty that the decision problems that can be demonstrated in a laboratory setting were behind anomalous behavior in the economy, we might be inclined to adopt policies to protect people from decision errors. A wide range of social policies including the structure of the Social Security system could be affected. But without a theory of why people behave this way, or any theory for predicting when they will or won't behave this way, economists are reluctant to suggest such policies.

Like us, David Friedman (2001) argues that evolutionary psychology has much to contribute to the growing field of behavioral economics. In his paper, he provided a compelling account of why people may have evolved a tendency to evaluate present and future opportunities in the way that experimental economics suggests they do. He argued that in making decisions about the present versus the future, we may confound uncertainty about future events with judgments about the

[24]Cohen & Dickens (2002) presents a discussion of these issues written for economists.

time value of resources. For a Pleistocenian hunter-gatherer, a promise of some consideration next month in exchange for some action today may not have been very reliable and may not have been much less reliable than the promise of the same consideration a year from now. Thus, something I can get today is valued a lot more than what I can get at any time in the future, but how far in the future doesn't matter very much. In the same article, Freidman provided evolutionary explanations for several other phenomena that have puzzled economists. His suggestions represent good first steps toward the development and verification of evolutionary theories for these behaviors using the methods that have been demonstrated by evolutionary psychologists.

Another cognitive constraint on decision making that people often encounter is the tendency to either underweight or overweight low-probability events. Economists typically assume that people make decisions on the basis of expected utility—they consider the utility they would gain from two different states of the world, weighted by the probability of each event occurring. There is evidence, however, that people sometimes ignore very low-probability events when making complex decisions. This is understood as the result of a decision heuristic of editing. People with unlimited time and resources might take all information into account in making a decision, but in most complex decisions that is infeasible. It is hypothesized that people have rules of thumb for deciding what to consider and what not to consider, and a frequently used rule of thumb is to ignore very low-probability events. When people don't ignore low-probability events, they often behave as if the event was much more likely than it actually is.[25]

Editing could have serious consequences when people purchase insurance and could lead some people to be overly likely to choose some hazardous occupations. If people indeed tend to weigh outcomes in this manner, the normal economic incentives employers would face to improve work safety (having to pay higher wages to attract workers to more dangerous jobs) may be ineffective. The workers who overweight the likelihood of an accident would find employment elsewhere, leaving only those who treat the probability as essentially zero. Again there could be implications for policy. Workers who view their jobs as essentially safe are not likely to be willing to pay as much to make them safer as someone who correctly perceives the danger, therefore, employers won't be able to fund safer jobs by offering lower wages. Thus, there could be an under provision of safety that would not occur if people were omniscient and rational and that could provide a rationale for safety intervention. But economists are reticent to develop these implications, because no theory can predict when people will or won't appropriately weight low-probability events.

A third example of behavioral anomalies is cooperation and people's willing participation in activities that benefit a group with little benefit to the individual participant. People regularly behave in cooperative ways when their individual

[25]See the discussion of biases with respect to low probability events in Kahneman, Slovic, and Tversky (1982) and in Kahneman and Tversky (1974).

self-interest is clearly not being served (e.g., stopping to give directions to strangers who they are never likely to see again). The voting paradox is one example of "irrational" social participation. The chance that your vote will influence the outcome of an election is infinitesimal, but that doesn't stop most people from voting. But while people often exhibit irrational cooperation or social participation, at other times they behave selfishly or even with hostility toward others. If we could understand why and when people will cooperate as opposed to behave selfishly, it could have enormous implications for how we design institutions and conduct social policy. Recently, economists taking an evolutionary perspective have made important progress in analyzing such problems.[26]

Evolutionary Psychology as a Theoretical Framework for Behavioral Economics

Evolutionary psychologists argue that adaptive pressures have shaped the functions of the mind through natural selection, just as our bodies have evolved in response to environmental pressures. They provide evidence that the mind is composed of a number of domain-specific, content-dependent information processing mechanisms that were well suited to solve problems faced by our ancestors living in the Pleistocene. For example, evidence shows that the human brain has complex algorithms designed to facilitate social exchange (Cosmides, 1989; Cosmides & Tooby, 1992), mate selection (Buss, 1992), emotional recognition between mother and child (Fernald, 1992), and incest avoidance (Wolf, 1966).

The methodology that evolutionary psychologists have adopted is to first develop a theoretical model of what an evolutionary explanation for a class of behaviors might be. This step often involves induction from observed behavior and has been the source of accusations that what practitioners are doing is nothing more than post-hoc story telling. But the next step in exploring the possible evolutionary origins of a behavior is deducing and testing implications of the theory for other behaviors. It is the sometimes startling nature of the predictions and findings that suggest that this method has considerable scientific merit. They also suggest that such an approach to behavioral economics could be fruitful.

We can imagine such a program proceeding in two ways. Where evolutionary psychologists have already worked on problems of interest to economists, behavioral economists might proceed by trying to identify implications of existing research on evolutionary psychology for economic theory. Where evolutionary psychologists have not worked on a problem, behavioral economists might wish to emulate their methodology in trying to formulate evolutionary theories to explain some of the anomalous behaviors that have been identified. If they are lucky, doing so will yield theories with excess empirical content that can be tested in the labora-

[26]For example, Sethi & Somanathan (2001) show that a class of utility functions with conditional interdependence of individual utility that have been shown capable of rationalizing behavior in a wide range of cooperation experiments is evolutionarily stable.

tory and/or by observing people's real world economic behavior. Some of that excess empirical content might include additional implications for behavior and policy beyond those of the behavioral observations motivating the theory. Confirmation of those implications would give us confidence in the predictions of the evolutionary theory that hopefully would include guidance as to when the anomalous behavior may arise and what other behaviors we might expect to observe concomitantly. This approach would be most useful for dealing with behavioral anomalies such as time preference and judgment about probabilistic outcomes that have not yet been studied by evolutionary psychologists.

Some evolutionary psychologists have gone to great lengths to distance themselves from behavioral genetics. Tooby and Cosmides (1990) argued that the demands of sexual reproduction tend to make evolved traits universal. But this argument doesn't stand up to the wide range of evidence that behavioral geneticists can offer that important behavior does differ across individuals in part due to genetic differences. We suspect that some of the very behaviors that evolutionary psychologists have been concerned with, such as cooperation, show important variation across individuals, which is due in some sense to genetic differences. Behavioral economists would do well to take note of this and think of ways to use this essentially exogenous source of variation in behavior to identify causality in statistical analysis. A greater use of data sets with information on degrees of relatedness in economic research, along with more careful thought about how to use that information, may be in order.

As optimistic as we are about the prospects for an evolutionary basis for behavioral economics, we have one important concern about that promise. It is relatively easy to develop theories of the product of evolution when the product is viewed as the optimal equilibrium solution to a reproductive fitness problem. In our view it is possible, but not likely, that the decision heuristics that sometimes lead to errors in judgment represent optimal solutions to problems our ancestors faced in the Pleistocene. Humans, however, haven't had much time to evolve. In particular, they haven't had that much time to evolve optimal structures for using our unique computing machinery. We think it is more likely that if decision heuristics have an evolutionary basis, they are a biological rough first or second attempt at an optimal decision algorithm, which is still in the process of improvement. It is much more difficult to develop useful theories of dynamic evolution or transitions between equilibria—which is what would be required for a theory of fitness-enhancing cognitive adaptations to changing environments—than to model optimal equilibrium solutions.

CONCLUSION

We set out to accomplish three tasks: 1) to show that the social implications of research on the genetic influences on behavior are not what many people have thought, 2) to develop a framework in which we can understand how genes might influence behavior that is consistent with our perceptions of ourselves as making choices about our behavior, and 3) to present a framework in which the social implications of genetic influences on behavior might be understood.

As such, we have argued that concerns that genetic influences on behavior either justify those behaviors or imply their inevitability are misguided as is the view that group differences due to genetic differences will necessarily be viewed as just. We have described the rational actor model and suggested that the role of genes in shaping behavior can be understood in that framework as shaping people's tastes, the constraints they face in satisfying those tastes, and the decision-making process itself. This way of viewing the role of genes in shaping behavior suggested a number of things about the relevance of behavioral genetics and evolutionary psychology to social policy.

We began by noting that the initial reaction to the findings of high heritability of many behaviors and the possible existence of specialized evolved cognitive mechanisms should be "so what?" At least in the context of the normative model we describe, the origins of behavior can be completely irrelevant for social policy. However, we can imagine several ways in which the study of behavioral genetics and evolutionary psychology could inform social choice.

We noted that understanding the origins of behaviors could be useful in a number of ways: It could help us understand how to more effectively intervene to change undesirable behaviors, it could allow us to better understand our own motivation and thus to act in ways that are more productive of our well being, it could inform discourse about social values, it might aid in the development of gene therapy for behavior, and might help us understand and even anticipate areas where our cognitive structures lead us to systematically do less well than we might. Finally, we considered how evolutionary psychology might inform the work of behavioral economics and lead to a more useful theory that would be more widely applied.

Looking at this list, it is clear that the potential benefit of research on genes and behavior is largely unrealized. We hope that the framework we have presented will inspire economists to think more about how to incorporate insights from biology, psychology, and cognitive sciences into their work. We also hope that our framework will help behavioral geneticists and evolutionary psychologists focus their work on questions that are most important if we are to derive social benefit from that work.

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