Advances in Behavior Genetics

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Behavior Genetics of Cognition Across the Lifespan

Springer

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ISBN 978-1-4614-7446-3 ISBN 978-1-4614-7447-0 (eBook)
DOI 10.1007/978-1-4614-7447-0
Springer New York Dordrecht Heidelberg London

Library of Congress Control Number: 2013943279

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Printed on acid-free paper

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Preface

Along with psychopathology, cognition has been one of the primary phenotypic focal points of the field of behavior genetics since its inception (Plomin et al. 2012). Darwin (1871) discussed commonalities between the mental powers of humans and other animals, implying a genetic basis to cognitive function. Francis Galton's 1869 examination of eminent families in Britain was one of the earliest attempts to investigate whether cognitive achievements run in families. As definitions and assessments of intelligence were developed and refined over the following decades (for a review see Chap. 1), behavior genetic investigation of intelligence experienced parallel increases in sophistication. In 1963, Erlenmeyer-Kimling and Jarvik summarized results from the first 50 years of modern behavioral genetic research on intelligence and concluded that the pattern of correlations among pairs of varying types of genetic relatedness "closely approaches the theoretical value predicted on the basis of genetic relationship alone" (p. 1477). They were careful to conclude that although genetic factors may play a large role in potential intellectual achievement, environmental factors will contribute to ultimate cognitive performance. Reactions to strong consistent evidence for genetic influences on intellectual ability prompted many behavioral geneticists to painstakingly explain the concept of heritability. Edited volumes on heredity, environment, and intelligence from that era focused on the perceived incongruity between behavioral genetic and socialization theories of intelligence and the correct interpretation of heritability (Ljungman 1975; Vandenburg 1968; Vernon 1979). In the meantime, behavioral genetic studies continued to accumulate data and refine their approaches to the issue.

Only 20 years after Erlenmeyer-Kimling and Jarvik (1963), a meta-analysis of familial studies of intelligence included twice as many studies (111 vs. 52) and four times as many correlational pairings (113,942 vs. more than 30,000; Bouchard and McGue 1981). Similar to the earlier review, the authors concluded that the pattern of correlations was remarkably consistent with polygenic theory, but did not discount the importance of environmental factors. Ten years later the results were verified using structural equation modeling, allowing the direct estimation of significant nonadditive as well as additive genetic variance (Chipuer et al. 1990). The development of molecular genetic methodologies over the last 20 years have allowed the field to move beyond anonymous genetic variance to the attempt to

identify specific genes or gene loci that contribute to intellectual functioning. A recent genome-wide association study agreed with previous conclusions that genetic variation makes a significant contribution to intellectual performance (Davies et al. 2011). The results are consistent with the accumulated impact of many small genes having small effects on cognitive function.

Parallel with these advances, behavioral geneticists were still arguing that "developmental psychologists should find room for behavioral genetics" as recently as 1994 (McGue 1994). Two volumes edited by Grigorenko and Sternberg in the late 1990s represent the accumulated state of knowledge at that time (Grigorenko and Sternberg 1997; Sternberg and Grigorenko 2001). The volumes can be considered a matched set, with one focusing on the impact of family environment on intelligence while acknowledge the role of genetics (Grigorenko and Sternberg 2001) and the other attempting to establish that the field has moved beyond the overly simplistic nature vs. nurture controversy with regard to intellectual functioning (Sternberg and Grigorenko 1997). Scarr (1997) wrote of reconciliation between behavioral genetic and socialization theories; but, in the same volume Bidell and Fischer (1997) argued that the basic techniques of behavioral genetics are flawed. Hunt (1997) declared that he did not want to hear the phrase "nature vs. nurture controversy" ever again, while proposing that the argument was more properly political rather than scientific.

Science moves swiftly and we believe that the 15 years intervening since the Sternberg and Grigorenko (1997) volume has brought many changes, both in the field of behavioral genetics of cognition and in its acceptance by scientists generally. In his chapter discussing unresolved questions in the behavioral genetics of intelligence at that time, Waldman (1997) listed: (a) developmental behavioral genetics, (b) gene by environment interaction and correlation, (c) behavior genetics as a tool for examining the construct validity of intelligence, and (d) behavior genetics as a tool for examining causal influences on intelligence. Significant advances in the last decade on all four fronts merit collection in a new volume dedicated to summarizing the current state of the art in behavioral genetic investigations of cognition across the lifespan. Two of the most significant advances in the field guide the structure of the current volume. First, developmental behavioral genetics forms the basic structure of the book, which is divided into sections on childhood and adolescence, middle adulthood, and aging. Recent advances in both collection and statistical modeling of twin data, particularly longitudinal twin data, make this an especially advantageous moment to produce a work that presents a collection of the groundbreaking research on cognitive abilities across the lifespan. Second, two chapters focus specifically on investigations of gene by environment interplay in childhood (Chap. 2) and adulthood (Chap. 6). Increasing sophistication in statistical modeling and molecular genetic methods combine to allow for nuanced investigations of gene by environment correlation and interaction.

The current volume is presented as a survey of the current research in the field of behavior genetics of cognition. This volume presents an overview of the current state of quantitative and molecular genetic investigations into the many facets of cognitive performance and functioning across the lifespan. In the past, it may have been easier to identify distinct fields of study or approaches within behavioral

genetics. Now, borders are more fluid and researchers are working together across boundaries. To divide the topic of behavior genetics of cognition across the lifespan into individual chapters is fundamentally arbitrary and the chapters collected here will overlap to some extent. As these chapters were prepared, it became clear that even defining the end of childhood and the beginning of adulthood—or the boundary between middle adulthood and aging—was not straightforward. Similarly, dividing discussions of aging into normative, nonnormative, gene by environment interplay, and even brain morphology does not accurately capture the cross-pollination that exists in these fields today. Our goal is to ensure that each chapter can both stand alone and work with the other chapters to present the field as the integrated whole it is becoming.

Part I focuses on childhood and Chap. 1 by Wadsworth, Corley, and DeFries provides a summary of the history of conceptions of intelligence, an introduction to behavioral genetic methods of investigation, and a discussion of behavior genetic and molecular genetic investigations of normative intellectual development in childhood. Chapter 2, by Turkheimer and Horn, reviews the evidence that heritability of intelligence in childhood is moderated by parental socioeconomic status. In Chap. 3, Carlier and Roubertoux summarize the current state of the field in understanding genetic influences on atypical intellectual development in childhood.

In Part II, the emphasis is on adulthood, including both middle-adulthood and aging. Midlife has long been perceived as a period of "latency" in which functioning is maintained before the transition to aging, per se. As Kremen, Moore, Franz, Pannizon, and Lyons demonstrate in Chap. 4, researchers are beginning to focus their attention on midlife as a potential source of subsequent changes in intellectual functioning and changes in genetic and environmental influences on functioning. With the aging of the baby-boomer generation, genetic and environmental influences on cognitive aging have drawn increasing interest over the last two decades and multiple recent reviews exist (Finkel and Reynolds 2009, 2010; McGue and Johnson 2008). In Chap. 5, Johnson, McGue, and Deary focus on overarching trends in behavior genetics of cognitive aging and recent molecular genetic advances. The focus of Chap. 6 by Reynolds, Finkel, and Zavala is gene by environment interplay in normative cognitive aging. Chapter 7 by Gatz, Jang, Karlsson, and Pedersen summarizes the current state of the art in behavioral and molecular genetic investigations of dementia.

Part III focuses on the contributions made by advances in biological and neurobiological approaches to our understanding of the nature of cognition and genetic and environmental influences on cognitive functioning. In Chap. 8, Chavarría-Siles, Fernández, and Posthuma review the impact that recently developed neuroimaging techniques has on our knowledge of brain morphology and function, and subsequent advances in our understanding of genetic and environmental influences on biological underpinnings of cognitive function. The longitudinal perspective of this volume is evident in the advances in animal models of cognition and cognitive aging reviewed by Galsworthy, Arden, and Chabris in Chap. 9.

Finally, in Chap. 10 we try to build on and respond to Waldman's (1997) stellar discussion of the unresolved issues and future directions in behavior genetic studies

of cognition across the lifespan. We identify the issues raised by Waldman that are still in need of attention or resolution and identify new directions that we feel the field is prepared to explore.

The editors would like to thank the following for serving as reviewers of chapters in this volume: Kaare Christensen, Gene Fisch, Boo Johansson, Wendy Johnson, William Kremen, Matthew Panizzon, Stephen Petrill, Sally Wadsworth, and Irwin Waldman.

References

Bidell, T. R., & Fischer, K. W. (1997). Between nature and nurture: The role of human agency in the epigenesist of intelligence. In R. J. Sternberg & E. Grigorenko (Eds.), *Intelligence, heredity, and environment* (pp. 193–242). Cambridge: Cambridge University Press.

Bouchard, T. J., & McGue, M. (1981). Familial studies of intelligence: A review. *Science, 212,* 1055–1059.

Chipuer, H. M., Rovine, M. J., & Plomin, R. (1990). LISREL modeling: Genetic and environmental influences on IQ revisited. *Intelligence, 14*(1), 11–29.

Darwin, C. (1871). *The descent of man, and selection in relation to sex* (1st ed.). London: John Murray.

Davies, G., Tenesa, A., Payton, A., Yang, J., Harris, S. E., et al. (2011). Genome-wide association studies establish that human intelligence in highly heritable and polygenic. *Molecular Psychiatry, 16*(10), 1–10.

Erlenmeyer-Kimling, L., & Jarvik, L. F. (1963). Genetics and intelligence: A review. *Science, 142,* 1477–1479.

Finkel, D., & Reynolds, C. A. (2009). Behavioral genetic investigations of cognitive aging. In Y.-K. Kim (Ed.), *Handbook of behavior genetics* (pp. 101–112). New York: Springer.

Finkel, D., & Reynolds, C. A. (2010). Cognitive and physical aging pathways: Contributions from behavioral genetics. In J. C. Cavanaugh & C. K. Cavanaugh (Eds.), *Aging in America: Volume 2: Physical and mental health* (pp. 26–56). Denver: Praeger Publishing.

Galton, F. (1869). *Hereditary genius: An inquiry into its laws and consequences*. London: Macmillan.

Grigorenko, E., & Sternberg, R. J. (Eds.). (2001) *Family environment and intellectual functioning: A life-span perspective*. Mahwah: Lawrence Erlbaum Associates.

Hunt, E. (1997). Nature vs. nurture: The feeling of *vujà dé*. In R. J. Sternberg & E. Grigorenko (Eds.), *Intelligence, heredity, and environment* (pp. 531–551). Cambridge: Cambridge University Press.

Ljungman, C. G. (1975). *What is IQ? Intelligence, heredity, and environment*. London: Gordon Cremonesi.

McGue, M. (1994). Why developmental psychology should find room for behavioral genetics. In C. E. Nelson (Ed.), *Threats to optimal development: integrating biological, psychological, and social risk factors* (pp. 105–149). Hillsdale: Lawrence Erlbaum Associates.

McGue, M., & Johnson, W. (2008). Genetics of cognitive aging. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (3rd ed., pp. 55–96). New York: Psychology Press.

Plomin, R., DeFries, J. C., Knopik, V., & Neiderheiser, J. (2012). *Behavioral genetics* (6th ed.). New York: Worth.

Scarr, S. (1997). Behavior-genetic and socialization theories of intelligence: Truce and reconciliation. In R. J. Sternberg & E. Grigorenko (Eds.), *Intelligence, heredity, and environment* (pp. 3–41). Cambridge: Cambridge University Press.

Sternberg, R. J., & Grigorenko, E. (Eds.) (1997). *Intelligence, heredity, and environment*. Cambridge: Cambridge University Press.

Vandenberg, S. G. (1968). The nature and nurture of intelligence. In D. C. Glass (Ed.), *Biology and behavior: Genetics* (pp. 3–58). New York: Sage Foundation.

Vernon, P. E. (1979). *Intelligence: Heredity and environment*. New York: Freeman.

Waldman, I. D. (1997). Unresolved questions and future directions in behavior-genetic studies of intelligence. In R. J. Sternberg & E. Grigorenko (Eds.), *Intelligence, heredity, and environment* (pp. 552–570). Cambridge: Cambridge University Press.

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Behavior Genetics of Cognition Across the Lifespan
Finkel, D.; Reynolds, C.A. (Eds.)
2014, XV, 300 p., Hardcover
ISBN: 978-1-4614-7446-3