ARE YOU A "NATURAL"?

Bouchard, T., Lykken, D., McGue, M., Segal, N., & Tellegen,A. (1990). Sources of human psychological differences: The Minnesota study of twins reared apart. *Science, 250*, 223-229.

This study represents a relatively recent and ongoing fundamental change in the way many psychologists view human behavior in its broadest sense. You can relate to this change in a personal way by first taking a moment to answer in your mind the following question: "Who are you?" Think for a moment about some of your individual characteristics: your "personality traits." Are you high strung or "laid back"? Are you shy or outgoing? Are you adventurous or do you seek out comfort and safety? Are you easy to get along with or do you tend toward the disagreeable? Are you usually optimistic or more pessimistic about the outcome of future events? Think about yourself in terms of these or any other questions you feel are relevant. Take your time .... Finished? Now, answer this next, and, for this reading, more important question: "Why are you who you are?" In other words, what factors contributed to "creating" this person you are today?

If you are like most people, you will point to the child-rearing practices of your parents and the values, goals, and priorities they instilled in you. You might also credit the influences of brothers, sisters, grandparents, aunts, uncles, and peers, teachers, and other mentors who played key roles in molding you. Still others of you will focus on key life-changing events such as an illness, the loss of a loved one, or the decision to attend a specific college, choose a major, or take a particular life course that seemed to lead you toward becoming your current self. All of these influences share one characteristic: they are all *environmental* phenomena. Hardly anyone ever replies to the question "Why are you who you are?" with, "I was born to be who I am; it's all in my genes."

Everyone acknowledges that physical attributes, such as height, hair color, eye color, and body type are genetic. More and more people are realizing that tendencies toward many illnesses such as cancer, heart disease, and high blood pressure have significant genetic components. But almost no one thinks of genes as the main force behind who they are *psychologically*. This may strike you as odd when you stop to think about it, but in reality there are very understandable reasons for our "environmental bias."

First of all, psychology during the second half of the twentieth century was dominated by a theory of human nature called behaviorism. Basically, the theory of behaviorism states that all human behavior is controlled by environmental factors, including the stimuli that provoke behaviors and the consequences that follow response choices. Strict behaviorists believed that the internal psychological workings of the human mind were not only impossible to study scientifically, but also that such study was unnecessary and irrelevant to a complete explanation for human behavior. 'Whether the wider culture accepted or even understood formal theories of behaviorism is not as important as the reality of their influence on today's firmly entrenched popular belief that *experience* is the primary or exclusive architect of human nature.

Another understandable reason for the pervasive acceptance of environmental explanations of behavior is that genetic and biological factors do not provide visible evidence of their influence. It's easy for someone to say, "I became a writer because I was deeply inspired and encouraged by my seventh grade composition teacher." You remember those sorts of influences; you see them; they are part of your past and present conscious experiences. You would find it much more difficult to recognize biological influences and say, "I became a writer because my DNA contains a gene that has been expressed in me that predisposes me to write well." You can't see, touch, or remember the influence of your genes, and you don't even know where in our body they might be located!

Finally, many people are uncomfortable with the idea that they might be the product of their genes rather than the choices they have made in their lives. Such ideas smack of determinism and a lack of "free will." Most people have a strong dislike for any theory that might in some way limit their conscious ability to determine the outcomes in their lives. Consequently, genetic causes of behavior and personality tend to be avoided or rejected. In reality, genetic influences interact with experience to mold a complete human, and the only question is, which is more dominant? Or to phrase the question as it frequently appears in the media: *"Is it nature or nurture?"*

This article by Thomas Bouchard, David Lykken, and their associates at the University of Minnesota in Minneapolis, is a review of research began in 1979 to examine the question of how much influence your genes have in determining your personal psychological qualities. This research grew out of a need for a scientific method to separate genetic influences (nature) from environmental forces (nurture) on people's behavior and personality. This is no simple task when you consider that nearly every one of you, assuming you were not adopted, grew and developed under the direct environmental influence of your genetic donors (your parents). You might, for example, have the same sense of humor as your father (no offense!) because you learned it from

him (nurture) or because you inherited his "sense-of-humor" gene (nature). It appears that there is no systematic way to tease those two influences apart, right?

Well, Bouchard and Lykken would say "wrong." They have found a way to determine with a reasonable degree of confidence which psychological characteristics appear to be determined primarily by genetic factors and which are molded more by your environment.

THEORETICAL PROPOSITIONS

It's simple really. All you have to do is take two humans who have exactly the same genes, separate them at birth, and raise them in significantly different environments. Then, you can assume that those behavioral and personality characteristics they have in common as adults must be genetic. But how on earth can researchers possibly find pairs of *identical people* (don't say "cloning"; we're not there yet!)? And even if they could, it would be unethical to force them into diverse environments, wouldn't it? Well, as you've already guessed, the researchers didn't have to do that. Society had already done it for them. Identical twins have virtually the same genetic structure. They are called *monozygotic twins* because they start as one fertilized egg, called a *zygote*, and then split into two identical embryos. Fraternal twins are the result of two separate eggs fertilized by two separate sperm cells and are referred to as *dizygotic twins*. Fraternal twins are only as genetically similar as any two nontwin siblings. As unfortunate as it sounds, twin infants are sometimes given up for adoption and placed in separate homes. Adoption agencies will try to keep siblings, especially twins, together, but the more important goal is to find good homes for them even if it means separation. So, over time, thousands of identical and fraternal twins have been adopted into separate homes and raised, frequently without the knowledge that they were a twin, in different and often contrasting environmental settings.

Bouchard and Lykken began in 1983 to identify, locate, and bring together pairs of these twins. This 1990 article reports on results from 56 pairs of monozygotic reared-apart (MZA) twins from the United States and seven other countries who agreed to participate in weeklong sessions of intensive psychological and physiological tests and measurements (that this research is located in Minneapolis, one half of "the Twin Cities" is an irony that has not, by any means, gone unnoticed). These twins were compared with monozygotic twins reared together (MZT). The surprising findings continue to reverberate throughout the biological and behavioral sciences.

METHOD

Participants

The first challenge for this project was to *find* sets of monozygotic twins who were separated early in life, reared apart for all of most of their lives, and reunited as adults. Most of the participants were found through word-of-mouth as news of the study began to spread. The twins themselves or their friends or family members would contact the research institute, the Minnesota Center for Twin and Adoption Research (MICTAR), various social-services professionals in the adoption arena would serve as contacts, or, in some cases one member of a twin-pair would contact the center for assistance in locating and reuniting with his or her sibling. All twins were tested to assure that they were indeed monozygotic before beginning their participation in the study.

Procedure

The researchers wanted to be sure they obtained as much data as possible during the twins' one-week visit. Each twin completed approximately 50 hours of testing on nearly every human dimension you might imagine. They completed four personality trait scales, three aptitude and occupational interest inventories, and two intelligence tests. In addition the participants filled in checklists of household belongings (such as power tools, telescope, original artwork, unabridged dictionary) to assess the similarity of their family resources, and a family environment scale that measured how they felt about the parenting they received from their adoptive parents. They were also administered a life history interview, a psychiatric interview, and a sexual history interview. All of these assessments were carried out individually so that there was no possibility that one twin might inadvertently influence the answers and responses of the other.

As you might imagine, the hours of testing created a huge database of information. The most important and surprising results are discussed here.

RESULTS

Table 1 summarizes the similarities for some of the characteristics measured in the monozygotic twins reared apart (MZA) and includes the same data for monozygotic twins reared together (MZT). The degree of similarity is expressed in the table as correlations or "R" values. The larger the correlation, the greater the similarity. The logic here is that if environment is responsible for individual differences, the MZT twins who shared the same environment as they grew up *should* be significantly more similar than the MZA twins. As you can see, this is not what the researchers found.

The last column in Table 1 expresses the difference in similarity by dividing the MZA correlation on each characteristic by the MZT correlation. If both correlations were the same, the result would be 1.00; if they were entirely dissimilar, the result could be as slow as 0.00. Examining column 4 in the table carefully, you'll find that the correlations for characteristics were remarkably similar, that is, close to 1.00, and no lower than. 700 for MZA and MZT twin pairs.

DISCUSSION AND IMPLICATIONS OF FINDINGS

These findings indicate that genetic factors (or "the genome") appear to account for most of the variation in a remarkable variety of human characteristics. This finding was demonstrated by the data in two important ways. One is that genetically identical humans (monozygotic twins), who were raised in separate and often very different settings, grew into adults who were extraordinarily similar, not only in appearance but also in basic psychology and personality. The second demonstration in this study of the dominance of genes is the fact that there appeared to be so *little* effect of the environment on identical twins who *were* raised in the same setting. Here's Bouchard and Lykken's take on these discoveries:

> For almost every behavioral trait so far investigated, from reaction time to religiosity, an important fraction of the variation among people turns out to be associated with genetic variation. This fact need no longer be subject to debate; rather, it is time to consider its implications.

TABLE 1 Comparison of Correlations (*r*) of Selected Characteristics for Identical Twins Reared Apart (MZA) and Identical Twins Reared Together (MZT)*

CHARACTERISTIC	*r* (MZA)	*r* (MZT)	SIMILARITY *r* (MZA) ÷ *r* (MZT)**
Physiological	—	—	—
Brain wave activity	.80	.81	.987
Blood pressure	.64	.70	.914
Heart rate	.49	.54	.907
Intelligence	—	—	—
WAIS IQ	.69	.88	.784
Raven intelligence test	.78	.76	1.03
Personality	—	—	—
Multidimensional personality questionnaire (MPQ)	.50	.49	1.02
California personality inventory	.48	.49	.979
Psychological interests	—	—	—
Strong Campbell interest inventory	.39	.48	.813
Minnesota occupational interest scale	.40	.49	.816
Social attitudes	—	—	—
Religiosity	.49	.51	.961
Nonreligious social attitudes	.34	.28	1.21

*Adapted from Table 4, p. 226.
**1.00 would imply that MZA twin pairs were found to be exactly as similar as MZT twin pairs.

There are, of course, those who will argue with Bouchard and Lykken's notion that the time to debate these issues is over. Some varying views are discussed in the next section. However, a discussion of the implications of

this and other similar studies by these same researchers is clearly warranted. In what ways do the genetic findings reported in this study change psychologists' and, for that matter, all of our views of human nature? As mentioned earlier, psychology and Western culture have been dominated for over 50 years by environmental thinking. Many of our basic beliefs about parenting, education, crime and punishment, psychotherapy, skills and abilities, interests, occupational goals, and social behavior, just to name a few, have been interpreted from the perspective that people's experience molds their personalities, not their genes. Very few of us look at someone's behavior and think, "That person was born to behave like that!" We *want* to believe that people *learned* their behavior patterns because that allows us to feel some measure of confidence that parenting makes a difference, that positive life experiences can win out over negative ones, and unhealthy, ineffective behaviors can be *unlearned*. The notion that personality is a done deal the moment we are born leaves us with the temptation to say, "Why bother?" Why bother working hard to be good parents? Why bother trying to help those who are down and out? Why bother trying to offer quality education? And so on. Well, Bouchard and Lykken want to be the first to disagree with such an interpretation of their findings. In this article, they offer three of their own implications of their provocative conclusions:

1. Clearly, intelligence is primarily determined by genetic factors (70% of the variation in intelligence appears to be due to genetic influence). However, as the authors state very clearly,

   > [T]hese findings do not imply that traits like IQ cannot be enhanced .... A survey covering 14 countries, has shown that the average IQ test score has increased in recent years. The present findings, therefore, do not define or limit what might be conceivably achieved in an optimal environment. (p. 227)

   Basically, what he is saying is that while 70% of the variation in IQ is due to naturally occurring genetic variation, 30% of the variation remains subject to increases or decreases due to environmental influences. These influences include many that are well known, such as education, family setting, toxic substances, and socioeconomic status.

2. The basic underlying assumption in Bouchard and Lykken's research is that human characteristics are determined by some combination of genetic and environmental influences. So, when the environment exerts less influence, differences must be attributed more to genes. The converse is also true: as environmental forces create a stronger influence on differences in a particular characteristic, genetic influences will be weaker. For example, most children in the United States have the opportunity to learn to ride a bicycle. This implies that the environment's effect on bicycle riding is somewhat similar for all children, so differences in riding ability will be more affected by genetic forces. On the other hand, variation in, say, food preferences in the United States are more likely to be explained by environmental factors because food and taste experiences in childhood and throughout life are very diverse and will, therefore, leave less room for genetic forces to function. Here's the interesting part of the researchers' point: They maintain that personality is more like bicycle riding than food preferences.

   The authors are saying, in essence, that family environments exert less influence over who the kids grow up to be than do the genes they inherit from birth. Understandably, most parents do not want to hear or believe this. They are working hard to be good parents and to raise their children to be happy individuals and good citizens. The only parents who might take some comfort from these findings are those who are nearing their wit's end with out-of-control or incorrigible sons or daughters and would appreciate being able to take less of the blame! However, Bouchard and Lykken are quick to point out that genes are not necessarily destiny and devoted parents can still influence their children in positive ways, even if they are only working on a small percentage of the total variation.

3. The most intriguing implication that Bouchard and Lykken suggest is that it's not the environment influencing people's characteristics, but vice versa. That is, people's genetic tendencies actually mold their environments! Here's an example of the idea behind this theory: The fact that some people are more affectionate than others is usually seen as evidence that some parents were more affectionate with their children than were other parents. In other words, affectionate kids come from affectionate

environments. Then this kind of assumption has been studied, it is usually found to be true. Affectionate people have, indeed, received more affection from their parents. Bouchard and Lykken are proposing, however, that variation in "affectionateness" may be, in reality, genetically determined so that some children are just born more affectionate than others. Their in-born tendency toward affectionate behavior causes them to *respond* to affection from their parents in ways that reinforce the parents' behavior much more than nongenetically affectionate children. This, in turn *produces* the affectionate behavior in the parents, not the other way around. The researchers contend that genes function in this way for many if not most human characteristics. They state it this way:

> The proximal [immediate] cause of most psychological variance probably involves learning through experience, just as radical environmentalists have always believed. The effective experiences, however, to an important extent are self-selected, and that selection is guided by the steady pressure of the genome. (p. 228)

CRITICISMS AND RELATED RESEARCH

As you might imagine, a great deal of related studies have been carried out using the database of twins developed by Bouchard and Lykken. In general, the findings continue to indicate that many human personality characteristics and behaviors are strongly influenced by genes. Many attributes that have been seen as stemming largely or completely from environmental sources are being reevaluated as twin studies reveal that heredity contributes either the majority of the variation or a significantly larger proportion that was previously contemplated.

For example, studies from the University of Minnesota team found that not only is the vocation you choose largely determined by your genes, but also about 30% of the variation in your overall job satisfaction and work ethic appears due to genetic factors (Arvey et al., 1989; Arvey et al., 1994) even when the physical requirements of various professions were held constant. Other studies comparing identical (monozygotic) twins with fraternal (dizygotic) twins, both reared together and reared apart, have focused more directly on specific personality traits that are thought to be influential and stable in humans (Bouchard, 1994; Loehlin, 1992). These and other studies' findings determined that the people's variation on the characteristics of extraversion-introversion (outgoing versus shy), neuroticism (tendency to suffer from high anxiety and extreme emotional reactions), and conscientiousness (degree to which a person is competent, responsible and thorough) is explained more (65%) by genetic differences than by environmental factors.

Of course, not everyone in the scientific community is willing to accept these findings at face value. The criticisms of Bouchard and Lykken's work take several directions (see Billings et al., 1992). Some studies claim that the researchers are not publishing their data as fully and completely as they should, and, therefore, their findings cannot be independently evaluated. These same critics also claim that there are many articles reporting on case studies demonstrating strong environmental influences on twins that Bouchard and Lykken fail to consider.

In addition, some researchers have voiced a major criticism of one aspect of twin research in general, referred to as the "equal environment assumption" (i.e., Joseph, 2002). This argument maintains that many of the conclusions drawn by Bouchard and Lykken about genetic influence assume that MZ and DZ twins raised together develop in identical environments. These critics maintain that such an assumption is not valid and that fraternal twins are treated far more differently than are identical twins. This, they contend, draws the entire method of twin research as a determinate of genetic influences into question. However, several other articles have refuted this criticism and supported the "equal environment assumption" (i.e., Kendler et al., 1993).

Recent Applications

In 1999, Bouchard reviewed the nature-nurture evidence from the Minnesota twin registries (Bouchard, 1999). He concluded that, overall, 40% of the variability in personality and 50% of variation in intelligence appears to be genetically based. He also reiterated his position discussed earlier that your genes drive your selection of environments and your selection or avoidance of specific personality-molding environments and behaviors.

Research at the Minnesota twin centers continues to be very active. Some fascinating research has examined very complex human characteristics and behaviors that few would have even guessed to be genetically driven, such as love, divorce, and even death (see http://www.psych.umn.edu/ psylabs/mtfs/special.htm, 2004). They have studied people's selection of a mate to see if "falling in love" with Mr. or Ms. Right is genetically

predisposed. It turns out that it is not! However, the researchers have found a genetic link to the likelihood of divorce and to people's age at their time of their death.

Finally, Bouchard and Lykken's research has been applied to the larger philosophical discussion of human cloning (see Agar, 2003). If a human being is ever successfully cloned, the question is, as you are probably thinking, to what extent will a person's essence, an individual's personality, be transferred to his or her clone? The fear that human identity might be changed, degraded, or lost has been a common argument of those opposed to cloning. On the other hand, results of twin studies such as those of Bouchard and Lykken suggest that "the cloned person may, under certain circumstances, be seen as surviving, to some degree, in the clone .... However ... rather than warranting concern, the potential for survival by cloning ought to help protect against the misuse of the technology" (Agar, 2003, p. 9). This is much more a philosophical than genetic discussion, but it makes very interesting food for thought.

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