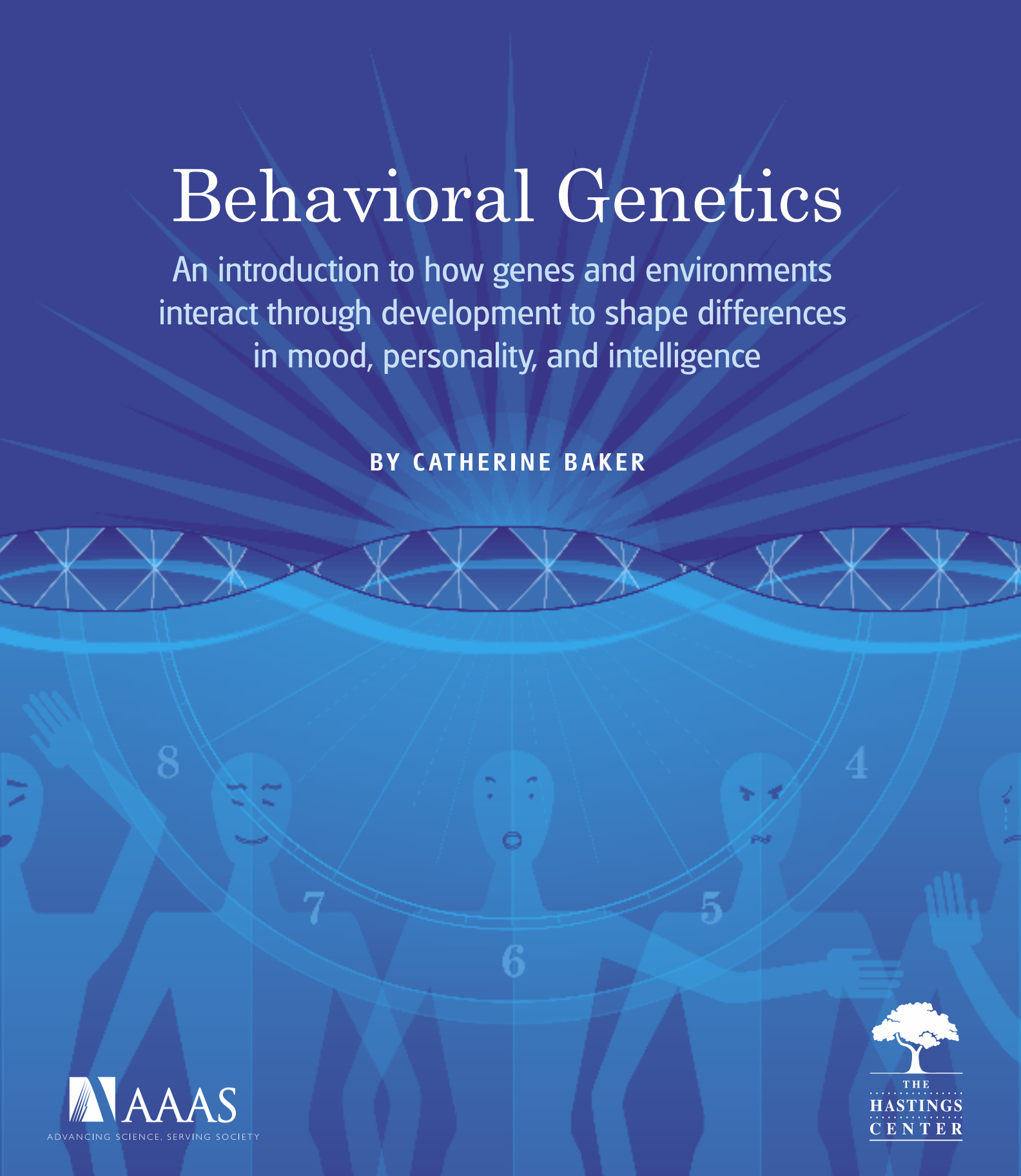
Behavioral Genetics

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

BY CATHERINE BAKER



AAAS
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

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

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

THE HASTINGS CENTER

For Carolyn, my genetic equivalent

Printed in the United States of America

ISBN 0-87168-697-X

Layout and cover design by
AAAS Publication Services.

Additional copies of this report
are available from:
AAAS Scientific Freedom,
Responsibility and Law Program
1200 New York Avenue, NW
Washington, D.C. 20005, USA
Telephone: USA +1-202-326-6606
Fax: USA +1-202-289-4950
E-mail: kallema@aaas.org
Web: www.aaas.org/spp/bgenes/

This report is also available on the Web:
http://www.aaas.org/spp/bgenes/
publications.shtml

Preparation and publication of this volume was supported by a grant from the National Human Genome Research Institute (RO1 HG001873) and by contributions to the AAAS Fund for Excellence designated for the Directorate for Science & Policy Porgrams.

TABLE OF CONTENTS

NOTE: *Words contained in the glossary/index are* blue *where they first appear in Chapters 1 through 7.*

Preface

Behavioral geneticists aim at no less than showing us how genes help to explain why we behave the way we do. One big reason they do their work is that understanding why we behave the way we do is inherently interesting. The second big reason is that they hope their work eventually will lead to curing behavioral disorders as different as alcoholism and schizophrenia. Today they are far from understanding how genes influence those behaviors, but that is their goal.

One might think that such a fascinating field would by now have spawned many brief introductions for lay readers. But that hasn't happened. Part of the explanation for this gap is that the science is complicated. Part of the explanation is that the subject matter of behavioral genetics—mental disease, personality, intelligence—is controversial. Moreover, in the past, research in behavioral genetics has been used to support hateful prejudices, and so perhaps this has led many otherwise-interested writers to steer clear of the topic.

The process that led to this book was started in 1999 as part of a project to explore ideas for improving the public's understanding of behavioral genetics and to fill the void described above. A series of meetings brought together genetic researchers, social scientists, lawyers, and ethicists. Participants shared their knowledge of the science and together explored the question, "What does the public need to know to understand and talk about behavioral genetics?" An experienced writer (not a scientist) listened, asked questions, took notes, and read the papers contributed by participants for another project product, a scholarly volume. Then she started drafting this book, which was subsequently reviewed at several stages by project participants. The result is, we think, a work that is both instructive and a delight to read.

Each chapter begins with a fictional but plausible anecdote about an individual with a question that has to do with behavior. These anecdotes set the genetic science into a real world context. They start readers thinking about basic questions such as, How do behavioral geneticists study the connection between genes and behavior? Can those studies tell me anything about why I act the way I do? Can they tell me anything about the chances that I can make my child do well or badly in life? And so forth. With the story as the hook, readers are pulled into each chapter, where they are introduced to the scientific concepts that can help answer the fictional character's question.

Writing about behavioral genetics is like building a structure on shifting sands. Each day, new discoveries are being made, previously heralded claims are being revised, and new paradigms for the relationship between genes and behavior are being proposed. For example, as this book explains in Chapter 2, the human genome used to be compared to a codebook, a book of life, or an encyclopedia. But today scientists

recognize that the genome is much more dynamic than any kind of book and so new metaphors are being tried out — metaphors that may or may not stick with time, depending on what researchers learn next.

Despite the difficulty of capturing a fast-moving subject, we believe this text succeeds as an introduction to the field. It should help readers obtain a firm grounding in the basic science and the tools used by researchers to explore the contribution of the genes (and their essential counterpart, the environment) to behavior. Readers should come away with a vocabulary for discussing the science and with a sense of what genetic science can tell us and do for us, and what its limitations are.

This text describes the promise of — and the problems with — the complex science of behavioral genetics in a way that should be accessible to a broad audience, from high school and college students with an interest in science to the educated lay person whose family may be experiencing events similar to those portrayed in the book's stories. If you want to see where the fascinating and sometimes controversial science of behavioral genetics is headed in the 21st century, you've come to the right place.

As the lead investigators for the larger project, we are indebted to the staff at the Ethical, Legal and Social Implications Research Program at the National Human Genome Research Institute, especially Joy Boyer and Elizabeth Thomson, for their generous support of our work (RO1 HG001873). We are also deeply grateful to Elving Anderson for, at every step of this project, giving so generously of his time and knowledge, as well as to the many project participants (listed on page 131) who contributed their expertise to the preparation of this volume. Finally, we thank Catherine Baker for her tireless work to understand and then describe for you the work of behavioral genetics.

If you would like to read the special supplement of the Hastings Center Report, which summarizes the findings of the project that produced this introduction to behavioral genetics, or you would like to learn more about the volume of essays for advanced students and scholars, please visit our website at http://www.aaas.org/spp/bgenes, where this volume is also available.

Erik Parens
The Hastings Center

Mark S. Frankel
AAAS

Audrey R. Chapman
AAAS

Introduction

Why do humans range so widely in their susceptibility to mental illness, in their willingness to take risks, and in their performance on intelligence tests? One answer to this question comes from scientists in the field of behavioral genetics. They say that the variation in behavioral traits across a population is due, in part, to the genes. So many studies have pointed to connections between genes and particular behaviors that most scientists now feel comfortable stating that there is such a link for every possible behavior.

But what does it really mean to say that there is a link between genes and behavior? Does it mean that there is a gene that makes some of us blush when embarrassed; that there is one gene that makes you prefer classical music and another gene that makes you dislike it; that there is a bunch of genes that each provides for different levels of skill in playing poker? The answer to all these questions is no. Does it mean behavior passes down from generation to generation, i.e., is inherited, just like baldness and eye color? Again, the answer is no.

So when next you see an article that proclaims, "Gene for *[insert a human behavior here]* discovered," read it with a critical eye. Or when you next hear someone say, "He inherited his *[insert a human behavior here]* from his father," receive that with skepticism, too.

The pervasive role of genes in behavior does *not* mean what it is commonly misunderstood to mean. It does not mean that a gene or even several genes can make you act in any particular way. It does not mean that a behavior can "pass down through the genes." Such claims are *not* accepted in behavioral genetics.

It *does* mean that genes play a vital role in the body's development and physiology, and it is through the body, acting in response to and upon surrounding environments, that behavior manifests itself. So while we do inherit our genes, we do not inherit behavior traits in any fixed sense. The effect of our given set of genes on our behavior is entirely dependent upon the context of our life as it unfolds day to day.

Nonetheless, we have tended to assign the genes a grander role. Perhaps one reason why we tend to inflate the role of genes in behavior is that there is no good verb to use when talking about them. It's clearly wrong to say that genes *control* behavior. We might instead say that genes *influence* behavior, that genes *impinge* upon behavior, that genes *are implicated* in behavior, or that they *help instigate* the cellular activity through which behavior is executed. None of these constructions are quite right, either.

It is very difficult to capture in a single verb the gene-behavior relationship, because the way in which genes relate to behavior is complex, indirect, and highly nuanced. It is contingent upon events inside and outside the body — such as diet and features of upbringing — and it is modulated over time. If you keep all these things in mind, it can

help you think more coherently about the questions that naturally arise, such as:

- Is our potential predetermined at conception?
- Are we powerless to control our thoughts and actions?
- Will our children turn out a certain way no matter how we raise them?

The answer to each of these questions is once again a resounding *no*. Genes are not enough. They have little predictive power at the level of the individual and they do not override the many other influences on behavior. In fact, it's fair to claim the following statement, though it is unproven and probably unprovable:

Based on your genes, no one can say what kind of human being you will turn out to be or what you will do in life.

If you can only learn one thing about behavioral genetics, that statement should be it. But if you would like to obtain a more sophisticated and deeper understanding of this subject, please read the rest of this book. You will find straightforward definitions of genes and environments. You will learn how genes operate *within* a sensitive and complicated network involving other DNA elements and proteins and *in* specific environments *throughout* the development of an individual. You will gain an understanding of how behavioral genetic research is conducted, particularly in regard to three topics that have been the focus of much of the research in this field: mood disorders, impulsivity, and intelligence. Finally, you will be introduced to the ways in which behavioral genetic research can affect individuals and society at large.

If you read this book, you also will learn about some of the contentious debates that surround behavioral genetics. Scholars argue about the quality of the field's research methods. They disagree about the significance of findings. They question whether the benefits from behavioral genetic research will outweigh the drawbacks.

This last concern stems in part from this field's historic connection to eugenics. This was a doctrine, first emerging in the late 1800's, which held that some people are innately superior due to their genes and therefore those persons should reproduce more than others. Eugenic policy became official practice in many countries, ranging from involuntary sterilization of those deemed unfit in the U.S. and other countries to mass murder of those deemed unsuitable in Nazi Germany. After World War II, overtly eugenic attitudes were forced underground. Nonetheless, there are people today who continue to manipulate and sensationalize science, consciously or subconsciously, to justify social inequities and prejudices.

Many people fear that preliminary and unconfirmed studies, unwarranted conclusions, and misinterpreted data from behavioral genetic research will be used to support

modern eugenic policies that maintain privilege and unfairness. They worry that findings from behavioral genetic research will be manipulated to promote prejudice, spread discrimination, invade privacy, and foster unequal treatment under the law. They also worry that as a genetically based definition of normal human behavior advances, the range of socially acceptable human behavior will shrink.

On the other hand, many people are frustrated by so-called "hand-wringing Jeremiahs" who dwell on the problems that could potentially emerge from behavioral genetic research. The people with this view assert that behavior is a worthy avenue of exploration. They believe that studying the genes is one way — one way among many — to learn about behavior. They think that the acquisition of knowledge is good, even knowledge about something as personal and revealing as our own behavior. Indeed, they believe that such knowledge could improve the lives of individuals as well as humanity at large. They acknowledge that the scientific methodology in behavioral genetics is imperfect, but no more so than in any other relatively new field of exploration. Though they share concern about the misuse of information from behavioral genetics, they believe that the pursuit of this knowledge offers more advantages than disadvantages.

This book is the product of a project that brought together advocates and skeptics. The partners in this project share the conviction that an informed public understanding of the principles of genetic science and behavioral research can be an antidote against premature and faulty claims and the misapplication of findings. Our intent with this book is to help non-scientists like yourself gain a better understanding of concepts and terms in behavioral genetics. This education can help you better evaluate what you read and hear about behavioral genetics. It can help you become your own judge of information. And to some extent, it might help you better understand your own behavior.

Acknowledgements

This book results from a four-year project of The Hastings Center and the American Association for the Advancement of Science. The subject of this project was "Tools for Public Conversation about Behavioral Genetics." Early on, project participants decided that a useful tool to foster conversation would be an easy-to-read primer on behavioral genetic research for an audience of interested nonscientists.

The text was shaped by the papers presented and discussions that took place at five meetings of the project's working group and a final conference that was open to the public. Project participants are listed on page 131. My thanks go to each of them.

I am particularly indebted to the following persons who provided specific comments on, and corrections to, parts of this manuscript at various stages in its development: Elving Anderson, Jon Beckwith, Greg Carey, Troy Duster, Marcus Feldman, Mark S. Frankel, Irving I. Gottesman, and John Loehlin. Special acknowledgement goes to Elving, who answered many questions and served as coach, and to Irving, who constantly brought relevant articles to my attention and who was helpfully specific in his suggestions for the text. I give tremendous thanks to Lee Ehrman, who reviewed the entire manuscript with a very sharp scientific and editorial eye, and to Kenneth Schaffner, who also conducted a thorough critique of the whole draft.

Members of the project's management team gave me valuable support through this long writing project: Audrey Chapman, Mark S. Frankel, Erik Parens, Nancy Press, and Elving. I also am grateful to designer Beth Elzer at AAAS; she did a fine job with an unwieldy set of computer files and an anxious writer. Kevin Alleman, Christine Bellordre, Bryn Lander, Clinton Musil, and Kathy Fishback, members of AAAS staff, also provided valuable assistance in the production of this volume.

Peter Wehrwein, a science writer and long-time friend, helped me many times with advice, telephone tutorials, and useful bits of information. Carolyn Reser helped me track down a most elusive fact — the name of the Ray Bradbury story mentioned in Chapter 3.

I relied on two textbooks as valuable references — Greg Carey's *Human Genetics for the Social Sciences* and *Behavioral Genetics* by Robert Plomin *et al.* I also am beholden to the many genetics glossaries on the web – especially to the "gene definitions" and the "SNPs and other genetic variations" glossaries at the website of the Cambridge Healthtech Institute. Finally, I must acknowledge my huge debt to Google.com, which helped me track down in an instant relevant articles, loose facts, bibliographic details, and definitions.

Although many people have guided me on this project, I assume all responsibility for errors and out-of-date information, and for any sections in which I failed to make things clear.

Catherine Baker
September 2003, Bethesda, Maryland