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AN EVOLUTIONARY THEORY OF HEALTH, LONGEVITY, AND PERSONALITY: SOCIOBIOLOGY AND r/K REPRODUCTIVE STRATEGIES[1]

J. PHILIPPE RUSHTON

University of Western Ontario

Summary.—Health, longevity and personality are placed within an evolutionary framework. Using symbols from population biology, species can be distinguished in terms of the reproductive strategies they adopt, which range from r, the production of large numbers of offspring provided with minimal care, to K, the production of few offspring nurtured intensively. Between-species comparisons demonstrate that these reproductive strategies correlate with a variety of life-history traits, including longevity. As a species humans are at the K end of the continuum. Some people, however, are proposed to be more K than others. If longer lives are part of a K reproductive strategy, then it follows that the healthier, longer lived, compared to the less healthy, shorter lived, should have a longer gestation period, a later age of menarche, a later age of first intercourse and pregnancy, a lower ovulation rate, a longer menstrual cycle, a lower sex drive, a lower frequency of copulation outside of bonded relationships, more stable bonding, a lower fecundity, fewer wasted pregnancies, fewer illegitimate children, a longer spacing of births, a lower incidence of multiple birthing, a smaller over-all family size, more intensive parental care, and a later menopause. Moreover, on average, K people are expected to be more energetically efficient, more geographically stable, more intelligent, more social-rule following, and more restrained in personality and temperament. Population differences are also hypothesized, such that, in terms of health, longevity and K: higher socioeconomic > lower socioeconomic; and Mongoloids > Caucasoids > Negroids.

> How odd it is that anyone should not see
> that all observations must be for or against
> some view if it is to be of any service!
> Charles Darwin
>
> There is nothing as practical as a good
> theory.
> Kurt Lewin

The importance of personality and individual differences in susceptibility and response to illness is being increasingly recognized. Eysenck (1985) has long hypothesized that those high in Neuroticism and low in Extraversion have a lowered incidence of certain diseases such as cancer, perhaps through having a particularly effective immune system. Kobassa (1979) has identified a dimension of "hardiness" comprising an internal locus of control, an intrinsic

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sense of self worth, and a strong commitment to work or family, to differentiate those who are resistant to environmental stressors from those who are not. More recently, Rodin (1986) has implicated the sense of control with good health in older age.

Many individual difference variables associated with health have been shown to be heritable. Genetic influences have been found for blood pressure (Sims, Hewitt, Kelly, Carroll, & Turner, 1986); obesity (Stunkard, Sorensen, Harris, Teasdale, Chakraborty, Schull, & Schulsinger, 1986); resting metabolic rate (Fontaine, Sarvard, Tremblay, Despres, Poehlman, & Bouchard, 1985); behavior patterns such as smoking, alcohol use, and physical exercise (Kaprio, Koskenvuo, & Sarna, 1981); personality traits such as extraversion and locus of control (Eysenck, 1985; Miller & Rose, 1982); susceptibility to infectious diseases (Gedda, Rajani, Brenci, Lun, Talone, & Oddi, 1984; Harsanyi & Hutton, 1981); from 30-50% of hospitalized illnesses in the pediatric age group, and up to 50% of hospitalized pediatric deaths (Scriver, 1981, 1984); the onset of degenerative diseases associated with aging (Omenn, 1977); and longevity itself (Carmelli & Andersen, 1981; Hrubec, Floderus-Myrhed, de Faire, & Sarna, 1984; Hrubec & Neal, 1981). With respect to longevity, Hrubec and colleagues calculated the risk of mortality of a twin if the cotwin is deceased for 3,573 military veterans in the United States, and 5,579 Swedes, and estimated the heritabilities to be between 0.4 and 0.6.

Explanations for individual variation in longevity can be offered at both proximate and ultimate levels of causation. Proximate levels emphasize the environmental and physiological mechanisms involved, such as rate-of-living, autoimmunity, and somatic mutation; ultimate explanations consider the evolutionary significance of phenomena in terms of reproductive fitness, such as prevailing schedules of survivorship and fertility (Wilson, 1975). In this paper both these types of explanation will be organized within a sociobiological framework. Specifically, human health and longevity are postulated to be components of a K, rather than an r, reproductive strategy and, as such, are expected to co-occur with a variegated complex of characteristics concerning life histories, social behavior, and physiological functioning (Rushton, 1985a; Wilson, 1975).

THE r/K CONTINUUM

The symbols r and K originate in the mathematics of population biology and refer to two ends of a continuum of reproductive strategies organisms can adopt ranging from extreme r, involving maximum egg output and no parental care, to extreme K, emphasizing elaborate parental care in which the birthrate is reduced to a minimum (Wilson, 1975). As can be seen in Fig. 1, oysters, producing 500 million eggs a year exemplify the r-strategy, while the great apes, producing only one infant every 5 or 6 yr., exemplify the K-strategy.

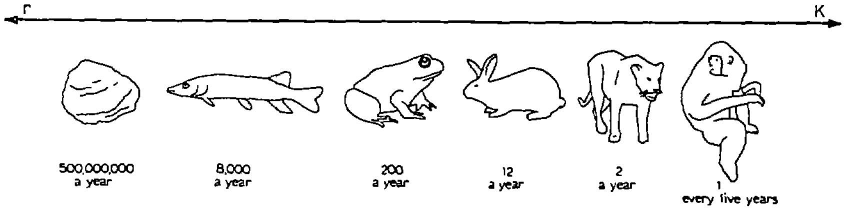

FIG. 1. The r/K continuum of reproductive strategies balancing egg output with parental care (After Johanson & Edey, 1981)

Evidence from both comparative studies and selective breeding experiments on species ranging from dandelions to fish to mice to men, indicate that reproductive strategies are correlated with other features of the organism's life history. Following Pianka (1970), Wilson (1975), Eisenberg (1981), and Barash (1982), these are summarized in Table 1. While each of the life-cycle traits might independently contribute to fitness, the important point is that they are expected to covary along a single axis both between and within species. Despite some anomalies, many evolutionary biologists, having con-

TABLE 1

SOME LIFE HISTORY, SOCIAL BEHAVIOR, AND PHYSIOLOGICAL DIFFERENCES BETWEEN r- AND K-STRATEGISTS (FOLLOWING PIANKA, 1970)

r-Strategist	K-Strategist
Family Characteristics	
Large Litter Size	Small Litter Size
Short Spacing Between Births	Long Spacing Between Births
Many Offspring	Few Offspring
High Rate of Infant Mortality	Low Rate of Infant Mortality
Low Degree of Parental Care	High Degree of Parental Care
Individual Characteristics	
Rapid Rate of Maturation	Slow Rate of Maturation
Early Sexual Reproduction	Delayed Sexual Reproduction
Short Life	Long Life
High Reproductive Effort	Low Reproductive Effort
Productive Energy Utilization	Efficient Energy Utilization
Low Intelligence	High Intelligence
Population Characteristics	
Opportunistic Exploiters of Environment	Consistent Exploiters of Environment
Dispersing Colonizers	Stable Occupiers of Habitat
Variable Population Size	Stable Population Size
Competition Variable, Often Lax	Competition Keen
Social System Characteristics	
Low Degree of Social Organization	High Degree of Social Organization
Low Amounts of Altruism	High Amounts of Altruism

sidered the literature, find the r/K continuum useful in organizing information on life histories (Barash, 1982; Daly & Wilson, 1983; Dawkins, 1982; Eisenberg, 1981; Wilson, 1975).

From Table 1, it can be seen that, in terms of *family characteristics*, r and K strategists differ in terms of litter size, birth spacing, total number of offspring, rate of infant mortality, and degree of parental care. In regard to *individual characteristics*, r and K strategists differ in rate of physical maturation, sexual precocity, life-span, body size, reproductive effort, energy use, and intelligence. Finally, in terms of *population and social system characteristics*, they differ in their treatment of the environment, tendency to disperse geographically, stability of population size, competitiveness, degree of social organization, and altruism.

Individuals and species are, of course, only relatively r and K. Thus rabbits are K-strategists compared to fish but r-strategists compared to humans. Primates are all relatively K-strategists, and humans are the most K of all. Indeed, as depicted in Fig. 2, the order primates display a natural scale going

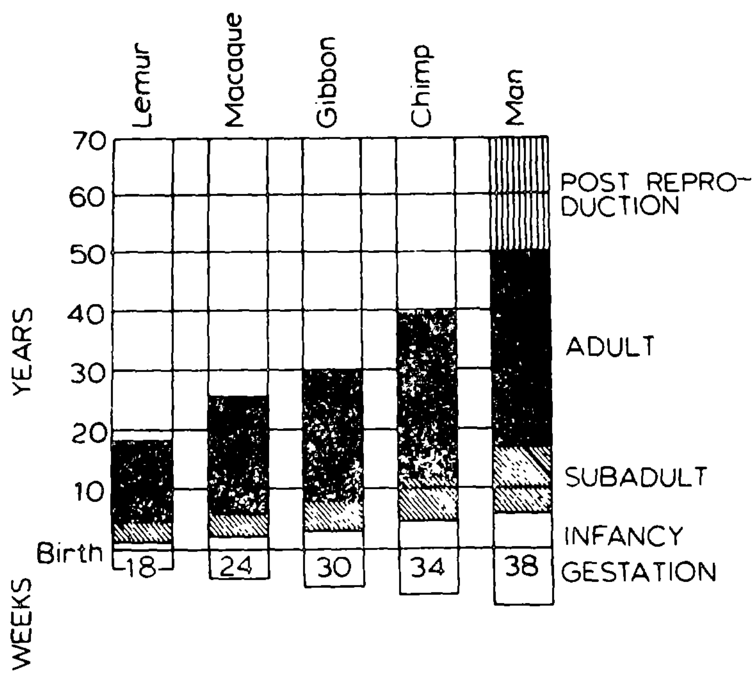

FIG. 2. Progressive prolongation of life phases and gestation in primates. [Source: From C. O. Lovejoy, The origin of man. *Science*, 1981, 211, 341-350. Copyright 1981 by the American Association for the Advancement of Science. Reprinted by permission.]

from lemur to macaque to gibbon to chimp to humans, in which there is a consistent trend toward K with progressive prolongation of gestation period and life phases (Lovejoy, 1981). Note the proportionality of the four indicated phases. The postreproductive phase is restricted to humans. With each step in the natural scale, populations devote a greater proportion of their reproductive energy to subadult care, with increased investment in the survival of offspring. As a species, humans are at the K end of the continuum. What is being proposed, however, is that some people are genetically more K than others, and that K-behavior is associated with a constellation of attributes, all deeply embedded in evolutionary history (Rushton, 1985a).

Individual Differences in K, Health and Longevity

From an evolutionary perspective, humans must stay healthy and live long enough to ensure the replication of their genes into future generations. According to Fig. 2, humans are the only primates with a postreproductive phase. One explanation for menopause is that since the human body becomes weaker with age, women eventually reach a point where continued child bearing would endanger their lives. While there is no equivalent pressure on men, sperm production does decline with age, and most older men would have difficulty attracting young females. Thus in the evolutionary past, older people aided copies of their genes better by caring for grandchildren than by producing additional offspring themselves. With increasing K, grandparents will have to live longer to be able to do this effectively since both their own offspring and their children's offspring will be delaying reproduction to later ages. Their genes therefore, will have been selected to dispose to good health, longevity, and the behavior traits associated with them such as intelligence, locus of control, and social and sexual restraint (Lovejoy, 1981; Rushton, 1985a; Scriver, 1981). These selection pressures would have applied less strongly to less K families where sexual maturation rates are faster, and there may be, in any case, less tendency to nurture intensively the more dispersing and numerous offspring through grandparenting.

Several falsifiable predictions derive from this analysis. Not only should good health be a generalized characteristic of an individual, but it, and longevity, should co-vary with the variegated complex of characteristics associated with the r/K dimension (Table 1). Shorter gestation times, faster rates of sexual maturation, larger family sizes with shorter spacings between births, less stable family structures, higher sex drives, less efficient energy systems (as in obesity), a greater tendency to geographically disperse, a lowered intelligence, and less social rule following and altruism would be expected to covary with poorer health and shorter lives. While the intercorrelations among all these indices of K might not be very high given that each is multiplicatively influenced, they might nonetheless be expected to co-vary along a single axis.

Consideration of the available evidence offers a degree of support for the K perspective. As a necessary preliminary, many indices of K have been found to be heritable. These include those reviewed earlier, but also rate of multiple birthing, family size, and structure (Bulmer, 1970); the rate of maturation from 3 months to 15 years (Wilson, 1983); the age of onset of puberty and menopause (Bouchard, 1984); the strength of the sex drive and its relation to age of first intercourse, frequency of intercourse, and total number of partners (Eysenck, 1976; Martin, Eaves, & Eysenck, 1977); and personality traits such as intelligence (Bouchard & McGue, 1981), social-rule following (Mednick, Gabrielli, & Hutchings, 1984), and altruism and aggression (Rushton, Fulker, Neale, Nias, & Eysenck, 1986).

Studies have also found the predicted covariation among the K attributes. Rushton (in press) contrasted the characteristics of the mothers of dizygotic twins who, because they produce more than one egg at a time can be considered to represent the r-strategy, with the mothers' of singletons representing the K-strategy. As expected, the former were found to have a lower age of menarche, a shorter menstrual cycle, a higher number of marriages, a higher rate of coitus, a greater fecundity, more wasted pregnancies, and an earlier menopause. Significantly, these mothers also have an earlier mortality measured by cancer of the pancreas (but not for other sites), by diabetes, other endocrine diseases, and allergies (Wyshak, 1984). The dizygotic twins themselves have a greater susceptibility to major health disorders such as schizophrenia, diabetes, hypertension, heart diseases, ulcers, and neuroses (Kendler & Robinette, 1983) and generally to have an earlier mortality due to both trauma and disease (Hrubec, *et al.*, 1984). In another domain, Ellis (in press) contrasted the characteristics of those low in social-rule following (criminals) with controls and found the former to have shorter gestation periods (more premature births), a more rapid development to sexual functioning, a greater copulatory rate outside of bonded relationships (or at least a preference for such), less stable bonding, lower parental investment in offspring (as evidenced by higher rates of child abandonment, neglect, and abuse), and a shorter life expectancy.

Population Differences in Health and Longevity

Additional evidence for the K theory of health and longevity comes from the comparison of human populations known to differ in egg production, namely: lower socioeconomic > higher socioeconomic, and Negroids > Caucasoids > Mongoloids. While the monozygotic twinning rate is nearly constant at about 3½ per 1,000 in all groups, dizygotic twinning (the r-strategy) is greater among lower than among upper social-class women in both European and African samples (Golding, 1986; Nylander, 1981). Also, the rate per 1,000 births among Mongoloids is 4; among Caucasoids, 8; and among Negroids, 16, with some African populations having rates as high as 57 per 1,000 (Bulmer, 1970). The pattern of population differences in rate of multiple birthing are paralleled by those in other K characteristics including sexual behavior, personality, intelligence, and social-rule following (Rushton, 1984, 1985a, 1985b; Rushton & Bogaert, 1987). It is predicted, therefore, that parallel social-class and racial differences would occur in health and longevity.

With respect to social class, Black (1980) carried out one of the most comprehensive reviews of the issue ever undertaken. The study examined mortality rates in Britain from 1921 to 1971. Everyone was living longer, Black concluded, but the professional classes had gained more years than semiskilled and unskilled workers. In 1930, people in the lowest social class had a 23 per cent higher chance of dying at every age than people in the highest social class. By 1970, this excess risk had grown to 61 percent. A decade later, it had jumped to 150 per cent. Subsequently Wilkinson (1986) provided additional evidence, again from Britain: while death rates for heart disease and lung cancer were higher among the upper social classes in the early part of the century, by the 1950s the position had reversed. In Britain a National Health System has long existed to minimize inequalities in health-related services. The increasing correlation of health and social class is explainable from the perspective being presented here, however, when it is appreciated that removing environmental barriers to health increases the variance accounted for by genetic factors (Scriver, 1984). In a parallel way, increasing equality of educational opportunity leads to an increase in the heritability of educational attainment (Heath, Berg, Eaves, Solaas, Corey, Sundet, Magnus, & Nance, 1985). Generally, removing environmental impediments makes individual-difference variance more dependent on innate characteristics. This implies that, in the 1980s at least, and on average, more genes coding for good health and longevity exist in persons of the upper classes than in persons of the lower classes.

With respect to race, it is well established that in the United States, blacks have poorer health and a shorter life span than whites (Bengston, Kasschau, & Ragan, 1977). Often, this fact has been attributed entirely to social-class differences. Using cross-validation on eight different surveys encompassing more than 20,000 respondents, however, Kessler and Neighbors (1986) demonstrated that the effect of race on illness (psychological disorders in their study) was independent of class. They observed an interaction between race and class such that the true effect of race was suppressed and the true effect of social class was magnified in models that failed to take the interaction into consideration. Unfortunately I do not have information on the health characteristics and longevity of Orientals. To the degree that Orientals are more K than

Caucasians (Rushton, 1985a, 1985b; Rushton & Bogaert, 1987), however, they are predicted to be both healthier and longer lived.

Discussion

A theory has been advanced that a single dimension—K—underlies diverse characteristics pertaining to life histories, social behavior, and physiological functioning. K is proposed to order diverse biosocial differences found between people regarding health, illness behavior, and longevity. Numerous traits are expected to covary along a single dimension. While the question of etiology remains open, the ordering of the physical variables such as twinning rate, the high heritabilities established for so many of the particular variables and the direct linkage to nonhuman species and evolutionary history, makes a major role for genetic influence likely. Indeed, since epigenetic rules and heritable personality dispositions underlie the development of many aspects of life style including smoking and dietary preferences, friendship and mate choice, and vocational and leisure pursuits (Eysenck, 1985; Lumsden & Wilson, 1985; Rushton, Littlefield, & Lumsden, 1986), even ostensibly "environmental" influences may have a genetic component (Plomin, Loehlin, & DeFries, 1985). Obviously this should not be construed as denying the importance of the environment. Distal genetic effects are necessarily mediated by proximate neuroendocrine and psychosocial mechanisms which have been shown to be independently affected by such variables as smoking, diet, and marital status (Hrubec, *et al.*, 1984) and stressors arising from social interaction (Henry & Stephens, 1976).

Conjecturing as to the physiological mechanisms underlying the phenomena discussed, two possible candidates include metabolic rate and gonadotropin level (in both cases K being indicated by lower scores). Thus gonadotropins distinguish, in the predicted direction, the races (Nylander, 1973; Soma, Takayama, Kiyokawa, Akaedo, & Tokoro, 1975), mothers of dizygotic twins from mothers with no dizygotic twins (Martin, Olsen, Thiele, Beaini, Handelsman, & Bhatnager, 1984), and within-population differences in K-linked temperament traits such as altruism and aggression (Baucom, Besch, & Callahan, 1985). The role of sex hormones (and age of menarche, age at first birth, and age at menopause) has also been considered in the development of breast cancer (Short, 1984). One challenge ahead, therefore, is to specify more clearly the routes by which genetic and environmental effects mediate the relation between personality and health behavior. Accurate knowledge of all sources of variance will increase opportunities for prediction and prevention.

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