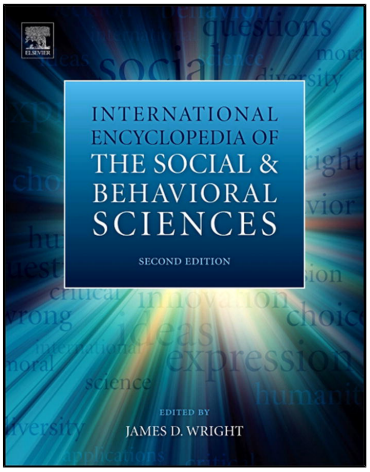

From Badcock, C.R., 2015. Nature-Nurture Controversy, History of. In: James D. Wright (editor-in-chief), International Encyclopedia of the Social & Behavioral Sciences, 2nd edition, Vol 16. Oxford: Elsevier. pp. 340–344.
ISBN: 9780080970868

Nature-Nurture Controversy, History of

Christopher R Badcock, London School of Economics, London, UK

Abstract

The nature/nurture distinction originated with Francis Galton, who was also the first to realize that twin studies could provide a crucial test of the contributions of each. Both behaviorists and social scientists made extreme claims for nurture during the twentieth century. In the Soviet Union Lysenkoism enshrined nurture over nature as a dogma of Marxist biology while in the West scientists who failed to subscribe to a less dogmatic equivalent were subject to campaigns of casuistic criticism and character assassination. Findings from experiments of nature such as feral children and attempted gender-assignment contrary to chromosomal sex, along with recent evidence from autism, Turner's syndrome, and the link between monoamine oxidase A and antisocial behavior suggest that Galton was substantially correct in thinking nature to be the dominant factor. But the recent discovery of epigenetic factors, which for example explain genetic differences between identical twins, suggests caution in accepting the traditional terms of the debate at face value.

Origins of Nature/Nurture: Francis Galton

Sir Francis Galton (1822–1911) introduced *nature* and *nurture* as understood with their modern connotations in his book of 1874, *English Men of Science: Their Nature and Nurture*. According to Galton,

> The phrase "nature and nurture"… separates under two distinct heads the innumerable elements of which personality is composed. Nature is all that a man brings with himself into the world; nurture is every influence from without that affects him after birth.

Galton was careful to add that "Neither of the terms implies any theory: natural gifts may or may not be hereditary; nurture does not especially consist of food, clothing, education or tradition, but it includes all these and similar influences whether known or unknown" (Galton, 1874: p. 12).

He went on: "It is needless to insist that neither is self-sufficient; the highest natural endowments may be starved by defective nurture, while carefulness of nurture can overcome the evil tendencies of an intrinsically bad physique, weak brain, or brutal disposition" (Galton, 1874: pp. 12–13). Galton concludes that "In the competition between nature and nurture, when the differences in either case do not exceed those which distinguish individuals of the same race living in the same country under no very exceptional conditions, nature certainly proves the stronger of the two" (Galton, 1874: p. 16).

Galton noticed that "There are twins of the same sex so alike in body and mind that not even their own mothers can distinguish them" (Galton, 1874: p. 13), and made a distinction between what we would now call identical, or monozygotic (MZ) twins (those which developed from a single fertilized egg cell) and fraternal, or dizygotic (DZ) twins (which develop from different eggs). Although Galton remarked that "It occurred to me that the after-history of those twins who had been closely alike as children, and were afterward parted… would supply much of what was wanted…" (Galton, 1869: pp. 294–295) he did not propose that the resemblance of MZ twins be compared to the resemblance of DZ pairs to assess genetic influence. Only much later in 1924, did Curtis Merriman in the USA and Hermann Siemens in Germany realize that MZ twins separated at birth provided what appeared to be an acid test of nature versus nurture because it was presumed that their common genetics held nature constant while their different environments varied the factor of nurture (Rende et al., 1990).

Making a Case for Nurture: Behaviorism

Galton was candid enough to admit "that my evidence may seem to prove too much, and be discredited on that account, as it appears contrary to all experience that nurture should go for so little" (Galton, 1874: p. 16).

The behaviorist John Broadus Watson (1878–1958) famously claimed that: "we no longer believe in inherited capacities, talent, temperament, mental constitution, and characteristics. Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select – doctor, lawyer, merchant-chief and yes, even beggar-man and thief, regardless of the talents, penchants, tendencies, abilities, vocations and race of his ancestors." He admitted that "I am going beyond my facts and I admit it," but added, "so have the advocates of the contrary and they have been doing it for many thousands of years" (Watson, 1930: p. 82).

Experiments by John Garcia showed that rats could be conditioned to associate the size of a food item with an electric shock, but that rats cannot be conditioned to associate a shock with the taste of food. Again, when paired with X-rays causing illness 1 h later, rats learn to associate the taste of food with illness, but cannot learn to associate the size of food items with illness caused in the same way. Clearly, insects with stings and poisoned baits that rats naturally encounter in their habitat might account for why the animals associate size with shocks, and taste with poisoning. But taste would seldom if ever be naturally associated with an instantaneous insult, and the size of a food item is no clue to its toxicity. In a similar way, pigeons

International Encyclopedia of the Social & Behavioral Sciences, Second Edition, 2015, 340–344

cannot be conditioned to associate odor or sound with food, but will readily associate its appearance. And even though pigeons quickly learn to peck an illuminated key before food is delivered because pecking is a natural food-finding activity, attempts to condition them not to peck the key by making pecking it prevent the food reward have no effect. On the contrary, once established, pecking persists, even if the pigeon starves to death as a result (Garcia, 1981, 1990).

In short, there are definite limits to conditioning, even in the case of classic laboratory animals such as rats and pigeons, and it would be astonishing if the same were not even more true of human beings.

The Cultural Claims for Nurture

Parallel claims to those of behaviorists for the overriding importance of nurture over nature were made by numerous social science writers, notably Franz Boas (1858–1942) and his colleague, Alfred Louis Kroeber (1876–1960). But these claims remained mere assertions until Boas's student, Margaret Mead (1910–78) wrote *Coming of Age in Samoa*, which purported to provide ethnographic proof that nurture was indeed the dominant factor – at least in Samoa (Mead, 1928).

However, the anthropologist, Derek Freeman, followed in her footsteps in the 1960s, and published a series of books suggesting otherwise. For example, Mead claimed Samoans were "one of the most amiable, least contentious, and most peaceful peoples in the world" but Freeman reports that serious assault in mid-1960s Western Samoa was 67% higher than in the USA, 494% higher than in Australia, and 847% higher than in New Zealand, while common assault was 500% that of the USA. In Samoa according to Mead "love between the sexes is a light and pleasant dance," male sexuality "is never defined as aggressiveness that must be curbed," adding that "the idea of forceful rape… is completely foreign to the Samoan mind." But Freeman reports that rape convictions in Samoa of the 1960s were twice the level of those in the USA and 20 times those of the UK. At the time Mead was in Samoa, rape was the third-most common criminal offense. Whereas Mead claimed that young girls had "as many years of casual love-making as possible" before marriage, there was in fact a cult of virginity; and contrary to her portrayal of it, the pattern of adolescent crime was much the same as anywhere else. Eventually, Freeman obtained a confession from one of Mead's informants and concluded that Margaret Mead's credulity for nurture over nature had led to her being hoaxed by her Samoan informants (Freeman, 1983, 1998, 2000).

According to Judith Rich Harris, the usual view of cultural transmission – that the culture is passed down from the parents to the child – is inadequate and misleading. An example is language in the USA. The children of immigrants who speak English with a heavy accent end up speaking English with no foreign accent at all if they grow up in a neighborhood of native-born Americans. Harris thinks that other aspects of culture are transmitted in the same way as language. In developed societies the parents start the process at home, but whether children retain what they learned at home will depend on what they find outside. Indeed, she claims that there are many societies where the parents hardly talk to their babies at all, and the babies do not learn language until they graduate from their mother's arms into the local playgroup. They learn both the language and how to behave from the older children in such groups, making peers the most important factor in nurture (Harris, 1999).

Politics Against Nature: Lysenkoism in the USSR and Parallels in the West

Mead's close contemporary, Trofim Denisovitch Lysenko (1898–1976) was promoted through positive discrimination in favor of peasants by Marxist revolutionaries in the USSR, and ultimately became Stalin's biology czar. Lysenko took the nurture-not-nature ideology of official Marxism to bizarre and extreme lengths, claiming that crops could be 'educated' to grow in winter (so-called *vernalization*), and that such learning was heritable. Lysenko denounced Mendelian genetics as a 'capitalist' and 'clerical conspiracy,' and denied the existence of genes, hormones, and viruses. Lysenko also unconditionally accepted the inheritance of acquired characteristics, denounced natural selection as 'Darwin's greatest mistake,' claimed species could transform into one another without intermediate steps, and believed that fish in puddles arose from spontaneous generation (Medvedev, 1969)!

Astonishingly, Lysenkoism became the official genetic doctrine of the USSR until the mid-1970s, and after 1948, thousands of scientists were purged, tortured and murdered in detention, or died of starvation and exposure exiled in Siberia. The teaching of Mendelian genetics and criticism of Lysenko's environmentalist inheritance became a crime, and Soviet agriculture was forced to adopt Lysenko's methods, with disastrous consequences that contributed to widespread famines and food shortages (Gershenson, 1990; Medvedev, 1969).

But such proscription of genetics was not limited to the USSR: in a less official form it also affected the USA, as the extract from the following letter, signed by 50 scientists and published in *American Psychologist* in July 1972, eloquently attests. After citing "periods when scientific research or teaching was censured, punished, or suppressed for nonscientific reasons, usually for seeming to contradict some religious or political belief," and naming Galileo, Darwin, Einstein, and 'Mendelian biologists, in Stalin's Russia,' as cases, the letter continues to point out that

> Today, a similar suppression, censure, punishment, and defamation are being applied against scientists who emphasize the role of heredity in human behavior. Published positions are often misquoted and misrepresented; emotional appeals replace scientific reasoning; arguments are directed against the man rather than against the evidence… And a large number of scientists, who have studied the evidence and are persuaded of the great role played by heredity in human behavior, are silent… it is virtually heresy to express a hereditarian view, or to recommend further study of the biological bases of behavior. A kind of orthodox environmentalism dominates the liberal academy, and strongly inhibits teachers, researchers and scholars from turning to biological explanation or efforts.
>
> Page (1972)

Examples of the abuses mentioned in this quotation are character assassinations of leading researchers who continued the start made by Galton on testing intelligence and its links to heredity or to physical factors such as brain-size or race. In a press campaign reminiscent of those whipped up by Lysenko, the leading British researcher, Sir Cyril Burt (1883–1971) was accused of wholesale scientific fraud after a biographer had revealed some of complexities of Burt's character and sometimes unconventional working methods (Hearnshaw, 1979). But in 1989 and 1991, the psychologist Robert Joynson (Joynson, 1989) and the sociologist Ronald Fletcher (Fletcher, 1991) independently showed that the attack on Burt had no factual basis. On the contrary, Burt's claim that identical twins reared apart have IQs correlated at 0.77 has been vindicated by the Minnesota Twin Study, which found 0.78 (Rushton, 1994).

According to Stephen J. Gould in his influential book *The Mismeasure of Man*, Henry H. Goddard's (1866–1957) pioneering work on IQ in the USA was aimed at "preventing the immigration and propagation of morons." But Goddard's own conclusion was the opposite: he believed that immigrants' low IQ scores would rise in better social conditions in the USA and asserted that "we may be confident that their children will be of average intelligence and if rightly brought up will be good citizens…" Again, contrary to Gould's portrayal of the facts, Lewis Terman (1877–1956) reported high IQs of Jewish and oriental immigrants, and IQ testers such as Goddard and Terman did not advocate restrictions on US immigration like those of the 1924 act. In fact, Congress took little or no notice of IQ findings in framing the legislation, none of the major testers testified, and their publications were not cited in the legislative record. And although Gould claimed that Samuel G. Morton (1799–1851) "unconsciously" doctored cranial capacity measurements to endorse Caucasian "racial superiority," remeasurement by John S. Michael in 1988 found few errors – and those not in the direction asserted by Gould. Michael concluded that Morton's research "was conducted with integrity" and that Gould was "mistaken" (Rushton, 1997).

Test Cases: Sex Determination

The reports of Mead and others were often interpreted as evidence for nurture against nature, and another example might be the claims of John Money (1921–2006), a psychologist at Johns Hopkins University, who held that sex was socially determined in childhood and could be reassigned up to age three. He based these claims principally on the case of 'Brenda' Reimer, one of a normal pair of twin males who was castrated following a botched circumcision and reassigned female by Money in the 1960s – the first ever attempt to do so with an otherwise normal male. Indeed, the case became paradigmatic as an apparent proof of the power of nurture over nature until later revelations revealed an altogether different story of a conflicted child who refused to wear dresses from the start, rejected girls' toys, was described as "boyish" by teachers and who changed his official name to Bruce. Bruce Reimer revealed the coercive side of the nurture dogma when he described himself as a David versus the Goliath of the medical profession and society and eventually married, adopted children and worked in an all-male occupation until he committed suicide in 2004 following the break up of his marriage and suicide of his twin 2 years earlier (Colapinto, 2001).

In the medical literature as a whole "there is no known case where a 46 chromosome, XY male, unequivocally so at birth, has ever easily and fully accepted an imposed life as an androphilic female regardless of physical and medical intervention" (Diamond and Sigmundson, 2000). On the contrary, a study of 18 cases of pseudohermaphroditism due to 5-α-reductase deficit in the Dominican Republic raised as girls who underwent normal male puberty found that 15 made a full sex-role change and were living with women at the time of the study (Imperato-McGinley et al., 1979). Similar findings were reported regarding the same pseudohermaphroditic syndrome among the Simbari Anga of Papua New Guinea who had a radically different culture from that of the Dominican Republic: after male initiation rites prior to puberty the two sexes are kept rigorously separate, and ritualized oral sex occurs between men from puberty until premarital age (Imperato-McGinley et al., 1991; LeVay, 1993: p. 134).

Experiments of Nature: Feral Children

A natural nature/nurture experiment is presented by feral children who provide potential answers to the question of how a child would develop if not nurtured at all, or nurtured by animals, and a surprisingly large number of cases are known. A classic example is The Wild Boy of Aveyron, who was discovered aged 12, living in woods in the late 1700s and found to be mute – but not deaf. He was taught some sign language by a local doctor who was a follower of Rousseau and a believer in the power of nurture over nature, but never spoke or developed social skills or attachments despite the best efforts of his mentor (Losure, 2013).

A modern equivalent is provided by the case of Genie, who was kept chained to a stool in a darkened room in a suburb of Los Angeles for years. Thought to be six on discovery, she was found to be a 49 lb, 3′8″ teenager who was permanently bent over, unable to walk, incontinent, and unable to focus on distant objects. Genie was fostered with psychologists who were enthusiastic about her prospects of rehabilitation, but she never acquired any real language ability, despite their best efforts (Rymer, 1993). However, better results were obtained with Justin, a boy who was raised as a dog. Justin was left with his grandmother aged 2 months until she died 11 months later, and was then raised by her boyfriend along with his dogs in a kennel. Discovered at age five unable to walk or talk, he was fostered and made a remarkably rapid recovery, doing well at school and speaking normally (Perry and Szalavitz, 2006).

Of course, all such cases are anecdotal, but a larger sample was provided by 165 Romanian orphans who were brought to the UK in the 1980s. Most were under a year and had suffered extreme neglect in state orphanages, but by age four, most had recovered. Eleven older children showed signs of autism, but by age six most symptoms had ameliorated and their IQs increased by 20 points compared to an average increase of 7 points in the rest of the group (Frith, 2003: pp. 50–51).

The Lesson of Autism and Turner's Syndrome

Autism is another test case, since this early onset illness evidenced by deficits in social and mentalistic skills (often with severe withdrawal, language delay or complete mutism) was claimed to be caused by nurturing – or the lack of it – by "refrigerator mothers" (Bettelheim, 1967).

Today, however, autism is widely accepted to be a genetic – or at least epigenetic – disorder, and demonstrably runs in families, with high concordance in identical twins (Aitken, 2008). Nevertheless, and despite the fact that all autistic children show some kind of learning difficulties and that many are severely retarded, so-called *autistic savants* demonstrate remarkable abilities, invariably in mechanistic, computer-like skills, most notably and frequently calendar calculation, maths, and music (Treffert, 2000). To the extent that nurture equates to teaching, such cases show that although such children can learn and indeed perform remarkably, they do not do so in ways their parents or teachers wish, but quite independently, and to internal directions of their own: what you might call natural, rather than nurtured, talent (Badcock and Crespi, 2006).

Another crucial experiment of nature that argues the same case for the ability to be nurtured being determined by a child's nature is Turner's syndrome. Turner's affects 2–3 in 5000 births and some Turner's cases tend to be socially insensitive, easily upset, impulsive and difficult to control, with some diagnosed autistic. Turner's is caused by presence of a single X sex chromosome without the second X that would normally be found in a female or the Y that would be found in a male. A study by David Skuse and colleagues found that suffers whose X came from the mother were much more likely to show autism-like social deficits by comparison to those whose X came from the father (Skuse, 1999, 2000, 2002, 2007; Skuse et al., 1997). Given that family backgrounds of the sufferers were not otherwise much different, the finding argues the same conclusion as autism in general: *nurture via nature*, so to speak.

Monoamine Oxidase A and Antisocial Behavior

An even stronger case for the same conclusion comes from the Dunedin Multidisciplinary Health and Development Study which tracked 1037 children born in New Zealand in 1942 and assessed them at two-yearly intervals, with the original sample 96% intact 26 years later. The study notes that childhood maltreatment increases risk of later criminality by approximately 50%, and that the earlier it occurs, the more likely is it to have this effect. Nevertheless, most maltreated children do not become delinquents or criminals, but the reasons why are not known.

Monoamine oxidase A (MAOA) is an enzyme that degrades neurotransmitters such as serotonin, norepinephrine and dopamine. Disruption of the gene in mice increases concentration of these neurotransmitters along with aggression. Evidence that this gene might be implicated in violent behavior in man was found in a Dutch family where eight male members who had been convicted of assault, incestuous rape, arson, and attempted homicide were found to lack MAOA entirely. Of 442 males in the Dunedin sample, 12% who both were maltreated and had low-activity MAOA accounted for 44% of all convictions for violence in the sample; 85% with low MAOA activity showed some antisocial behavior; 45% of those with high-activity MAOA and maltreatment showed antisocial behavior; and 25% of nonmaltreated were antisocial irrespective of MAOA expression. The authors conclude that

> Maltreated children with a genotype conferring high levels of MAOA expression were less likely to develop antisocial problems. These findings may partly explain why not all victims of maltreatment grow up to victimize others, and they provide epidemiological evidence that genotypes can moderate children's sensitivity to environmental insults.
>
> Caspi et al. (2002)

Conclusion: X-Linkage, Epigenetics, and the New View of Nature and Nurture

Duchenne muscular dystrophy is a classic X-linked recessive disorder that affects approximately 1 in 3500 males and results in muscle wastage, paraplegia, and eventual death. But cases are known in which one of a pair of MZ female twins has the disease, and the other has not. The reason is that because males have only a single X-chromosome, they are effectively homozygous for the disorder, while females, with two Xs, will usually be heterozygous, and protected by the non-Duchenne X. On average, half of the cells in a woman's body express one X, and the other half express the other. But because cell lineages inherit their pattern of X-inactivation from very early precursors during embryonic development, and because the splitting that can result in MZ twins occurs at much the same time, it is possible that one of a pair of such twins may predominantly express just one parental X and the other the other one, explaining the remarkable fact that such female twins can be discordant for this classic genetic disorder (Bainbridge, 2003: pp. 145–154).

There are at least 150 genes linked to intelligence on the X-chromosome, and verbal IQ is definitely known to be X-linked (Goodman and Anderton, 1997). A recent study found that compared to male, female identical twins vary more on measures of social behavior and verbal ability thanks to differential X-inactivation. As a consequence of this, the heritability of intelligence has probably been systematically underestimated (Loat et al., 2008). Indeed, the fact that males have only one X-chromosome to rely on – the one they got from their mother – almost certainly explains not simply why so many more males than females have IQs below 70, but also why 20% more males than females have IQs above 140. Greater variability is inevitable if only one X-chromosome is being expressed as compared with the two on which a woman can normally rely (Lehrke, 1997).

As a result of such findings as these, a recent study of DNA expression profiles in MZ and DZ twins pointed out that "molecular mechanisms of heritability may not be limited to DNA sequence differences." Indeed, the authors speculate that, because identical twins reared together or apart are generally quite similar on measures such as brain-imaging, IQ and other psychometrics, "epigenetic differences between identical twins – in other words, those affecting gene expression – are

much more important than environment" (Kaminsky et al., 2009). And of course, if this is true, it may well be true of many other factors that demonstrably run in families, show high twin concordances, but do not obey classical Mendelian rules of inheritance – most importantly perhaps, mental illnesses such as autism or schizophrenia, where Crespi and Badcock recently proposed a general theory in terms of such epigenetic mechanisms (Badcock and Crespi, 2008; Crespi and Badcock, 2008).

At the very least, these recent findings suggest that Galton – and indeed most other writers on the subject since – was wrong to think that effects of nurture could be assumed to explain any and all differences between MZ twins and that nature explained all the similarities. It now seems that variations in the expression of genes like those found in MZ female twins could also explain observed differences quite independent of any environmental or nurturing factor. Furthermore, the emergence of epigenetics and the discovery of a possible regulatory role for 80% of the nonprotein coding DNA which makes up 97% of the human genome suggests that on the nature side too there remains much to be learnt (Ecker et al., 2012). Indeed, it has been argued that the nature/nurture controversy is itself little more than a cultural expression of more profound genetic conflicts originating in the extreme asymmetry of parental investment in human beings (Badcock, 2000: pp. 262–268).

See also: Autism Spectrum Disorders; Epigenetic Inheritance; Epigenetics of Brain Plasticity and Behavior; Galton, Sir Francis (1822–1911); Psychology, History of (Early Period); Psychology, History of (Twentieth Century); Social Epigenetics; Twin Studies and Epigenetics; Twin Studies in Demography.

Bibliography

Aitken, K.J., 2008. Intersubjectivity, affective neuroscience, and the neurobiology of autistic spectrum disorders: a systematic review. Keio Journal of Medicine 57, 15–36.

Badcock, C.R., 2000. Evolutionary Psychology: A Critical Introduction. Polity Press, Cambridge.

Badcock, C.R., Crespi, B., 2006. Imbalanced genomic imprinting in brain development: an evolutionary basis for the etiology of autism. Journal of Evolutionary Biology 19, 1007–1032.

Badcock, C.R., Crespi, B., 2008. Battle of the sexes may set the brain. Nature 454, 1054–1055.

Bainbridge, D., 2003. The X in Sex: How the X Chromosome Controls Our Lives. Harvard University Press, London.

Bettelheim, B., 1967. The Empty Fortress: Infantile Autism and the Birth of the Self. Free Press, New York.

Caspi, A., Mcclay, J., Moffitt, T.E., Mill, J., Martin, J., Craig, I.W., Taylor, A., Poulton, R., 2002. Role of genotype in the cycle of violence in maltreated children. Science 297, 851–854.

Colapinto, J., 2001. As Nature Made Him: The Boy Who Was Raised as a Girl. Harper Perennial, New York and London.

Crespi, B., Badcock, C., 2008. Psychosis and autism as diametrical disorders of the social brain. Behavioral and Brain Sciences 31, 241–320.

Diamond, M., Sigmundson, H.K., 2000. Sex reassignment at birth. In: Ceci, S.J., Williams, W.M. (Eds.), The Nature-Nurture Debate: The Essential Readings. Blackwell, Oxford.

Ecker, J.R., Bickmore, W.A., Barroso, I., Pritchard, J.K., Gilad, Y., Segal, E., 2012. ENCODE explained. Nature 489, 52–55.

Fletcher, R., 1991. Science, Ideology and the Media: The Cyril Burt Scandal. Transaction Publishers, New Brunswick, USA.

Freeman, D., 1983. Margaret Mead and Samoa: The Making and Unmaking of an Anthropological Myth. Harvard University Press, Cambridge, MA.

Freeman, D., 1998. The Fateful Hoaxing of Margaret Mead: A Historical Analysis of Her Samoan Researches. Westview Press, Boulder, CO.

Freeman, D., 2000. Was margaret mead misled or did she mislead on Samoa? Current Anthropology 41, 609–622.

Frith, U., 2003. Autism: Explaining the Enigma. Oxford, Blackwell.

Galton, Sir F., 1869. Hereditary Genius: An Inquiry into its Laws and Consequences. Macmillan, London.

Galton, F., 1874. English Men of Science: Their Nature and Nurture. Macmillan, London.

Garcia, J., 1981. Tilting at the paper mills of academe. American Psychologist 36, 149–158.

Garcia, J., 1990. Learning without memory. Journal of Cognitive Neuroscience 2, 287–305.

Gershenson, S.M., 1990. The grim heritage of Lysenkoism: four personal accounts IV difficult years in Soviet genetics. Quarterly Review of Biology 65, 413–479.

Goodman, J.D.T., Anderton, R.B., 1997. X-linkage, lyonization and a female premium in the verbal IQ results of Orkney school children, 1947–1975. Journal of Biosocial Science 29, 63–72.

Harris, J.R., 1999. The Nurture Assumption: Why Children Turn Out the Way They Do. Free Press, New York.

Hearnshaw, L.S., 1979. Cyril Burt, Psychologist. Hodder and Stoughton, London.

Imperato-McGinley, J., Miller, M., Wilson, J.D., Peterson, R.E., Shackleton, C., Gajdusek, D.C., 1991. A cluster of male pseudohermaphrodites with 5α-reductase deficiency in Papua New Guinea. Clinical Endocrinology 34, 293–298.

Imperato-McGinley, J., Peterson, R., Gautier, T., Sturla, E., 1979. Androgens and the evolution of male-gender identity among male pseudohermaphrodites with a 5α-reductase deficiency. New England Journal of Medicine 300, 1233–1237.

Joynson, R.B., 1989. The Burt Affair. Routledge, New York.

Kaminsky, Z.A., Tang, T., Wang, S.-C., Ptak, C., Oh, G.H.T., Wong, A.H.C., Feldcamp, L.A., Virtanen, C., Halfvarson, J., Tysk, C., McRae, A.F., Visscher, P.M., Montgomery, G.W., Gottesman, I.I., Martin, N.G., Petronis, A., 2009. DNA methylation profiles in monozygotic and dizygotic twins. Nature Genetics 41 (2), 240–245. doi: http://www.nature.com/ng/journal/v41/n2/suppinfo/ng.286_S1.html http://dx.doi.org/10.1038/ng.286.

Lehrke, R., 1997. Sex Linkage of Intelligence: The X-factor. Praeger, Westport, CT and London.

LeVay, S., 1993. The Sexual Brain. The MIT Press, Cambridge, MA.

Loat, C.S., Haworth, C.M.A., Plomin, R., Craig, I.W., 2008. A model incorporating potential skewed X-inactivation in MZ girls suggests that X-linked QTLs exist for several social behaviours including autism spectrum disorder. Annals of Human Genetics. http://dx.doi.org/10.1111/j.1469-1809.2008.00470.x.

Losure, M., 2013. Wild Boy: The Real Life of the Savage of Aveyron. Candlewick Press, Somerville, MA.

Mead, M., 1928. Coming of Age in Samoa: A Psychological Study of Primitive Youth for Western Civilisation. Jonathan Cape, London.

Medvedev, Z.A., 1969. The Rise and Fall of T. D. Lysenko. Columbia University Press, New York.

Page, E.B., 1972. Behavior and heredity. American Psychologist 27, 660–661.

Perry, B., Szalavitz, M., 2006. The Boy Who Was Raised as a Dog: And Other Stories from a Child Psychiatrist's Notebook–What Traumatized Children Can Teach Us about Loss, Love, and Healing. Basic Books, New York.

Rende, R.D., Plomin, R., Vandenberg, S.G., 1990. Who discovered the twin method? Behavior Genetics 20, 277–285.

Rushton, J.P., 1994. Victim of scientific hoax. (Cyril Burt and the genetic IQ controversy). Society 31, 40–45.

Rushton, J.P., 1997. Race, intelligence and the brain: the errors and omissions of the 'revised' edition of S.J. Gould's *The Mismeasure of Man* (1996). Personality and Individual Differences 23, 169–180.

Rymer, R., 1993. Genie: A Scientific Tragedy. Harper Collins, New York.

Skuse, D., 1999. Genomic imprinting of the X chromosome: a novel mechanism for the evolution of sexual dimorphism. Journal of Laboratory and Clinical Medicine 133, 23–32.

Skuse, D., 2 May 2002. Why is autism a male disorder: is the answer in the amygdala? In: Behavioural and Brain Sciences Unit Seminars. The Institute of Child Health.

Skuse, D.H., 2000. Imprinting, the X-chromosome, and the male brain: explaining sex differences in the liability to autism. Pediatric Research 47, 9–16.

Skuse, D.H., 2007. Rethinking the nature of genetic vulnerability to autistic spectrum disorders. Trends in Genetics 23, 387–395.

Skuse, D.H., James, R.S., Bishop, D.V.M., Coppin, B., Dalton, P., Aamodtleeper, G., Bacaresehamilton, M., Creswell, C., Mcgurk, R., Jacobs, P.A., 1997. Evidence from Turner's syndrome of an imprinted X-linked locus affecting cognitive function. Nature 387, 705–708.

Treffert, D.A., 2000. Extraordinary People: Understanding Savant Syndrome. iUniverse.com, Lincoln, NE.

Watson, J., 1930. Behaviorism. University of Chicago Press, Chicago.