Rushton's contributions to the study of mental ability

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ABSTRACT

This essay describes Rushton's contribution to examining the nexus of intelligence, race, and genetics, specifically what I termed "Spearman's hypothesis". It states that Black–White differences are "most marked in just those [tests] which are known to be saturated with *g*". I (Jensen) had confirmed this hypothesis using large data sets in the 1970s and 1980s and also found that Black–White differences were most marked on the more heritable rather than the more cultural subtests. Rushton confirmed and extended these findings in many highly innovative ways and demonstrated Spearman's hypothesis applied among samples of Gypsy Roma in Serbia, and East Asian, European, South Asian, Colored and Black samples in South Africa. He has not only documented group differences in brain size, intelligence, life span, family structure, infant mortality, developmental precocity, personality, and temperament, and rates of two egg twinning, and crime among East Asians, Europeans, and Africans, but also provided a life history theory that explains them.

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1. Introduction

I first became acquainted with Phil Rushton in 1981 while he was on sabbatical at the University of California at Berkeley, where I had been a professor of education since 1964. When he came to see me in my office at the Institute of Human Learning, we hit it off immediately. Perhaps because I had done a post-doc with Hans Eysenck at the UK's Institute of Psychiatry in the University of London and Rushton had done his B.Sc. and Ph.D. at the University of London (although not with Eysenck), we shared the same approach to the study of individual differences. Often called the "London School," the trajectory went back through Hans Eysenck (1916–1997), Sir Cyril Burt (1883–1971), Charles Spearman (1863–1945) and Karl Pearson (1857–1936), all the way to Charles Darwin's (1809–1882) cousin, Sir Francis Galton (1822–1911), the founder of differential psychology (see Miele, 2002; Nyborg, 2003). These were the founding fathers of behavior genetics, statistical methods, and of my own present focus, mental chronometry [reaction time] (Jensen, 2006, 2011).

I was impressed not only by Rushton's intellect, but his intellectual boldness as well. There seemed to be no question in behavioral science, however vexing or controversial, that he was unwilling to ask me about and later tackle. And he did so with the three characteristics that our mutual inspiration, Galton, identified as the defining characteristics of genius—ability, zeal, and industry. Rushton would display these in full measure in the years that followed. However, he has done far more than simply accumulate inductive data. Accumulate he has, but he has also used the hypothetico-deductive method in making novel predictions to test hypotheses.

2. Spearman's hypothesis and the nature of g

I had demonstrated in my research of the 1970s that mean Black–White differences in IQ were more pronounced on the more heritable, less cultural subtests. For example, Jensen (1973) cited a study by Nichols (1972) which found a correlation of $r = .67$ ($p < .05$) between the heritabilities of 13 tests estimated from twins and the magnitude of the Black–White differences on the same tests. I further demonstrated an inverse relation of $r = -.70$ ($p < .01$) between the environmentality (the converse of heritability, that is, the percentage of variance that can be attributed to non-genetic factors) for 16 tests estimated from differences between siblings and the mean White–Black differences (Jensen, 1973).

Jensen (1998) also tested Spearman's hypothesis using 12 reaction time (RT) measures from 820 9- to 12-year-olds in California. Reaction time is one of the simplest and most culture free measures. Many RT tasks are so easy that 9- to 12-year-old children can perform them in <1 s. Yet even on these very simple tests, children with higher IQ scores do so faster than children with lower scores, and East Asian 9- to 12-year-olds are, on average, faster than Whites who are, again on average, faster than Blacks. Moreover, the differences between Blacks, Whites, and East Asians in average RTs are largely on the *g* factor, with the correlations between the *g* loadings and the mean group differences ranging from .70 to .81. Since school children are not trained on reaction time tasks, as they are on paper-and pencil tests, the advantage of those

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with higher IQ scores on RT tasks is unlikely to arise from practice, familiarity, education, or instruction. Moreover, although East Asians averaged faster (cognitive) *decision* times than Whites or Blacks, Blacks averaged faster (motoric) *movement* times than Whites or East Asians, thereby arguing against the hypothesis that the differences on these tests reflect any difference in motivation or attention. These results bear out Spearman's hypothesis even more strongly than do those from conventional psychometric tests. The hypothesis that the group difference on these tests reflects a difference in motivation is also disconfirmed by the fact East Asians typically averaged higher than Whites on the *g* factor extracted from their (faster) reaction times.

While carrying out these studies I developed what I termed the *method of correlated vectors* (MCV). It tests whether there is an association between a column of quantified elements (such as the *g* loadings for a set of tests) and a parallel column of any independently derived scores (such as pass rate differences between groups). This technique produced a large number of results which made it clear that Spearman's *g* is the "active ingredient" in IQ scores. A test's *g* loading is embedded to a greater or lesser extent in every question on a mental test and is the best predictor, not just of that test's correlation with scholastic and work-place performance, but a number of *biological* measures including: heritability coefficients determined from twin studies, inbreeding depression scores calculated in children of cousin marriages, brain evoked potentials, brain pH levels, brain glucose metabolism, as well as nerve conduction velocity, and reaction time measures. These correlations argue strongly for the heritable and biological as opposed to the mere statistical reality of *g* (Jensen, 1998).

Rushton (1998) was kind enough to suggest the term "Jensen Effect" be used whenever a significant correlation could be demonstrated between *g* factor loadings and any other variable. Such "Jensen Effects" are not omnipresent and their absence can be as informative as their presence. For example, the Flynn Effect (the secular rise in IQ) is *not* a Jensen Effect because it does not occur on *g* (Rushton & Jensen, 2010).

Rushton (1989) carried out a particularly innovative and revealing study using inbreeding depression scores on subtests of the Wechsler Intelligence Scale for Children (WISC) in place of the usual *g* loadings and found remarkable generalization across populations. The inbreeding depression scores had been calculated by geneticists for each of 11 subtests from a study of Japanese twins. Using the method of correlated vectors, Rushton found these predicted the magnitude of the Black–White differences on the same subtests in the US ($r = .48$; $p < .05$). Inbreeding depression is an established genetic phenomenon that occurs when people who are genetically related have children together thereby producing in their offspring, on average, a lower score on IQ (or any heritable measure), than would otherwise have been the case. This occurs because of any combination of deleterious genes from both sides of the family. Usually kept recessive, these now combine to produce a dominant allele and the consequent loss of about 5 IQ points in the offspring of cousins. There is no known non-genetic explanation for the phenomenon of inbreeding depression or why inbreeding depression scores in Japan should predict the magnitude of Black–White differences in the US.

Rushton also demonstrated Jensen Effects in Southern Africa for differences among South Asians (East Indians) and "Coloreds" (the term used to refer to the mixed-race population of South Africa) as well as for Whites and Blacks. In one study, Rushton (2001) reanalyzed data on 10 subtests of the WISC–R published by Skuy, Schutte, Fridjhon, and O'Carroll (2001) on 154 Black South African high school students. Rushton found the African–White differences were mainly on *g*. Rushton and Jensen (2003) compared data on the WISC–R from 204 African 12- to 14-year-olds from Zimbabwe published by Zindi (1994) with the US normative sample for

Whites and found 77% of the between-groups race variance was attributable to a single source, namely *g*.

Another contribution of Rushton's was to confirm Spearman's hypothesis in South Africa by using *item analyzes* of the Raven's Progressive Matrices. Since the Matrices are an excellent measure of *g*, it follows that each item's correlation with the test's total score provides a good estimate of that item's *g* loading. Using the method of correlated vectors, Rushton and Skuy (2000) examined 309 university students at the University of the Witwatersrand and found that the more an individual item from the Raven's measured *g* (estimated by its item–total correlation), the more it correlated with the differences in pass rates between Africans and Whites on the same items. In two studies of engineering students in South Africa, Rushton, Skuy, and Fridjhon (2002, 2003) found that the more the items from both the Standard and the Advanced Matrices loaded on *g*, the better they predicted the magnitude of the African–East Indian–White pass rate differences on the same items. The *g* loadings showed remarkable cross cultural generalizability. For example, those calculated for the East Indian sample predicted the African–White differences.

Rushton, Skuy, and Bons (2004) corroborated Spearman's Hypothesis on Black–White differences in South Africa using a multi-group confirmatory factor analysis (MGCFA). This was another important study because it established that finding "Jensen Effects" is not an artifact of using the method of correlated vectors. These results also refuted the related criticism that the Raven's Matrices do not have a high *g* loading among Africans.

A particularly bold study by Rushton calculated item heritabilities on 58 items from the Matrices from 152 pairs of twins from the Minnesota Study of Twins Reared Apart (MISTRA; Bouchard & McGue, 2003). These predicted differences in item pass rates among 11 diverse groups including the Roma Gypsies in Serbia, White Canadian and US twins, as well as East Asian, European, South Asian, Colored, and African university students in South Africa (overall mean $r = .40$, $p < .05$; Rushton, Bons, Vernon, & Čvorović, 2007). Most of the twins in this database had been separated early in life, reared in adoptive families, and reunited only in adulthood. The heritabilities were calculated in several ways, including using the correlation between the monozygotic twins reared apart. The results were corroborated using a variety of methods including creating parcels of items in order to provide a more reliable composite than any single item. As the heritability of the parcels increased, so did the magnitude of the group differences. Using the MISTRA sample, the items were sorted into 6 parcels of nine heritabilities and correlated with the parcels of pass rate differences between the Minnesota twins and all the other groups, including the Roma in Serbia, and the East Asian, European, South Asian, Colored, and Black university student differences in South Africa (mean $r = .74$; range = .55–.93; $p < .0001$).

Strong inference is possible: (1) genetic theory predicts a positive association between heritability and group differences; (2) culture theory predicts a positive association between environmentality and group differences; (3) nature + nurture models predict both genetic and environmental contributions to group differences; while (4) culture-only theories predict a zero relationship between heritability and group differences. These results provide strong and reliable corroboration of the hypothesis that the cause of group differences is the same as the cause of individual differences, that is, about 50% genetic and 50% environmental (Rushton & Jensen, 2005, 2010).

3. Brain size-IQ relations

Back at Berkeley in 1981 when Rushton and I first discussed the issue of brain size and evolution, very little was known about how it might bear on racial differences in IQ. There was at the time, a

controversial theory by the physical anthropologist Carlton S. Coon (1962) asserting that the major races differed in evolutionary age, supposedly having crossed what he termed the *Homo erectus-Homo sapiens* threshold at different points in evolutionary history. There were also said to be average differences in cranial capacity and brain weight, in relation to overall body size, among races, and even social classes. Although I raised these topics in an early review (Jensen, 1973), I mainly limited my considerations to the quantitative genetic and psychometric aspects of group differences. I hoped that in due course students of anthropology and related disciplines would bring their specialized knowledge, methods, and evidence to bear on the topics.

Rushton turned his eyes to looking for that evidence. In 1980 an autopsy study found a 100 g brain weight difference between Blacks and Whites in 1261 American adults aged 25–80 from Cleveland, Ohio, from which obviously damaged brains were excluded (Ho, Roessmann, Straumfjord, & Monroe, 1980). The 811 European Americans averaged 1323 g and the 450 African Americans, 1223 g. This 100 g difference remained significant after adjusting for age, stature, body weight, and body surface area. Reliable data on cranial capacity appeared shortly thereafter. It showed an East Asian advantage (Beals, Smith, & Dodd, 1984). This was a database of 20,000 skulls from 122 ethnic groups, which Beals et al. classified in terms of climate and geography. They found a 2.5 cm^3 increase in brain volume with each degree of latitude away from the equator. Skulls (sex-combined) from East Asia averaged 1415 cm^3; from Europe 1362 cm^3; and from Africa, 1268 cm^3.

Like me, Rushton considered brain size to be an especially important variable. People with larger brains have been demonstrated to average higher IQs than do those with smaller brains (Rushton & Jensen, 2005). Rushton reviewed this literature several times, most recently with his zoology colleague C. Davison Ankney (2009). Over two dozen studies with 700 participants had established a significant relation between brain size and IQ using magnetic resonance imaging (MRI) to measure brain volume. They found an overall correlation of 0.40 with IQ. This is a much higher correlation than the one of 0.20 typically obtained using external head size measures (such as head perimeter), although that correlation too is significant. The brain size-IQ relation has been found for people of all ages, both sexes, and diverse backgrounds, including African Americans. One reason put forth as to why larger brains are more intelligent is they contain more neurons and synapses making them more efficient at processing information.

Rushton also added to the primary literature on race differences in brain size by calculating cranial capacities from measures of external head size. He tracked down and analyzed several large anthropometric surveys which had been collated by NASA (of international air-force pilots), by the US Army (of 6325 military personnel), by the International Labor Office (of tens of thousands of workers in diverse countries), and by the US National Collaborative Perinatal Project (of 35,000 children followed from birth to 7 years). Rushton and Ankney (2009) also summarized the world literature on race differences in brain size for the three major methods (autopsies, endocranial volume, and head size measures). These averaged, in cubic centimeters: East Asians = 1364; Whites = 1347; and Blacks = 1267. Since one cubic inch of brain matter contains millions of brain cells and hundreds of millions of synapses or neural connections, Rushton argued that race differences in average brain size help to explain their differences in average IQ.

4. The *r–K* matrix of life-history traits

In reviewing my own work on educability and group differences, Rushton seized upon a footnote I had written that "the three racial groups lie on a developmental continuum on which the Caucasian group is more or less intermediate [to East Asians and Blacks]

(Jensen, 1973, p. 289)". He then accumulated and collated data for the three major races on numerous other categories of behavior beginning with Richard Lynn (1977, 1982) finding of a higher mean IQ in East Asian populations (IQ = 106, 110) than in White populations for whom the tests had been developed and whose culture it reflected (IQ = 100). This was true even though the socioeconomic conditions of the East Asian nations were lower than for the majority of White nations (at least at that time). These findings present serious difficulties for purely cultural (that is, completely non-genetic) explanations of the Black–White IQ gap. Since those early studies, Lynn and Vanhanen (2002, 2006) have greatly increased the evidence for higher IQs in East Asian countries (mean IQ = 106) and lower ones in sub-Saharan African countries (mean IQ = 70), with European countries intermediate (mean = 100).

Perhaps most innovative of all was Rushton's application of Wilson (1975) *r–K* life history theory to human race differences (Rushton, 1985). Rushton had amassed and organized data for about 60 biological and behavioral variables on the three major populations descended from East Asia, Europe, and Africa. In addition to brain size and IQ, the other variables included speed of maturation and longevity, personality and temperament, family stability and crime, and sexual behavior and fertility (see Table 1 in Nyborg, in this issue). Rushton proposed that all these traits covaried because they form part of a life history—a genetically organized suite of traits that evolved together to allocate developmental resources to the goals of survival, growth, and reproduction.

Rushton then applied this general biological theory to human group differences. He (1985, 1995) proposed that East Asians were more *K*-selected than Europeans who were more *K* selected than Africans.

Rushton has described *r–K* theory in terms of the origin of parental care. Parental care, he argued, can be scaled from, at one end, a "fast" life history (the *r*-strategy) in which eggs and sperm are produced and simply discharged into the water (for example, in oysters) to a "slow" life history (the *K*-strategy) in which an egg is not only laid in a nest and food and care provided for the young (as birds). In mammals, the combined demands of gestation, delivery, production of milk, and protecting and physically caring for the young reach a peak (see Fig. 1 in Nyborg, in this issue).

K-strategists, Rushton has argued, provide a lot of parental care. They have complex social systems and work together in getting food and providing shelter. *K*-strategists have more developed nervous systems and bigger brains but produce fewer eggs and sperm. The bigger an animal's brain, the longer it takes to reach sexual maturity and the fewer offspring it produces. Number of offspring, time between births, parental care, infant mortality, speed of maturity, life span, even social organization and altruism all fit together like pieces of a puzzle.

Rushton has shown that animal species that adopt the *K*-strategy, especially monkeys, apes, and humans, have large brains, are more intelligent, and live longer than *r*-strategists. *K*-strategists give their offspring a lot of care. They work together in getting food and shelter, help their kin, and have complex social systems. And that is why, according to Rushton, the *K*-strategists also need a more complex nervous system and a bigger brain.

One striking example Rushton has offered of race differences in *K*: around the world the rate of dizygotic (i.e., two-egg) twinning is <4 per 1000 births among East Asians, eight among Whites, and 16 or greater among Blacks (a finding we discussed in 1981). And importantly, the tendency to produce dizygotic twins is heritable and mediated by sex hormones. Another example: Black babies sit, crawl, walk, and put on their clothes earlier than Whites or East Asians. And again, these differences have been found to be heritable. For example, children of mixed Black–Japanese ancestry average a faster rate of skeletal development than do children of mixed Japanese–White ancestry, who average a faster rate of

Table 1
Average differences between Africans, Europeans, and East Asians.

	Africans	Europeans	East Asians
Brain size			
Mean across methods (cm³)	1267	1347	1364
Autopsy data (cm³ equivalents)	1223	1356	1351
Endocranial volume (cm³)	1268	1362	1415
External head measures (cm³)	1294	1329	1356
Cortical neurons (billions)	13,185	13,665	13,767
Intelligence			
IQ scores	70–85	100	105
Decision times	Slower	Intermediate	Faster
Cultural achievements	Lower	Higher	Higher
Muscular–skeletal traits			
Muscle attachment sites on crania	Largest	Intermediate	Smallest
Postorbital constriction and temporalis fossae (indentations in skull for jaw muscles)	Largest	Intermediate	Smallest
Facial prognathism (forward jutting jaw)	Most	Intermediate	Least
Number of teeth	32	30–32	28–30
Size of molars	Largest	Intermediate	Smallest
Bi-condylar breadth of mandible (widening of upper back-of-jaw for attachment to wider skull).	Least	Intermediate	Largest
Mass of nuchal muscles	Largest	Intermediate	Smallest
Femoral head size (where thighbone exits pelvis)	Smallest	Intermediate	Largest
Femoral shaft curvature index (from pelvis to knee)	76.6	97.0	102.2
Size of tibial plateau (knee platform giving balance for curved femur)	Smallest	Intermediate	Largest
Maturation rate			
Gestation time	Shorter	Longer	Longer
Skeletal development	Earlier	Intermediate	Later
Motor development	Earlier	Intermediate	Later
Dental development	Earlier	Intermediate	Later
Age of first intercourse	Earlier	Intermediate	Later
Age of first pregnancy	Earlier	Intermediate	Later
Life-span	Shortest	Intermediate	Longest
Personality			
Activity level	Higher	Intermediate	Lower
Aggressiveness	Higher	Intermediate	Lower
Cautiousness	Lower	Intermediate	Higher
Dominance	Higher	Intermediate	Lower
Impulsivity	Higher	Intermediate	Lower
Self-esteem	Higher	Intermediate	Lower
Sociability	Higher	Intermediate	Lower
Social organization			
Marital stability	Lower	Intermediate	Higher
Law abidingness	Lower	Intermediate	Higher
Mental health	Lower	Intermediate	Higher
Administrative capacity	Lower	Higher	Higher
Reproductive Effort			
Two-egg twinning (per 1000 births)	16	8	4
Hormone levels	Higher	Intermediate	Lower
Size of genitalia	Larger	Intermediate	Smaller
Secondary sex characteristics	Larger	Intermediate	Smaller
Intercourse frequencies	Higher	Intermediate	Lower
Permissive attitudes	Higher	Intermediate	Lower
Sexually transmitted diseases	Higher	Intermediate	Lower

skeletal development than do children with two Japanese parents. For walking, East Asians, 13 months; Whites, 12 months; Blacks, 11 months. Blacks also have an earlier age of sexual maturity than do Whites, who in turn have an earlier age than do East Asians, whether measured by age of first menstruation, first sexual experience, or first pregnancy.

5. Race differences and human origins research

The current consensus view of human origins, the "out-of-Africa" theory, posits that *Homo sapiens* arose in Africa about 150,000 years ago and then expanded northward beyond Africa about 100,000 years ago, with a European–East Asian split about 41,000 years ago. Rushton (1995) has made the case that evolu-

tionary selection pressures were different in the hot savanna, where Africans lived, than in the cold northern regions Europeans experienced, or the even colder Arctic regions where East Asians evolved. Thus, the further north the ancestral populations migrated out of Africa, the more they encountered the cognitively demanding problems of gathering and storing food, making clothes and shelters, and raising infants in winter environments.

Neural complexity and brain size have been increasing over the last 575 million years of evolutionary history in both vertebrates and invertebrates (Rushton & Ankney, 2009), which are related not only to increasing behavioral complexity (i.e., intelligence) but also, according to Rushton, to the *r–K* matrix of life-history traits, at least in mammals. As large brains evolved, they required more prolonged and complex life histories to sustain them. Large brains are also metabolically expensive, representing 2% of body
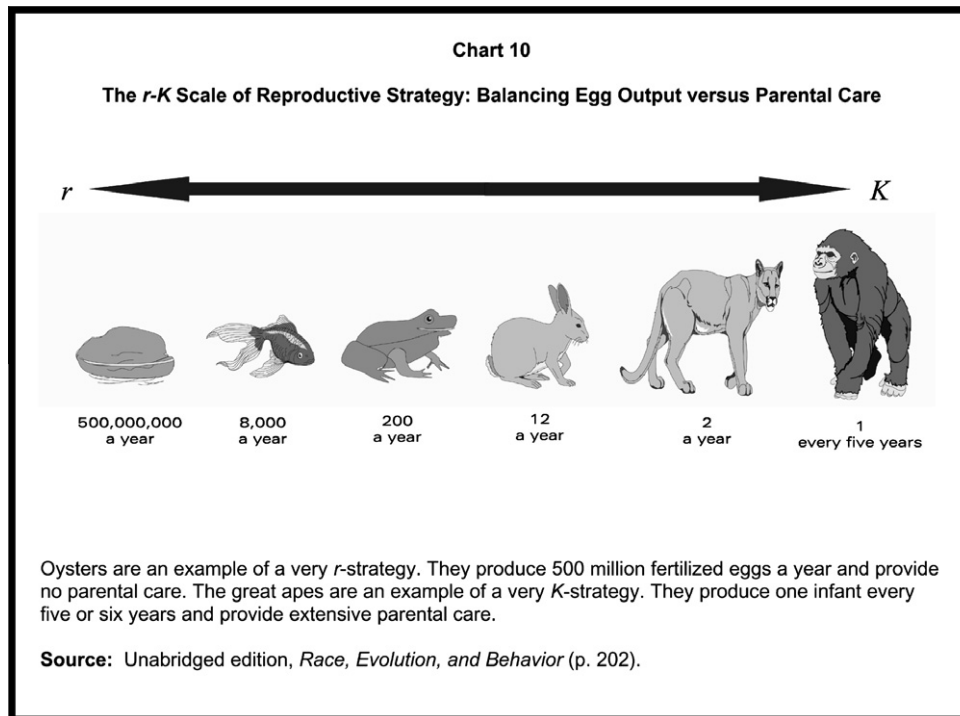
Fig. 1. The *r-K* scale of reproductive strategy.

mass but consuming 5% of basal metabolic rate in rats, cats, and dogs, 10% in rhesus monkeys and other primates, and 20% in humans.

One powerful way to test the validity of his extension of *r–K* theory is to examine, across a number of species, the variables hypothesized to covary. Rushton (2004) therefore examined the relation between brain size and life-history traits in 234 mammalian species. There was enormous variation among the species sampled. The low end of the size continuum included the Madagascar hedgehog (body length = 185 mm; brain mass = 2 g); at the high end was the African elephant (body length = 5,000 mm; brain mass = 4480 g). Sometimes, the data came from a single zoo specimen and at other times from a survey of a wild population. A principal components analysis across a single *r–K* life history factor had loadings such as: brain weight (0.85), longevity (0.91), gestation time (0.86), birth weight (0.62), litter size (0.54), age at first mating (0.73), duration of lactation (0.67), body weight (0.61), and body length (0.63). This, Rushton asserted, shows that having a *K* strategy is the keystone that explains a set of observed behaviors that rest upon it. In support of his position, he demonstrated that the factor loadings remained high even after body weight and length were statistically controlled. Neither did the results vary if a principal axis factor analysis was performed instead of a principal components factor analysis. So it is the *K* strategy, not body size, he concluded, that provides the prime mover.

6. Rushton and the galtonian tradition

Rushton's research conclusions have generated no small measure of controversy. Going back to Galton's three personality qualities of genius, however, he has shown even greater measures of intellect, zeal, and especially persistence in tackling the most controversial issues facing not only behavioral science but society as well.

Anthropologist Henry Harpending (1995), a member of the US National Academy of Science in reviewing Rushton's 1995 book, *Race, Evolution, and Behavior* in *Evolutionary Anthropology* wrote,

Rushton's Race, Evolution, and Behavior...is an attempt to understand [race] differences in terms of life-history evolution....Perhaps there ultimately will be some serious contribution from the traditional smoke-and-mirrors social science treatment of IQ, but for now Rushton's framework is essentially the only game in town.

Linda Gottfredson (1996), in her review in *Politics and the Life Sciences,* wrote:

....*Race, Evolution, and Behavior* confronts us as few books have with the dilemmas wrought in a democratic society by individual and group differences in key human traits.

"To these I can only add that Rushton's contributions to the sciences Galton initiated are truly worthy of their founder".

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