

Behavioral Genetics

An introduction to how genes and environments interact through development to shape differences in mood, personality, and intelligence

BY CATHERINE BAKER



ADVANCING SCIENCE. SERVING SOCIETY.



THE
HASTINGS
CENTER

Behavioral Genetics

An introduction to how genes and environments
interact through development to shape differences
in mood, personality, and intelligence

BY CATHERINE BAKER

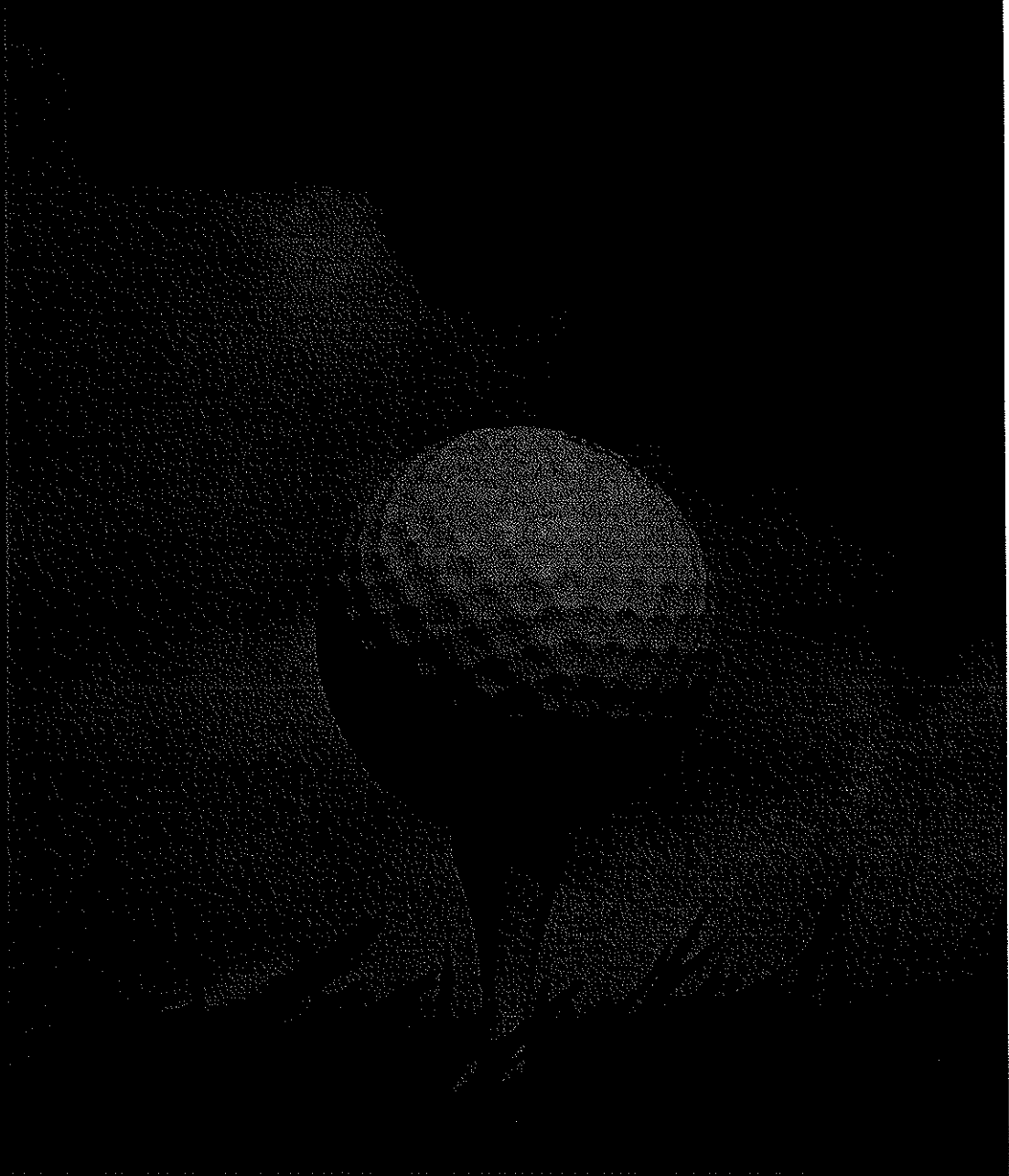
*A tool to inform public discussion of
behavioral genetic research
and its broader social implications*



Prepared for a project conducted by the
American Association for
the Advancement of Science
and The Hastings Center



chapter one



WHAT IS BEHAVIORAL GENETICS?

1

☛ ☛ ☛ Margaret, an ambitious mother

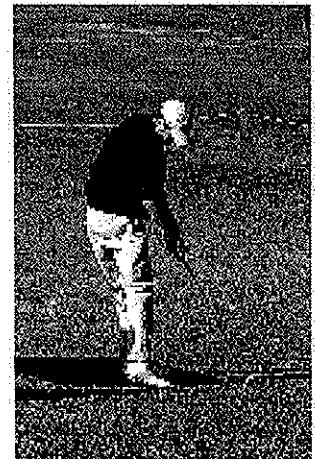
Margaret and her husband do not make a lot of money and they do not save much, but she's come up with a grand scheme to make her family wealthy. She's going to turn her two-year-old daughter Cassandra into a professional golfer.

She knows all about Tiger Woods, the golf prodigy who was coached and managed by his father and who has amassed millions of dollars in prize money and endorsements. The incomes of today's professional women's golfers are far below that of Tiger Woods, but Margaret figures that the earning potential of female golfers is bound to increase dramatically in the years ahead.

Margaret played on her college team and probably could have turned professional if she had been given the encouragement she plans to give her daughter. Though her husband's sport of choice is baseball, he too has physical talent that he has probably passed on to his little girl.

Margaret has bought Cassandra a pint-size set of golf clubs so they can start practicing. Of course at her age, Cassandra prefers to use the putter for knocking off the heads of dandelions or beating up anthills. Nonetheless, her mother thinks it should not be difficult as Cassandra gets older to get her to focus on the game.

Margaret figures that with the natural athletic abilities that run in the family, strenuous coaching, careful planning, and a little luck, she should be able to get Cassandra into the pro circuit within fifteen to twenty years. She has not told her husband about this plan yet. She knows just what he'll say: Are you crazy? But if her daughter has innate physical abilities and those abilities are nurtured, directed, and promoted, success is almost assured. Isn't it?



Defining behavior

Seers, prophets, and astrologers of ancient times have tried to predict behavior. Writers such as Shakespeare and Jane Austen have tried to describe it. Freud, Jung, and other psychiatrists have sought to explain it. Today's advice columnists assume they understand it, ministers sermonize about it, and some daytime TV talk show hosts provoke their guests into the worst of it. Yet much of behavior remains a mystery.

It's the unusual person (the differently *behaving* person) who has not tried to understand his or her own behavior or the behavior of others. Therefore, it should come as no surprise that many scientists choose to study behavior.

All living organisms, not just humans, behave. Animals behave, insects behave, and single-celled amoebas behave. Even

plants behave. For example, when a plant turns its leaves toward a source of light, it is behaving. The opposite is also true: things that are not alive do not behave. Rocks and oceans and planets do not behave.

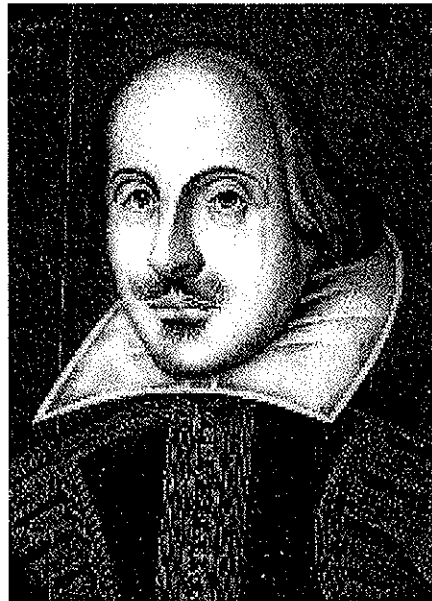
Behaviors are the actions a creature makes, as a whole, in response to the world around it. When an owl swoops down to catch a mouse or when children chase a soccer ball, these are behaviors. Behaviors also are holistic responses to stimuli from inside the body. When your hands begin to tremble and you feel agitated and hyper-alert after your fourth cup of coffee, that is behavior, too.

Mostly, we think of behavior as something conscious such as when we choose to eat a piece of cherry pie. But behavior also can be unconscious, automatic, or instinctual. Talking in your sleep is a behavior, because it is the mind responding to events that occurred while awake. A sneeze is a behavior, because it is the body's response to pollen in the air. The lizard that crawls out from under a rock to bask in the sun is behaving, even though we do not think lizards have a consciousness as human beings do.

Physical manifestations of most diseases are behaviors, too. When a man has an epileptic seizure or when a woman with uncontrolled diabetes falls unconscious, they display behavior despite the fact that they are not in conscious control of their actions.

Some behaviors are uniform across a

Genes were unknown in Shakespeare's time, yet his writing reveals an uncanny, intuitive understanding of human behavior.



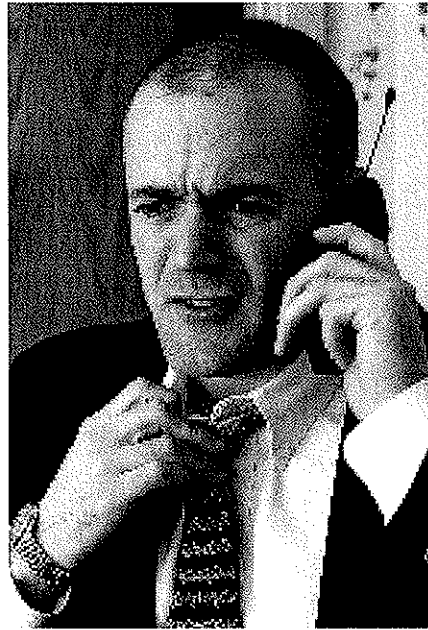
whole species such as the way bears hibernate in winter. Other behaviors are unique to an individual creature such as the way your dog barks twice when he wants to be let outside. Many behaviors are unique to a particular being on a particular occasion, such as the way you react when you find a twenty-dollar bill on the street at the end of a bad day.

Forms of behavior

Actions are one subset of behavior, and states of mind — emotions and moods — are another. This is not obvious. A person can be angry without necessarily doing anything physical like hitting or shouting. Nonetheless, the anger that is felt is a response to stimuli. Perhaps an expensive bill has arrived in the mail or your late-adolescence hormones are surging.

Mental illness falls into the category of behavior though this may not seem obvious, either. Depression does not seem to be a person's response to the world but rather an emotional state that descends upon him or her. In the same way, there is no single event or series of events that explain why a person develops schizophrenia.

However, scientists believe mental illness emerges in response to a series of causative events inside and outside the body. These events may be subtle, they may not be linked in time, and many of them remain unknown, but they are sus-



pected to have some influence on when and whether mood disorders appear. Thus, mood disorders fall into the category of behavior.

In another not-so-obvious connection, personality is behavior. This makes sense when you consider that personality is the sum total of a person's physical, mental, emotional, and social characteristics that distinguish that person from everyone else. Consistent patterns of behavior lead us to describe individuals as being docile and sweet or brusque and standoffish. And yet the typically quiet person might sometimes be quite vocal and the typically aloof individual might sometimes be quite sociable, because behavior always depends on a context.

Since mood and personality fall into the category of behavior, it stands to



Behavior includes not only actions but also the emotions we feel such as anxiety or joy.

reason that thinking itself is a behavior. So when you do addition in your head or try to puzzle out a dream from the night before, you are behaving. The type of thinking behavior that involves knowing and perceiving is called intelligence or cognition. Speed of thought, problem-solving skills, and the ability to make connections are different aspects of this behavior.

Behavioral genetics

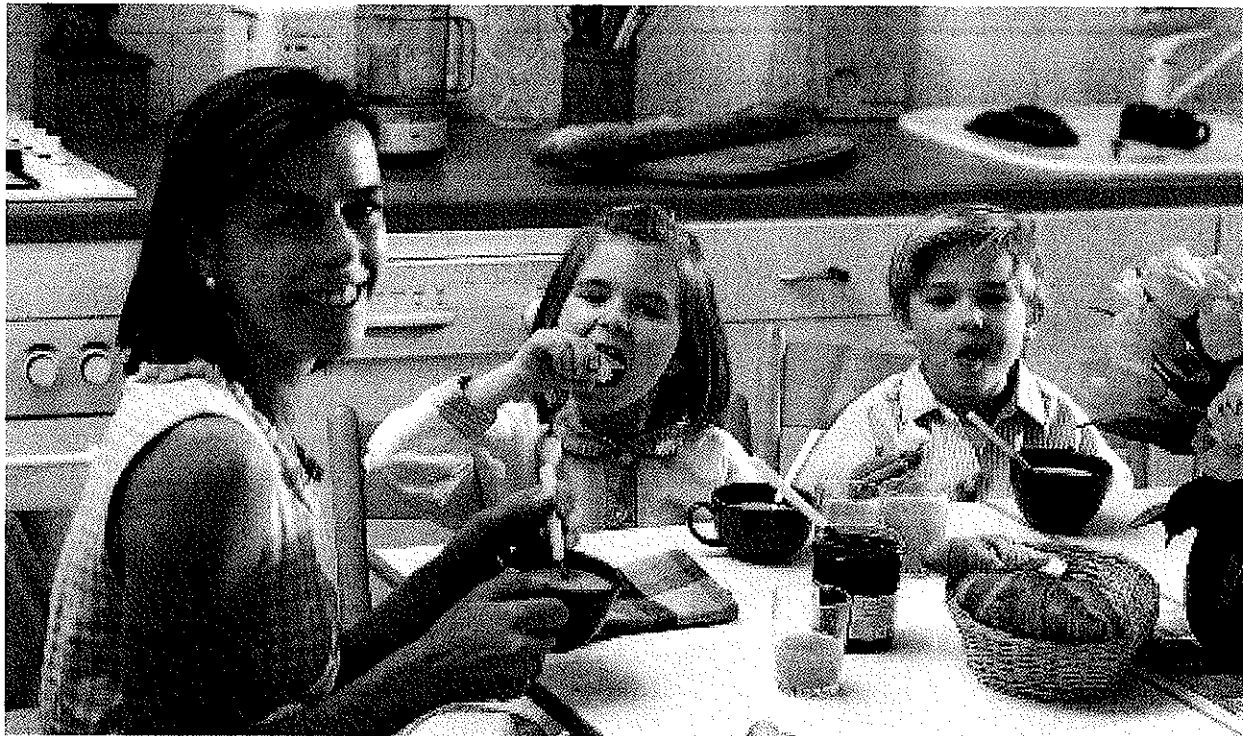
Researchers in the field of behavioral genetics study variation in behavior as it is affected by genes, which are the units of heredity passed down from parents to

offspring. A fuller description of these genes is provided in Chapter 2.

Scientists realize that genes by themselves do not control behavior. Genes enable organisms to respond to and use what is around them in their environments. At the same time, environments influence the actions of genes.

Unfortunately, the term “environment” often leads to confusion because it has a different meaning in behavioral genetics than the one that ordinarily comes to mind. As an ecological term, environment means the physical world. As a genetic term, environment means all influences other than inherited factors. Here’s a short list of some typical envi-

As any parent knows too well, biologically related children can differ widely in behavior.



ronmental factors that to one degree or another affect behavior: family and friends, home and workplace, and specific experiences from everyday life. These are aspects of our external, social world. Other environmental factors belong to the internal, biological world: nutrients, hormones, viruses, bacteria, toxins, and other products that affect the body during prenatal development and throughout life. Environments are addressed at greater length in Chapter 3.

People working in the field of behavioral genetics agree that genes and environments are both essential and interdependent factors in behavior. Their field is called behavioral *genetics*, not because they think genes are more important than environments but because they use gene-based research tools to sort out the factors that contribute to the variation in behavior. These tools are described in Chapter 4.

Behavioral genetic researchers study all sorts of life forms, simple and complex, from worms and fruit flies to chimpanzees and humans. Their work overlaps and complements behavioral research happening in other fields such as biology, psychology, physiology, medical genetics, evolutionary science, and neuroscience, to name a few. The particular interest of behavioral geneticists is in what makes members of a species (especially the human species) *differ* in their behavior. The field also is defined by a particular focus on topics that have

substantial social significance. Three such topics — mood disorders, impulsivity, and intelligence — are treated in Chapters 5, 6, and 7.

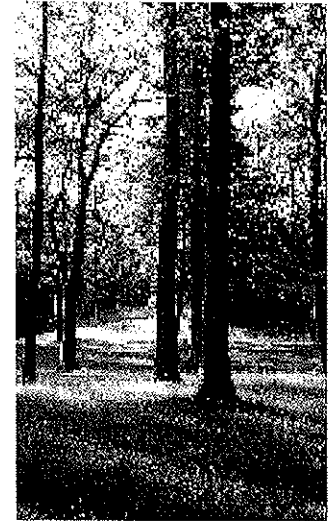
Margaret's ambition

What accounts for the fact that some people are more accomplished athletically than others? This is a question that interests many scientists including behavioral genetic researchers. It also is one that would interest Margaret, the woman who plans to groom her daughter into a professional golfer like Tiger Woods.

Tiger is an intriguing case study because his athletic performance is so extraordinary. He was a precocious child who before his third birthday could beat far older players on the course. By age 15, he had won five junior world tournaments. Then he claimed three U.S. amateur championships in a row. He turned professional at age 20 and earned \$800,000 in prize money his first season.

At age 21, he became the youngest winner of the Masters Tournament, and within four years he had his career grand slam — a victory in each of golf's four major tournaments. With a growing collection of victories, he is surpassing the records set by Jack Nicklaus and other legends of the sport.

Tiger combines a powerful swing with great putting skills, excellent stamina, incredible discipline, and impressive self-control. He has all the assets for an



Genes and environments are interdependent: one does not have an effect on behavior without the other.



Success in any endeavor requires more than an advantageous set of genes.

exceptional career. His success is so unusual that it compels us to ask, where does Tiger get it? Or, as Margaret might put it, “How can I get some of that for my child?”

We do not know whether Tiger was born with a set of genes that are particularly advantageous for golf (molecular study could someday shed light on this), though we might intuitively conclude that he is built for the sport. We do know that at an early age his father Earl Woods recognized, nurtured, shaped, and pushed his son’s talent. We also know that Tiger was willing and eager to be coached, to work extremely hard, and to aim for high goals.

We can assume that chance has played a part in Tiger’s success. Just consider how he might have turned out if his father had not liked golf, if he had developed a debilitating illness as a youth, or if he had been born a few decades earlier when most golf courses were Whites-only.

Genes, environment, choice, and chance: each plays off the others over the course of a lifetime. Biographers have already begun to speculate on how these various threads have woven together to make Tiger who he is. But for Margaret proactively to *make* Cassandra into a successful professional golfer, she has to control all the variables — and that is simply not possible.

Science in society

As a field, behavioral genetics is concerned not so much with individuals such as Tiger or Cassandra, but with patterns of variety among groups of people. It is concerned with questions of probability; for example, what is the probability that you will have good hand-eye coordination given a particular set of genes and a particular set of environmental conditions?

Behavioral genetics does not have an answer to the question just posed, though it might someday. And it is not the domain of behavioral genetics to answer the question of whether Margaret *ought* to aggressively manipulate her daughter’s future. It is society through its values, cultural practices, and laws that determines how we should behave. Behavioral genetics can only help us understand what makes us behave as we do.



Individual scientists who study behavior cannot and should not decide which behaviors are valued and acceptable and which are outside the norm. Such important decisions must be made by society as a whole.

RESOURCES FOR CHAPTER 1

- Biological Sciences Curriculum Study (BSCS). 2000. *Genes, environment, and human behavior*. Colorado Springs: BSCS.
- Carey, G. 2003. *Human genetics for the social sciences*. Thousand Oaks, CA: Sage Publications.
- Dick, D. M. and R. J. Rose. 2002. "Behavior genetics: What's new? What's next?" *Current Directions in Psychological Science* 11, no. 2: 70-74.
- Plomin, R., J. C. DeFries, G. E. McClearn, and M. Rutter. 1997. *Behavioral genetics*, 3rd ed. New York: Freeman Press.
- Shapiro, L. 2002. "Woods successfully defends title, captures third overall." *Washington Post*, 15 April, C-1.
- "Tiger Woods." 2001. (Accessed 3 October); available from <http://www.infoplease.com/ipa/A0109760.html>.