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Milestones in the History of Behavioral Genetics: Participant Observer

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Abstract: The history of Behavioral Genetics and (now) genomics, viewed in cross-section, is a kaleidoscopic pattern derived from the individual histories of the psychology of individual differences, plant, animal, and human genetics, biology, evolution, anthropology, demography, biometry, sociology, jurisprudence, and some of their neighboring disciplines. There will be positive correlations between any two renditions of the historian's task, but the idiosyncratic experiences of any two with the listed contributors to the pattern guarantees that the correlations may be modest, without invalidating either one.
Keywords: history of behaviour genetics; interdisciplinary science; individual contributions

Common Sense and Anecdotes

Anecdotal information that behaviors were to some extent heritable from parents to offspring very likely arose some 12,000 years ago with the self-selection of some wolves for "enjoying" human company and the subsequent human selection among their pups for traits of domesticity and obedience. Current dog breeds evolved from those early wolves into some 350 recognized breeds, the latter based on artificial selection for desired behavioral traits (hunting, retrieving, herding, pointing, children's' pets) as well as for morphological features (Brewer, Clark, & Phillips, 2001; Scott & Fuller, 1965; Jones, Chase, Martin, et al. 2008). With the later rise of agriculture to ensure a stable source of food less dependent on hunting and gathering for survival, other animals such as cattle and sheep were selected for their domesticity. The Greek philosophers commented on various features of temperament in humans based only on the familiality observed, assuming that familiality resulted from "breeding". By the time of Shakespeare, in *The Tempest*, we see him attributing unmodifiability to Caliban's personality, assuming a hereditary predisposition: Prospero asserts, "A devil, a born devil, on whose nature nurture can never stick, on whom my pains, humanely taken, all , all lost, quite lost" (4.1.187-190). The alliteration, later made famous by Sir Francis Galton, haunts us to this day, despite a wish it had remained only of interest in the world of drama.

Prelude to a Science of Behavioral Genetics

It is only in the middle of the 19th Century that we can observe a strong move toward a scientific approach to understanding man as an animal, an idea easily rejected then on the grounds of common sense and a faith in received religious wisdom. Charles Darwin's [1809—1882] leap toward understanding our species, its origins, and its variations, encapsulated in his books explicating evolutionary theory – *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (1859); *The Descent of Man, and Selection in Relation to Sex* (1871); *The Expression of the Emotions* in *Man and Animals* (1872) created a revolution that would endure. He encouraged, and was encouraged by, his first cousin Francis Galton [1822—1911] when it came to explaining man's behavioral characteristics and how to quantify them for further analysis; his books *Hereditary Genius: an Inquiry into its Laws and Consequences* (1869), *English Men of Science: their Nature and Nurture* (1874), and *Inquiry into Human Faculty and its Development* (1883) are also milestones in the history of behavioral genetics. Galton's curiosity and funded-by-himself tinkering also yielded early efforts to devise family, adoption, and twin methods, as well as such statistical tools as the correlation coefficient. He introduced the concept of eugenics before there were scientific facts to support its application; that did not dull his passion

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for promulgating the notions as a socio-political idea in scientific clothing (Lombardo, 1996). His ideas about twins could not be fully informed as he did not yet know about the distinction between identical twins and same-sex fraternal twins, i.e., their origins from one ovum fertilized by one sperm versus two ova fertilized by two different sperms. Nonetheless, his 1875 paper in *Fraser's Magazine*, "The history of twins as a criterion of the relative powers of nature and nurture" was a landmark deserving special mention for the wave of research it would launch in later years.

For better or worse both of these forerunners conducted their deepest thinking about "nature" without the benefit, or the burden, of a rudimentary knowledge of the actual mechanisms and laws of genetics as they had emerged from the botanical experiments of the Moravian monk Gregor Mendel [1822—1884] whose work was published in 1865. It would not be until 1900 that Mendelian genetics would be rediscovered independently in Holland (De Vries), Germany (Correns), and Austria (von Tschermak) and then promulgated efficiently by William Bateson [1861—1926] in England in 1902 and William Castle at Harvard in 1903. (For a personal illustration of the recency of the history of these areas, Castle became the Ph.D. advisor of Sheldon C. Reed [1910—2003] an early fruit fly behavioral geneticist and leader of huge pedigree studies of mental retardation (1965) and the psychoses (1973), who would later, 1957, become this author's Ph.D. advisor at the University of Minnesota.) In fact, the essential constructs required for advancing a science of behavioral genetics came a bit later.

The term for the field, "genetics", was only first coined by Bateson in 1906; the terms gene, genotype, and phenotype emerged from the writings of the Danish botanist Wilhelm Johannsen [1857—1927] between 1903 and 1905. An understanding of the distinction between genotype and phenotype is absolutely essential to progress in behavioral genetics; confounding the distinctions have muddled the field by those with a superficial understanding. One genotype can give rise to many different phenotypes, and, one phenotype (e.g., "mental retardation") can arise from many different genotypes. Another enormous contribution to our necessary understandings for progress in behavioral genetics, as well as genetics generally, was produced by H. Nilsson-Ehle, a Swedish plant breeder working with wheat, when he reconciled the conflict between explanations for discontinuous (mendelizing) versus continuous distributions of phenotypes with his theory of polygenic/multiple factor inheritance in 1908. East, at Harvard University, confirmed the results and theory in 1910 working with maize. A widely accepted resolution to the gap between the genetics behind qualitative and quantitative traits and diseases emerged from the mathematical approaches of R.A. Fisher (1918), J.B.S. Haldane (1924), and Sewall Wright (1932), with an accessible synthesis by K. Mather in 1949: there was no conflict at the level of the genome; in the basic research design, the independent variable was the genotype (1 locus with 2 alleles for qualitative traits, and >2 loci, each with 2 alleles for quantitative traits), and the dependent variable would always be the phenotype measured as present or absent for mendelizing traits, and on some scale for continuous traits.

In-depth histories of the two core disciplines of psychology and genetics will be of importance in nations building new libraries, as well as to novices seeking to improve their knowledge about behavioral genetics. E.G. Boring's (1950) history of experimental psychology is a standard, and treats individual differences as a nuisance. The heart of behavioral genetics focuses on individual differences, a topic first pursued in depth by the German psychologist William Stern [1871—1938] in his 1900 book. He explored differential psychology at many levels, gave us the concepts of mental age and IQ, and escaped from Nazi Germany in 1933 to spend his final five years as a professor at Duke University in North Carolina. Stern's approach was taken up by two American psychologists Anne Anastasi (1937, first edition) and Leona Tyler (1947 first edition), the latter trained at the graduate level at the University of Minnesota under the influences of R.M. Elliott and D.G. Paterson who had developed the assessments of abilities in men called up for service in World War I, under Robert Yerkes. The two undergraduate textbooks lead to the development of university courses across the USA and provided a rich soil to nurture the roots of what would formally become behavioral genetics. A basic, must-read resource on the history of genetics (plant, animal, and human) can be found in the short book by A.H. Sturtevant (1965), available at no cost at http://www.esp.org/books/

sturt/history/readbook.html. Sturtevant had helped to propel genetics forward as a laboratory-based science, using species of fruit flies as a tool (Morgan, Sturtevant, Muller & Bridges, 1915). An eye-witness account of the history of human genetics in the USA, one that values the role of behavioral genetics and is cautious and skeptical about the abuses committed in the past and possible in the future, can be in read Sheldon Reed's (1979) low-keyed memoir.

A balanced history and primer of behavioral genetics, per se, up to 1960, was provided by Gerald McClearn (1962) within a collection of histories of psychological topics for sophisticated students, edited by Leo Postman in Berkeley. Given the range of subject matter covered by a truly comprehensive and in-depth treatment of the human genome, from molecular to societal, it would take a multi-volume encyclopedia to do justice to our needs. One is now available (Cooper, 2003) and it did indeed take five volumes, 5,280 pages, and 1,047 peer-reviewed articles from 1,400 worldwide experts writing at different levels of difficulty. Eleven area editors, with the advice of 52 advisors around the world, solicited the one-thousand plus articles, and one of the 11 areas deemed important for the structure of the encyclopedia was behavioral and psychiatric genetics with this author serving in that role. Almost all the entries contained an historical perspective as a section of the individual articles.

Putting Behavior into Behavioral Genetics

E.C. Tolman (1924), the American learning theorist, initiated small scale studies of rats selected and then bred for their learning ability in one kind of maze. His early success at Berkeley in showing genetic control over learning ability encouraged him to encourage his student Robert C. Tryon [1901—1967] to expand and improve the research program over three decades in an elegant manner and to provide another milestone (1940). By the seventh generation of breeding brights with brights and dulls with dulls, as inferred from total errors in multiple runs, the two lines were quite separate with little overlap. Tryon's student Searle (1949) further refined the work by examining 30 features of learning, emotionality, and activity level, using nine different maze configurations; no general superiority or inferiority appeared across mazes, and he called for further research which was forthcoming to the present day of QTLs and SNPs (Plomin et al. 2008). Subsequent researchers were successful in selecting for other traits in flies, mice, and dogs such as emotionality, activity level, aggression, anxiety, and cognitive abilities, and, in the process, often obtaining evidence for genotype × environment interactions.

Demonstrations of both g × e and the plasticity/modifiability of the phenotype even when highly heritable appeared in the Canadian laboratories of D.O. Hebb (1949), another learning theorist. The experiment of Cooper and Zubek (1958) built on the availability of already bred maze dull and maze bright rats. The two strains were reared in three qualitatively different laboratory environments – enriched, natural (for a lab rat), and restricted. They were then tested in a Hebb-Williams maze, structured along the lines of a Stanford-Binet test for children with numerous items at various levels of difficulty to obtain a total score as a reliable indicator of each rat's cognitive ability. Under enriched conditions of stimulation during rearing, the brights made the fewest errors but so did the dulls, contravening their dull pedigrees. Under restricted rearing (not sensory deprivation), the dulls made the most errors but so did the brights, contravening their bright pedigrees. It was only under the standard rearing conditions for lab rats that the error scores diverged, and they did so as a function of the predictions from their two pedigrees. These results permit the deduction for the concept of reaction range of phenotypes (Gottesman, 1974), also known as norm of reaction (Dobzhansky) and as reaction surface by Turkheimer, Goldsmith, and Gottesman (1995). The results echo those with morphological features in the eyes of fruit flies as a function of their prenatal temperature exposure (Krafka, 1919), and with phenotypic variability in sizes of cloned plants as a function their elevations during their growth along the Sierra Nevada mountain range (Clausen, Keck, & Hiesey, 1940). All of these studies on the plasticity of phenotypes as a function of genes, environments, and their interactions should have demolished any enthusiasms for so-called genetic determinism.

Studies using twins as participants have provided the bulk of data in human behavioral genetics during the 20th century. Objective quantifiable data could be analyzed after 1924 when C. Merriman in the USA and H. Siemens in Germany independently provided the methods that Galton never reached. Adequate measurement tools for intelligence and personality were required for the twin strategy to generate useful information. Between 1905 and 1908 the French psychologists A. Binet and T. Simon constructed a test of cognitive abilities commissioned by the Paris school system that would identify those young children who would not benefit from the standard curriculum, slow learners; most of them would probably have been evaluated as mentally retarded by today's standards. Henry Goddard [1866—1957] quickly translated the test into English in 1908 for similar applications in the USA, highlighting the need for special education for many handicapped children. As a tool for research, the test required revisions, resulting in the well-known Stanford-Binet in 1916 by Lewis M. Terman [1877—1956], professor of psychology at Stanford University. That revision was revised again in 1937, after 11 years of research, with the assistance of Maude Merrill (James), a former student and child clinical psychologist.

With this brief history of an IQ test, the landmark work with 100 pairs of twins reared together (50 identical or MZ and 50 same-sex fraternal or DZ), and 19 pairs of MZ reared-apart from infancy, conducted by Newman, Freeman, and Holzinger (1937) can be summarized. The team not only used the Stanford revision of the Binet, an individually administered test, and a group test of intelligence, but also a wider battery to evaluate specific achievements, handwriting, early efforts to measure personality traits and emotions, and a host of physical measures to contrast with the psychological ones. Although the tests and samples have been refined over time, the overall results have stood the test of time and show that general statements about the relative importance of genetic vs. rearing variables are not warranted, each trait deserving its detailed story (cf. the story of mazes above in the work of Tryon and Searle with rats). Adoption designs complemented the information derived from twin and family studies of intelligence, bolstering support for an emphasis on genetic factors. Burks (1928), using the Stanford-Binet, compared the IQs of 214 children with their foster parents' mental ages. As controls, she examined the same variables for 105 children and their biological parents; the correlations for the control pairings gave the expected values near 0.50. The values were 0.20 in the experimental group. Using the formulas of Sewall Wright, her mentor, Burks calculated variance components of what we would now call heritability and found a value "from 75 or 80 per cent", with home environment accounting for "about 17 per cent of the variance in I.Q." Similar results were obtained by Leahy (1935) in a separate Minnesota study.

Psychopathologists have long been interested in whether the deviances they observed in their patients were the consequence of their "stars" (astrological fates) or themselves. The question about causality is more complex as we have seen so far for other behavioral characteristics, and it is now clear that provisions must be made for genetic factors, their epigenetic controlling factors leading to endophenotypes (Gottesman & Gould, 2003), environmental factors, stochastic factors, and various interactions (g × g as well as g × e), with an awareness of gender and developmental contributors. The earlier research in psychopathology was not so ambitious and was pleased to demonstrate an appreciable genetic component when it was evidence-based.

Kraepelin [1856—1926] was to psychopathology what Linnaeus had been to botany – a great categorizer seeking an optimal number of taxons each with their own core features. By 1896 he had separated dementia praecox (after 1911 it was called schizophrenia by E. Bleuler [1857—1939]) and its subtypes (hebephrenic, catatonic, and paranoid) from the other major cluster of mental suffering, manic-depressive insanity. He directly challenged the hypothesis that these psychoses resulted from the increases in urbanization in Europe with its psychological strains on youth. He conducted field studies in Singapore and Java [~ 1903] with their large populations of Malaysians, Chinese, and Javanese; the psychotic patients he observed (and the Japanese patients he heard described by local physicians) all resembled his own European patients quite closely in their onsets, symptoms, and course of illnesses. From such data Kraepelin concluded that the alleged causal factors he could exclude were race, diet, culture including child rearing practices, urbanization, and general circumstances of life. He and other central European psychiatrists of the day believed that dementia praecox was somehow inherited as some 50 to 70 percent of patients had a positive family history, looking at grandparents and closer relatives. Mendel's theories based on plants, mentioned earlier, were working their way into human diseases. In 1908 A.E. Garrod proposed that some inborn errors of metabolism could be accounted for by a Mendelian recessive gene locus model. Neither parent need be affected clinically with the disease, but each would transmit one of the 2 alleles/genes required; therefore 1 child in 4 would be homozygous and affected, 2 in 4 would be disease-free but heterozygous carriers, and 1 in 4 would be homozygous for the normal allele. The theory worked neatly when the enzyme abnormality could be detected at birth. It formed the basis for what would become the important area of biochemical genetics.

However, the possibilities of recessive loci accounting for psychiatric disorders were enthusiastically embraced even absent hard data. Kraepelin was an enthusiast, predisposed by his own data to look for genetic or organic causes. He hired another enthusiast, the Swiss psychiatrist Ernst Rüdin, to become the director of research as head of the Department for Genealogical-Demography in 1917 in Munich where he had been working for Kraepelin since 1906. Rüdin would develop the department into a world-wide center for psychiatric genetics research, attracting famous postdoctoral fellows, and eventually be tried as a war criminal by the Americans after World War II, for collaborating and catering to the needs of the Nazi party, including writing laws for the mandatory sterilization of the mentally ill. He was detained in various camps and prisons 1945-46, and was then found guilty at his denazification trial as a "lesser offender" –Level III, later plea bargained down to Level IV, "follower" (Gottesman & Bertelsen, 1996; Proctor, 1988; Weber, 2000). Encouraged by Kraepelin to explore the fit of a Mendelian recessive model to data on dementia praecox families, Rüdin produced the first large, scientifically sound study of the transmission of *schizophrenia.* In 701 sibships of schizophrenics with neither parent affected, he found a risk of 4.48%, rising to 8.6% with the inclusion of other psychotic-appearing siblings. These data eliminated a dominant gene model which would have required 1 parent to be affected, and it eliminated the expected recessive model, requiring some 25% of sibs to be affected. However, the data did fit with a hypothesis of 2 necessary recessive loci -- .25 × .25 = 6.25%-- and that was the first model put forward. That simple extension of mendelism prevailed along with a variation of a dominant gene model that allowed for "incomplete penetrance" for many years until both were gradually replaced by the multifactorial polygenic threshold model put forward with data by Gottesman and Shields in 1967.

Many (6) careful twin studies followed from 1928-1961, followed by another 8 with improved national sampling, accurate zygosity determination, blindfolded and structure-based diagnoses, often, case histories to back up the diagnoses. The results have converged with MZ probandwise concordance rates exceeding DZ rates by a ratio of 4:1, in accord with the rates in other family relationships, and with the results of numerous adoption studies (McGuffin, Owen, & Gottesman, 2004 [this volume along with Cooper's 2003 Encyclopedia may be consulted for historical background to other disorders including the dementing ones]). No well-documented twin studies of major psychoses have yet appeared from Asia or Southeast Asia, but they are awaited eagerly to examine for the possible effects on the preferred models of whatever may be unique about such cultures, geographies, and gene pools.

People, Politics, Organizations, and Documents

Behavioral and psychiatric genetics as we know these disciplines today was not launched until 1960 when John L. Fuller and William R. Thompson published their textbook, *Behavior Genetics,* by pulling together a seemingly disparate literature that spanned many different domains of knowledge: geotaxis in flies, experiments in agronomy, selection of dog breeds for their temperament, activity levels in mice, personality, intelligence, and mental disorders. They provided a framework with their concept of a gene-to-behavior pathway that should have served to prevent simplistic thinking about how genes actually produce variation in behaviors. A primordium of what would become an informed search for the role of genetic factors in psychopathology, de-nazified and eschewing genetic determinism was visible in the ashes of World War II at the First World Congress of Psychiatry in Pairs in 1950. At that event T. Sjögren of Sweden invited Fraser-Roberts, Penrose, and Slater (United Kingdom), Kallmann (USA), Essen-Möller, Ödegaard, and Strömgren (Scandinavia), and M. Bleuler (Switzerland) to outline a research agenda for their shared interests at the interface of mental disorders and the infancy of human genetics. German psychiatrists were excluded, but Essen-Möller, Kallmann, Strömgren, and Slater had all been postdoctoral fellows in Munich after Hitler had come to power; they had escaped much contact with Rüdin himself and had been mentored by Bruno Schulz who was a true scientist and had never joined the Nazi party. The group in Paris kept the science alive as prolific authors in their own countries but did not organize into any structure. In retrospect it is mildly amusing to read Sjögren's introductory remarks to the effect that the possibility of using fly and mouse generated ideas about multiple alleles, polygenic systems, and linkage in this field "still appears remote."

The first English language journal specializing in human genetics did not appear until 1949. It became the outlet for the American Society of Human Genetics, born in September 1949 with H. J. Muller as president and F. J. Kallmann on the board of directors (Reed, 1979). A professional association for behavioral genetics (all species) began to take form on March 30, 1970 at a small gathering in Urbana, Illinois hosted by Jerry Hirsch and Richard Rose of the University of Illinois and organized by Richard H. Osborne, editor of *Social Biology* (formerly *Eugenics Quarterly)* the journal of the American Eugenics Society (Osborn, 1974) (name changed shortly thereafter to Society for the Study of Social Biology). This author attended. About one year later in April the first meeting of the Behavior Genetics Association (BGA) was held in Storrs, Connecticut, hosted by Benson Ginsburg and R.H. Osborne. The first president elected was no less than Theodosius Dobzhansky; president-elect was John Fuller, Secretary, V. Elving Anderson, with executive board members Seymour Kessler and L. Erlenmeyer-Kimling. There was a strong consensus that we needed our own journal as so many papers submitted by members to other behavioral journals had been rejected, not on scientific grounds. The journal Behavior Genetics was launched at the University of Colorado in 1970 under the strong leadership of Steven G. Vandenberg (with a background in twin research) and John C. DeFries (with a background in quantitative agricultural genetics and mouse behavior). A boost to the field was provided by the United States Public Health Service providing the infrastructure via their funding for doctoral level specialty training and postdoctoral crossover training. Daniel G. Freedman (to study with Jan Böök in Uppsala, Sweden) and Irving I. Gottesman (to study with Eliot Slater and James Shields in London) were the first to be selected for foreign cross training in 1962. Ph.D. programs were initiated in the mid-1960s at Colorado, Minnesota, and Texas.

Another way to gain information about the history of behavioral genetics is to examine, using the internet (PubMed, PsychInfo, Google Scholar) the publications of those awarded the highest honor by the BGA by conferring upon their elders the T. Dobzhansky Award for Lifetime Achievement; their names are provided in Table 1.

Table 1. *Names of T. Dobzhansky awardees by year*

year	names	year	names
1977	Steven Vandenberg	1993	Peter Parsons
1978	Eliot Slater	1994	Aubrey Manning
1979	Ernst Caspari	1995	David Fulker
1980	Benson Ginsburg	1996	n.a.
1981	Sheldon Reed	1997	Ronald Johnson
1982	Gardner Lindzey	1998	Stephen Maxson
1983	Peter Broadhurst	1999	Lindon Eaves
1984	Leonard Heston	2000	Pierre Roubertoux
1985	L. Erlenmeyer-Kimling	2001	Thomas Bouchard
1986	Raymond Cattell	2002	Robert Plomin
1987	J.L. Fuller & J.P. Scott	2003	Norman Henderson
1988	Lee Ehrman	2004	Sandra Scarr
1989	Gerald McClearn	2005	Nicholas G. Martin
1990	Irving Gottesman	2006	Jerry Hirsch
1991	John Loehlin	2007	Richard Rose
1992	John DeFries	2008	John K. Hewitt

A number of noteworthy compilations of selected and difficult to find original research appeared in the 1960s, stimulated in part by the Fuller and Thompson (1960, 1978) textbook. This was much before there was such a thing as the internet and inexpensive computers for information retrieval. Unlike the recent past there was also a viable marketplace for such collections, now superseded by e-mail to authors, requesting a pdf. A few deserve mention here with brief notations:

- J. J. Jenkins & D.G. Paterson (Eds.) (1961). *Studies in Individual Differences — The Search for Intelligence.* A collection of 66 original papers that focus on individual differences in intelligence going back to Galton, Binet and Simon, World War I test uses, up to 1959. It includes original twin and adoption studies.
- E. L. Bliss (Ed.) (1962). *Roots of Behavior: Genetics, Instinct, and Socialization in Animal*

Behavior. A subset of papers resulting from a 4-part symposium presented at the December 1959 meeting of the American Association for the Advancement of Science [http://.jstor.org/stable/1756876] and focused on content in the subtitle of the book.

▪ S. G. Vandenberg (Ed.) (1965). *Methods and Goals in Human Behavior Genetics*. Proceedings of an advanced seminar including edited but pointed discussions of the papers of a meeting organized by Vandenberg in Louisville, Kentucky, with the advice of G. Lindzey and J.L. Fuller, and with a grant from NIMH.

▪ J. Hirsch (Ed.) (1967). *Behavior-Genetic Analysis*. A Janusian compilation of advanced papers looking forward and backward that "pushed the envelope"; contributions were presented in the summers of 1961 and 1962 at the Center for Advanced Study in the Behavioral Sciences, an endowed think tank adjoining Stanford University and now a part of the latter. The elite group of invitees, organized by Hirsch, Ginsburg, McClearn, and H.F. Hunt laid out a road map for the broader field of behavior genetics, having no idea that the next two decades would revolutionize the field beyond their fondest hopes (cf. Plomin, DeFries, Craig, & McGuffin, 2003; McGuffin, Owen, & Gottesman, 2004; Plomin et al., 2008).

▪ M. Manosevitz, G. Lindzey, & D. D. Thiessen (Eds.) (1969). *Behavioral Genetics: Methods and Research*. A collection of empirical papers in their original form covering many species and demonstrating the mushrooming growth since Fuller & Thompson and including many works that can now be called classics of their day.

Keeping up with the pace of discovery and empirical disconfirmations requires attention to free online sources on the internet. Classical full text papers in biometrical genetics, even going back to Fisher's 1918 paper that reconciled Mendelian and quantitative inheritance, can be found on the internet at a site constructed by Nicholas G. Martin of the Queensland Institute of Medical Research in Brisbane at http://genepi.qimr.edu.au/staff/classicpapers.html. Martin is also the editor of the heir to the journal founded in 1952 by Luigi Gedda in Rome –Acta Geneticae Medicae et Gemellologiae [1952-1998] that specialized in all aspects of twin research in all species. The successor is named Twin Research and Human Genetics.

Historical Wounds

Even a brief rendering of the historical milestones of behavioral genetics would be considered remiss were it to exclude certain dark topics that have sometimes embarrassed the field and have sometimes led to guilt by association. Among the topics that must be dealt with in passing and not swept under the rug are negative eugenics, racism, group differences, and the uses and abuses of the summary statistic named heritability. Sensible treatments of these sensitive topics can be found in contemporary, refereed texts with the proper caveats attached (Reed, 1979; Loehlin, Lindzey, & Spuhler, 1975; Carey, 2003; Dobzhansky, 1962; Vogel & Motulsky, 1997; Plomin et al. 2008). However, the topics are of such wide interest, with policy implications at many levels, that debate, pronouncements, and premature judgments flood the popular culture with varying degrees of solid information. The media search for shocking headlines, sometimes assisted by scientists who produce valid data but who are naïve about the uses to which they may be put by others with a political rather than a scientific agenda. Some of the most difficult debates to referee are those where experts in one area, not behavioral genetics, assert themselves as if their expertise were readily transferable to behavioral genetics. Such debates can sometimes be useful and promote mutual understanding, but they require informed arbitrators with good will on all sides (Parens, Chapman, & Press, 2006), able to tolerate a degree of compromise.

Quantification of findings in behavioral genetics often requires the use of the summary statistic "heritability." It should be considered like a double edged sword, unsafe in the hands of non-experts (even when they may have been trained to some degree in behavioral genetics). Mis-uses in the literature are easily found, but future errors can be avoided by expose to the explications by Carey (2003) or by Visscher, Hill, and Wray (2008).

An object lesson in the breadth and depth of controversy about whether data in this field, produced in the past by unscrupulous scientists, should be expurgated from the literature or not is provided by the example of the writings of Ernst Rüdin (see above). A free for all broke out in the journal *American Journal of Medical Genetics*

(Neuropsychiatric Genetics) in 1996 and 1997 in which this author was both referee and participant. Edith Zerbin-Rüdin, daughter of ER, and the American psychiatric geneticist Kenneth Kendler submitted abstracts in English of the major papers produced early in the 20th century and not readily accessible; the new work had been summarily rejected at another journal. The new editors believed that, with the proper safeguards of informed commentary about the historical context and legal outcome, publishing would be compatible with current standards of freedom of speech and scientific inquiry. The old papers were published with commentaries by the editors and another by a German historian of medicine and biographer of Rüdin, working in the archives of the latter's former Institute. Publication in 1996 unleashed a torrent of impassioned, collegial replies, 4 of which were published in 1997 together with a rejoinder from Kendler himself. History and its re-telling are not boring in this field. There is no space to delve into the equally fascinating and controversial stories connected to the writings of Arthur Jensen (1969) and Richard Herrnstein and Charles Murray (1994) dealing with race and social class, but the internet will bring you rapid bibliographies.

If any justification is required for including a paper on the history of behavioral genetics in this overview of the current status of data, theories, and methods, it may be found in the wisdom of this anonymous author:

History is prophecy, hope, and desire as much as it is retrospection.

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一个参与者眼中的行为遗传学史上的里程碑

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摘 要：行为遗传学的历史，从横切面看，就好似一个由心理学、遗传学、生物学、进化论、人类学、人口学、生物统计、社会学以及法哲学等学科组合成的万花筒。任何一对学科的演进都呈正相关。虽然任何一对学科都不至于相互否定，但是，他们各自独特的历史和人物，又使得每一对学科并不完全相似。

关键词：行为遗传学史；交叉学科；个人对学科的贡献

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