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# Life History Analysis And Individual Differences In Humans: A Test Of The Application Of An R/k Analysis

Dwight S. Mazmanian

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LIFE HISTORY ANALYSIS AND INDIVIDUAL DIFFERENCES IN HUMANS:  
A TEST OF THE APPLICATION OF AN r/K ANALYSIS

by

Dwight S. Mazmanian

Department of Psychology

Submitted in partial fulfilment  
of the requirements for the degree of  
Doctor of Philosophy

Faculty of Graduate Studies  
The University of Western Ontario

London, Ontario

August 1987

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## ABSTRACT

A number of psychologists have begun to apply principles from evolutionary biology to their domains in an attempt to provide an integrated model of human behaviour. One such application, a theory based on the r/K continuum of reproductive strategies, postulates that a single heritable reproductive dimension underlies a broad range of individual differences in life histories, physiological functioning, and social behaviour (Rushton, 1985). The two experiments reported here provide a test of this theory. Experiment 1 was conducted to determine if such a reproductive dimension exists and the extent of its heritability. Numerous reproductive and other variables from a sample of 7620 twins were subjected to principal component analyses. The obtained solutions for both male and female twins revealed factors which resembled the proposed dimension. Comparisons of aggregated standard scores for monozygotic twin pairs and same-sexed dizygotic pairs indicated that the dimension was moderately heritable. The second experiment replicated and extended the first study using a broader range of variables from a sample of 250 university undergraduates. In both experiments, strongest support for the theory was found for the physiological and sexual-reproductive variables, with the findings for personality variables being less supportive. The results were generally interpreted as providing initial support for the application of r/K theory to humans.

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Darwin's (1859) theory of evolution through natural selection, while highly influential in areas such as agriculture and morphology, appears to have had little impact in the modern social sciences and humanities until very recently. Insofar as Darwin's theory provides a conceptual framework for understanding the behaviour of all living organisms, it seems odd that those disciplines devoted to the study of human behaviour, most especially psychology, almost uniformly neglect to include any reference to evolutionary biology in their theories. As Dawkins (1976) has pointed out, most of the social sciences and humanities are being taught as though Darwin's theory had never existed. Given the extent of its original impact on psychology in the 1890s to 1930s (e.g., Galton, 1869; Romanes, 1898), one might reasonably wonder as to why this is the case.

There are perhaps a number of explanations for this lack of integrative effort, aside, of course, from humankind's well-entrenched reluctance to view ourselves as animals subject to the same natural laws as bacteria or chimpanzees. Behaviourism's virtual conquest of North American psychology in the early part of this century no doubt played a leading role. From the behaviourists' perspective, most if not all human and animal behaviour was viewed as a product of environmental influences and scant attention was paid to innate behaviors. Enormous efforts were made to construct general theories of learning which would account for the range of behaviours shown by different species in different

situations. This "radical environmentalism" dominated psychological research and theorizing in North America until the late 1960's. At this time a growing body of research findings of "biological constraints" on learning prompted a somewhat belated recognition of the fact that innate characteristics do limit what can be learned and that behaviour was not "almost infinitely malleable by experience", as was suggested by behaviourists such as Watson and Skinner (Domjan and Burkhard, 1986, p. 10).

Barash (1977) has also pointed out that the widespread misinterpretation and misapplication of Darwinian notions such as "survival of the fittest" gave rise to a philosophy of "Social Darwinism" in which aggressive, life-and-death competition and the ruthless exploitation of peoples were viewed as natural and inevitable. He suggests that the social scientists of the day, having initially contributed to this state of affairs, were superceded by a different set, who performed a sort of intellectual "penance" by subsequently becoming rampant environmentalists (p.7). Perhaps most important in this regard was the usurping of Darwinian principles by ideologies such as Fascism before and during the Second World War (1939-1945). This resulted in the theory being so discredited that decades were needed to remove the taint of association. Finally, it is possible that this lack of integration might also be due, in part, to the degree of success psychology has had in determining "proximal" or more immediate causes of human behaviour (see Rushton, 1984, for

discussion). Whatever the case, the bulk of psychological theories from the early 1900's until very recently have been philosophically more in keeping with western society's prevailing liberal ideology.

While mainstream North American psychology was busily developing theories of behaviour with little or no reference to evolutionary biology, considerable advances were being made by researchers in the field of ethology. Coming from a stronger biological background, ethologists paid more attention to evolutionary principles than did researchers in psychology. These efforts culminated in the awarding of a Nobel Prize in 1973 to Konrad Lorenz, Niko Tinbergen, and Karl von Frisch for their contributions on the social behaviour of non-human species.

During this period a number of advances were being made in evolutionary theory, perhaps the most significant being the work of John Maynard Smith (1964) and William Hamilton (1964), who provided a far-reaching solution to the "paradox" of altruism. In his original formulation, Darwin proposed that the mechanism by which natural selection occurred was through the survival of the fittest individual. One phenomenon that this formulation could not explain was altruism, a difficulty that Darwin recognized at the time as an anomaly to his theory (Darwin, 1859). Altruism, which is usually defined as behaviour that benefits another, functionally decreases the fitness of the helper and increases the fitness of the recipient (Wilson, 1975). Consequently, within the logic of

Darwin's theory, altruism should never have evolved! Should a mutation for an "altruism gene" occur through random variation, selection pressures would favour selfish individuals, thus leading the altruism gene to eventually disappear. And this, of course, is manifestly not the case. Altruism, even to the degree of self-sacrifice, is prevalent in a significant proportion of species, including insects and humans (Wilson, 1975).

Hamilton (1964) and Maynard Smith (1964) resolved this paradox by proposing the notion of inclusive fitness, which redirects theoretical attention to the "gene" as the unit of analysis rather than the "individual". Inclusive fitness is "the sum of an individual's fitness as measured by personal reproductive success and that of relatives, with those relatives devalued in proportion to their genetic distance, i.e., as they share fewer genes" (Barash, 1977; p. 329). Using the gene as the unit of analysis, one may consider the individual organism to be no more than a vehicle, albeit a highly sophisticated vehicle, for ensuring the survival and replication of its constituent genes (Dawkins, 1976). Or as Wilson (1975, p.3) elegantly expressed it by modernizing Samuel Butler's famous aphorism, just as "the chicken is only an egg's way of making another egg... the organism is only DNA's way of making more DNA". Thus when an individual behaves altruistically toward its kin, though it may be decreasing its individual fitness, the individual is still ensuring the survival and replication of its genes, as these

will be present to a greater or lesser extent in all of its kin. For example, an individual's siblings will share exactly 50% of its genes identical by descent and the offspring of its siblings will share an average of 25% identical by descent. (The true proportion, not identical by descent, will be considerably greater). This significant contribution provides a biological basis for altruism that nicely resolves the apparent paradox.

It was the combination of this theoretical work and the empirical work of the ethologists which culminated in the renaissance of evolutionary biology in the mid-1970s (Dawkins, 1976; Wilson, 1975). This new synthesis is often called sociobiology (Wilson, 1975) and appears to hold great potential for providing distal or "ultimate" explanations of human behaviour. More recently, several personality and social psychologists recognized this potential and began to apply the theory to their domains of enquiry (e.g., Buss, 1984; Cunningham, 1981; Freedman, 1979; Hogan, 1982; Rushton, 1984). Sociobiological explanations have been proposed for such diverse areas as interpersonal attraction and marriage (Rushton, Russell, and Wells, 1984), grief following bereavement (Littlefield and Rushton, 1986), jealousy (Daly, Wilson, and Weghorst, 1982), social dominance and conflict (Omark, Strayer, and Freedman, 1980), infant development (Freedman, 1974), and child abuse (Daly and Wilson, 1981).

One such application, proposed by Rushton (1985), potentially systematizes a variety of hitherto unrelated



biosocial differences in humans. This account is an extrapolation of the r/K continuum of reproductive strategies to humans and is referred to as Differential K Theory. Rushton postulates that the degree to which an individual inherits a K reproductive strategy underlies numerous life history attributes, including personality characteristics, social behaviour, intelligence, and physiological functioning. Before examining this theory in detail, it would be useful to discuss its theoretical foundations, which are derived principally from population biology.

#### Basic Principles of Population Growth

The Reverend Thomas R. Malthus was one of the first individuals to systematically examine population growth and its consequences. His (1798) An Essay on the Principle of Population, which both Darwin and Wallace later cited as providing the crucial insight necessary for their independent formulations of evolution through natural selection, was, in fact, written in answer to some wild speculations on the perfectability of humankind which were very much in vogue after the French Revolution. Malthus argued that these speculations were naively optimistic in that they ignored some very basic laws of biology, most notably the fact that the means of subsistence, even under the most ideal circumstances, was incapable of increasing faster than in an arithmetic ratio, whereas population size, when unchecked, increased in a geometric ratio (Malthus, 1798; Tierney, Kagan, and Williams,

1976; much of the remaining discussion is based on Emmel, 1976 and Wilson and Bossert, 1971).

While most populations over long periods display a zero growth rate, many can and do, under certain optimal conditions and for short periods of time, display the geometric growth potential suggested by Malthus. (He was, however, remarkably prescient with regard to human population growth, which continues to increase geometrically.) The basic factors which affect population growth in general are individual birth rates, individual death rates, immigration, and emigration per unit of time. In large populations, immigration rates and emigration rates are assumed to balance each other out and these values can therefore usually be set to 0. The geometric or exponential growth form described by Malthus is presented in Panel A of Figure 1. This pattern of population growth may be expressed by the formula

$$N_t = N_0 e^{rt}$$

where  $N_t$  is the number of units after some arbitrary unit of time ( $t$ ),  $N_0$  is the original number of individuals,  $e$  is the constant 2.7183 (the base of natural logarithms), and  $r$  is the intrinsic rate of increase or "Malthusian parameter" of the population (a constant which equals individual birth rate per unit of time minus the individual death rate per unit of time).

Populations cannot, for obvious reasons, maintain this rate of growth for extended periods of time. As Wilson and Bossert (1971, p.102) have pointed out, "any population"

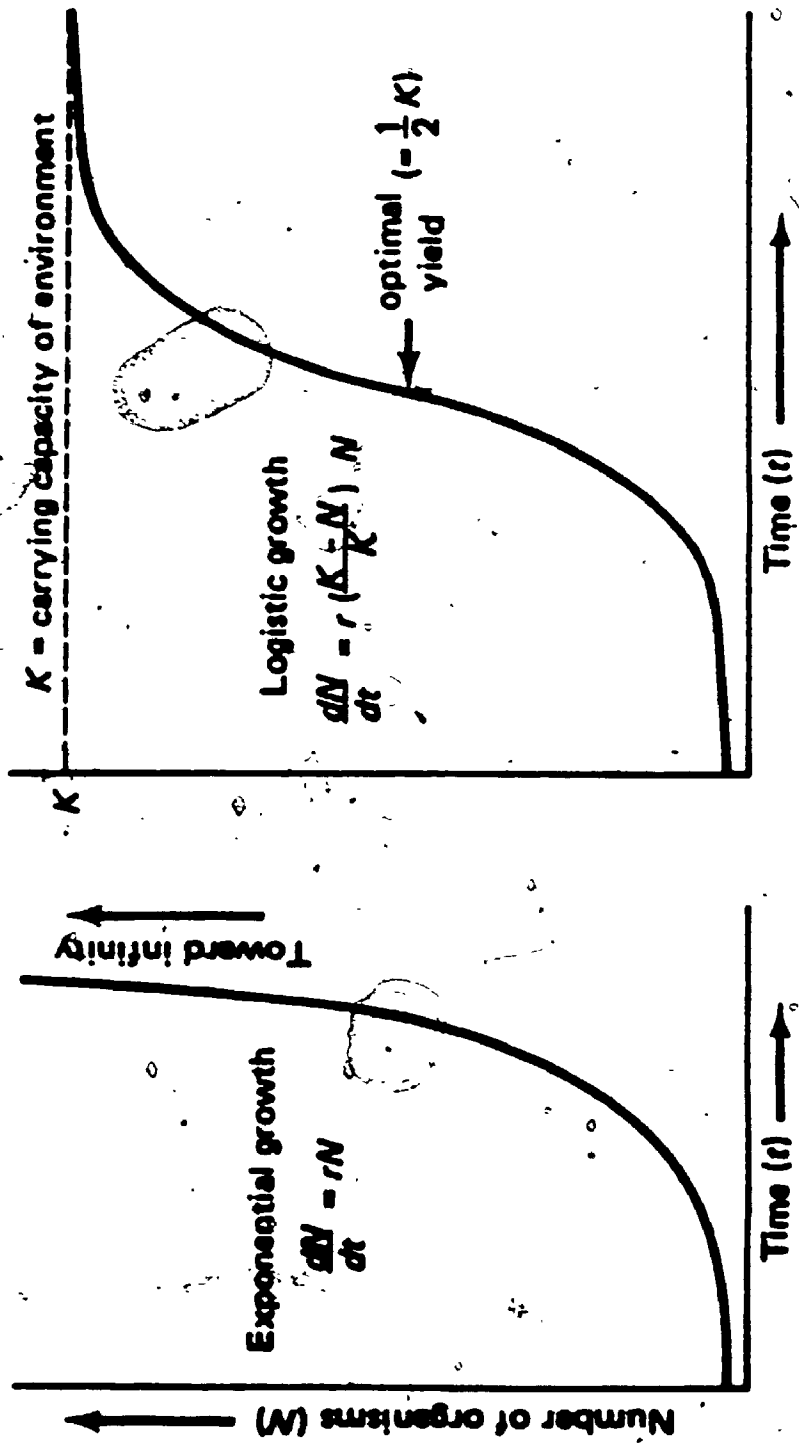


Figure 1. Exponential and logistic growth curves (from Emmel, 1976).

miraculously permitted to grow at its full exponential rate for just a few years would come to weigh as much as the visible universe and expand outward at close to the speed of light. At some point in its growth, a population begins to encounter environmental resistance as a consequence of increased density and the growth curve begins to flatten out at some asymptotic level, as is shown in Panel B of Figure 1. This form of population growth is referred to as logistic, or more precisely, Verhulst-Pearl logistic growth and may be expressed by the formula

$$rN\left(\frac{K-N}{N}\right)$$

where  $r$  is, as in the preceding formula, the intrinsic rate of increase per unit of time,  $N$  is the number of organisms, and  $K$  is the carrying capacity of the environment, that is, the maximum number of individuals that can be supported in a given habitat. A variety of controls or regulatory mechanisms, which are a direct function of population density, serve to maintain a population at or near the carrying capacity of the environment by affecting individual birth and death rates. These mechanisms are collectively known as density-dependent controls and include food shortages, increased inter- and intra-species competition, alteration of the chemical environment through secretions and metabolites, predators, parasites, disease pathogens, and emigration. Density-dependent controls may be contrasted with density-independent controls, or factors which influence

individual birth and death rates independent of population density. These include ambient climatic changes and other changes in the physical environment, such as floods, droughts, and volcanic eruptions.

While this logistic model of population growth may be justly criticized as oversimplified, it has proven useful to population biologists in a number of respects (see Emmel, 1976, p. 105 for discussion). Moreover, the model does provide a reasonably good fit to many empirical growth curves obtained in laboratory and field studies. In any event, this brief overview provides an introduction to certain elementary concepts, most especially the notions of intrinsic rate of increase ( $r$ ) and carrying capacity ( $K$ ), which provide the theoretical foundation upon which the remaining discussion is based.

#### Life History Strategies and $r$ and $K$ Selection

Cross-species comparisons of life-history strategies reveal considerable variation in attributes such as the number of offspring produced, the amount of parental care invested in each, speed of development, age at maturity, and longevity. Migratory salmon, for example, live for four or five years and reproduce only once, in a single, massive, and inevitably suicidal burst. Somewhere between 3,000 and 5,000 eggs may be laid at this time and no further parental care is invested in the offspring (Daly and Wilson, 1983). This sort of "one-shot, fire-and-forget" strategy of reproduction is known

as semelparity. Many other species reproduce repeatedly, or iteroparitively, producing a smaller number of offspring, and investing significantly more parental care in each, such as in the case of most mammals.

Dobzhansky (1950) is generally credited as being one of the first individuals to suggest that natural selection might operate in different ways to adjust these various life-history attributes, depending on the nature of the environment. He argued that in a habitat where mortality is relatively independent of individual characteristics and population density, selection pressures would favour rapid development and high fecundity. In this situation, then, the reproductive advantage lies with individuals who mature quickly, reproduce in great numbers, and invest little matter and energy in offspring. He argued further that in stable, long-lived, and more constant environments that are at or near their carrying capacity (K), mortality is often more selective to individual characteristics and population density, and selection pressures would no longer favour organisms with the reproductive strategy described above. In an environment of this sort, the optimal strategy would be to produce a smaller number of offspring but invest significantly more time and matter in each in order to promote greater competitive ability in a "no-vacancies" situation (Barash, 1982; Daly and Wilson, 1983).

In an attempt to systematize these differences in reproductive strategies, MacArthur and Wilson (1967) proposed

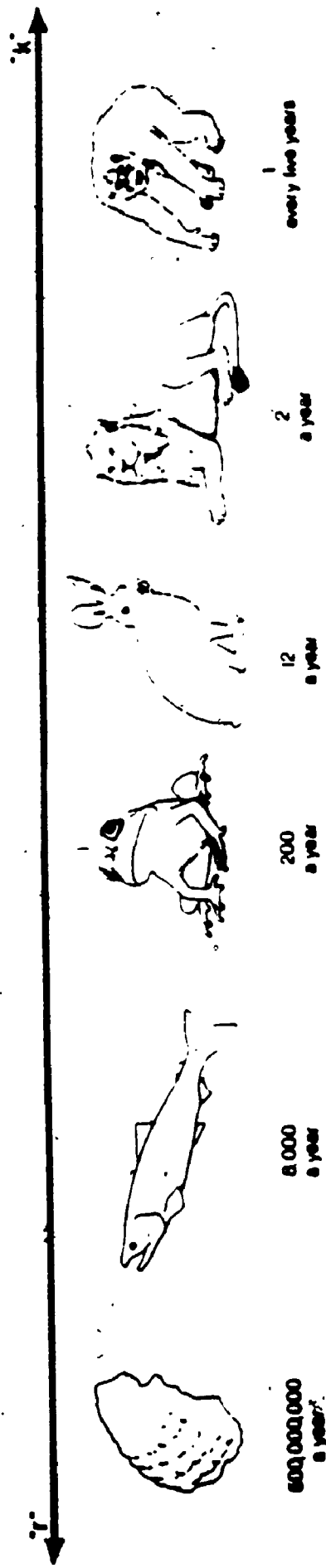


Figure 2. A representation of MacArthur and Wilson's (1967) r-K continuum of reproductive strategies (from Johanson & Edey, 1981).

Table 1. Life history characteristics associated with r- and K-strategists (after Barash, 1977; Pianka 1970; Wilson, 1975, & Eisenberg, 1981).

Correlate	r-strategists	K-strategists
Environment	Variable climate Unpredictable resources Transient habitat	Constant climate Predictable resources Stable habitat
Population Size	Variable in time Usually well below K	Fairly constant in time Usually at or near K
Mortality	Often catastrophic Relatively nonselective Density independent	Steady More selective Density dependent
Reproduction	Many offspring Infant mortality high Low parental investment	Fewer offspring Infant mortality low High parental investment
Individual Characteristics	Small body size Short life span Rapid development Younger age at first reproduction Decreased encephalization	Large body size Longer life span Slower development Older age at first reproduction Increasing encephalization
Energy Utilization	High productivity Emphasis on quantity	High efficiency Emphasis on quality
Social Structure	Poorly integrated Competition lax Altruism rare	Well integrated Competition keen Altruism common



a single dimension along which they could be conceptualized, which they referred to as the r-K continuum (see Figure 2). The symbols r and K are derived from population biology and, as will be recalled from the preceding section, denote the intrinsic rate of increase of a population and the carrying capacity of the environment, respectively. Species emphasizing quantity over quality represent the r end of the continuum and are referred to as r-strategists, so called because they maximize r (high birth rates and high death rates). Those species which emphasize quality and competitive ability over numbers are called K-strategists.

Pianka (1970) has delineated a variety of other life-history attributes associated with r and K reproductive strategies, which are presented in Table 1. In addition to being what Daly and Wilson (1983) call "profligate speed-breeders", r-strategists also mature more quickly and begin reproducing at a younger age. They tend to be smaller, have shorter life-spans and higher rates of infant mortality than K-strategists. In terms of social behaviour, r-strategists have poorly integrated social systems in which altruism is rare and competition lax. K-strategists, in contrast, mature more slowly and begin reproducing at an older age. Body size is typically larger, life-span longer, and infant mortality rates lower than r-strategists. Social systems are more highly developed, altruism more common, and competition is generally keen.

These two strategies represent the end-points of

MacArthur and Wilson's (1967) continuum, and the strategies of most species would actually fall somewhere between these two extremes. In addition, describing a species as r or K is, of course, a relative statement. Squirrels, for example, would be considered r-strategists relative to baboons, but K-strategists relative to codfish (see Figure 2). Finally, it should be noted that these different reproductive strategies are but different means to the same actual ends, as, in fact, all sexually reproducing species produce on average two successful offspring per two parents (Barash, 1982).

As Daly and Wilson (1983) discuss, certain anomalies have been reported that are not immediately explainable in terms of this framework. Strathmann and Strathmann (1982), for example, found a negative relationship between body size and parental care in a number of marine invertebrate species, a finding which is opposite to that which would be expected from r-K theory. Hart and Begon (1982) have also reported anomalous life history correlations between neighbouring populations of periwinkles (Littasina rudis). One population tended to produce a greater number of smaller sized offspring than did a second, near-by population, yet these offspring also tended to mature later and have a larger body size. In addition to these empirical exceptions, Stearns (1976) has argued that r and K reproductive strategies need not necessarily be a product of r or K selection and has proposed a "bet-hedging" theory, based on mortality rates alone, to explain the observed differences in life histories. On the

whole, however, the r-K continuum has proven most useful in organizing a multitude of life-history characteristics across a wide range of species (see Barash, 1982; Daly and Wilson, 1983; and Wilson, 1975, for reviews).

While most sociobiologists have focussed on between-species differences in r and K, behaviour geneticists and some differential psychologists have stressed an obvious but much neglected fact, namely that, for evolution to occur, there must be within-species differences as well (Plomin, DeFries, and McClearn, 1980; Rushton, 1984). A central premise of Darwinian theory is that there be individual differences within a species, thus providing the raw material on which natural selection operates. Data from several different experiments using a wide range of species, do, in fact, suggest the existence of within-species variation in r and K. Gadgil and Solbrig (1972), for example, have reported within-species variation in dandelions (Taraxacum officinale sensu latu). Plants examined from relatively undisturbed sites devoted significantly more resources to leaf biomass, at the expense of reproductive biomass, than did plants from a site that was subjected to frequent lawnmowing -- a difference that remained even after plants from both sites were removed and reared under identical conditions in the laboratory. Kraemer (1946; as cited in Barash, 1982) has reported that populations of lizards in areas where there is heavy predation tend to produce greater numbers of smaller offspring than do populations in areas with minimal predation. Clutch sizes, in

a number of species of birds increase as the habitat moves geographically from tropical to temperate zones (Cody, 1966). Similar sorts of within-species variation in  $r$  and  $K$  have been reported for flies (*Drosophila pseudoobscura*; Taylor and Condra, 1980), milkweed bugs (*Oncopeltus fasciatus*; Hegmann and Dingle, 1982), American shad (*Alosa sapidissima*; Leggett and Carscadden, 1978), and field mice (*Microtus pennsylvanicus* and *M. orchragaster*; Krebs, Gains, Keller, Myers, and Tamarin, 1973).

#### The Human Case and Differential K Theory

Human beings are extreme  $K$ -strategists relative to most other species. Single births are the rule and there is usually a three-year or more interval separating each occurrence. Our gestation period of nine months is longer than that for all other primates and is surpassed only by whales and elephants. Offspring receive prolonged and intensive nurturing, sometimes for up to two decades. Sexual maturity is not reached until an individual is some ten to fifteen years old, at which time the females of the species typically begin producing one egg about every four weeks. Close kinship bonds are maintained across generations and our social systems are generally complex and highly integrated (Daly and Wilson, 1983; Lovejoy, 1981):

Under the rubric of Differential  $K$  Theory, Rushton (1985) proposed that the  $r/K$  framework be extrapolated to humans in order to systematize numerous biosocial differences which have

been theoretically unrelated in the past. He postulated that the extent to which individuals inherit a K reproductive strategy will, in part, influence predictable differences in life history characteristics, personality, social behaviour, intelligence, and physiological functioning. Of particular interest, then, is that in addition to organizing and inter-relating biological variables, this theory holds unique potential for providing a biological basis for individual differences in personality and social behaviour-- domains which have hitherto resisted any such attempts. On the basis of data from non-human species, Rushton predicts that humans who inherit a higher K reproductive strategy will develop more slowly, reach sexual maturity at an older age, begin reproducing later in life, and have fewer children, spaced more widely apart, than individuals who are less K. Higher K individuals are also predicted to have lower rates of infant mortality, a lower incidence of DZ twinning (a measure of "litter size"), be larger, generally healthier, more intelligent, and live longer than less K individuals. Moving outside the realm of these more biological measures, Rushton further conjectured that high K individuals will be more altruistic, law-abiding, behaviourally restrained, and have lower sex drives. These latter predictions were made partly on the basis of extrapolations from r/K theory, and partly on the basis of previously reported correlations among relevant biological measures and other psycho-social variables.

Others besides Rushton (1985) have proposed similar, but

less elaborated views. Thus, Weinrich (1977) and Weigal and Blurton Jones (1983) in the context of socioeconomic and race differences in sexual behaviour, and Reynolds and Tanner (1983) in the context of the role of religious beliefs on reproductive success, have suggested that some humans adopt a more K strategy than others. In these accounts, individual differences in K are said to reflect different processes of socialization, with low-income people adopting an r-strategy and high income people adopting a K-strategy due to different perceptions of the predictability of their environments. What Rushton (1985) proposed, however, is that some of the variance in K among humans is under genetic influence and that K-behaviour is associated with a constellation of attributes, deeply embedded in evolutionary history.

Four central preconditions must be met in order to establish the initial validity of this theory. First, individual differences must exist among humans in K-related measures such as fecundity, age at sexual maturity, age at first pregnancy and degree of parental investment. Second, some of the variance in these characteristics must be shown to be heritable. Third, these disparate genetically linked characteristics should co-vary along a single axis. In other words, a single factor should underlie any large body of biosocial life-history phenomena, almost irrespective of the specific variables entered, perhaps in the same sense that a general or g factor has been postulated to underlie any large group of cognitive tasks (Jensen, 1985; 1986). Finally,

individual differences in positioning on this axis should be to some extent heritable. The first two points, as I will briefly show, have already been established in the literature.

#### Individual Differences in K-Related Phenomena

It is widely known that biological measures of K, such as body size, age at sexual maturity, age of first pregnancy, family size, birth spacing, parental investment, and family structure demonstrate wide individual differences. Related behavioural phenomena, such as age at first coitus, frequency of sexual intercourse, number of different partners, and frequency of extramarital coitus, similarly demonstrate wide individual differences, as do attitudes toward sexual behaviour. Though less known, significant variation has been reported for other presumed measures of K, such as maximum number of orgasms (males), length of menstrual cycle and duration of menstrual flow (females), fertility, and gonad (testes) size in males (Eysenck, 1976; Gebhard and Johnson, 1979; Kinsey, Pomeroy, and Martin, 1948; Snyder, Simpson, and Gangstad, 1986; Short, 1984; Willatt and Bartlett, 1986). Short (1984), for example, reported that mean testis weight at autopsy for 349 individuals ranged from 15 g to 42 g (body size contributed only slightly to this variation).

Of particular importance to K theory is the finding that many of the above characteristics also relate to other measures of K. For example, it is well established that intelligence, as measured by conventional tests of IQ and

educational attainment, co-varies negatively with the number of children born to a family, and when family size is held constant, with a narrow spacing of children (Belmont and Marolla, 1973; Lancer and Rim, 1984). Similarly, unstable family structure, as measured by single parenting, is a predictor of lower intellectual achievement. IQ, in turn, has been related to a number of other behaviours suggestive of K, including altruism and law abidingness (Rushton, 1985). Research has also been carried out on personality and sexuality (Eysenck, 1976). Individuals with high sex drives tend to score higher on measures of extraversion and psychoticism than do individuals with lower sex drives. Extraverts also begin having sex at a younger age, more frequently, and with a greater number of partners than do introverts. Individuals who report guilt feelings about sex, view sex as disgusting, and experience sexual dysfunction, often score high on measures of neuroticism. Finally, persons with generally low sex drives who dislike sexual permissiveness, pornography, and physical sex, also tend to score high on measures of conservatism.

Studies using the "known groups" method have also found that many r/K attributes covary in the predicted directions. Rushton (1987), for example, contrasted mothers of dizygotic twins with mothers of singletons. Because the mothers of dizygotic twins can produce more than one egg at a time, they may be represented as r-strategists, relative to the mothers of singletons. As would be predicted from the r/K framework,



the mothers of dizygotic twins were younger at menarche, had shorter menstrual cycles, more miscarriages, greater fecundity, earlier menopause, and higher rates of coitus than did mothers of singletons. Ellis (1987), in contrasting criminal populations with controls, reported similar covariation among a number of other r/K characteristics. Relative to controls, individuals in the criminal groups were found to have had shorter gestation periods, reached sexual maturity at an earlier age, less stable pair-bonding, shorter life expectancies, and lower parental investment in their offspring, as reflected in higher rates of abuse, neglect, and abandonment of children.

Typically, many of the above relationships are explained by purely cultural transmission models, including the effects of environmental stress (e.g., Zajonc, 1976). Differential K Theory, in contrast, predicts that the covariance structure underlying these and many other relationships will be partly genetic in origin.

#### The Genetic Basis to Individual Differences in K Behaviours

Several procedures are available for estimating the proportion of variance in a set of measurements that is attributable to genes rather than the environment (Cattell, 1982; Eaves, Last, Young, and Martin, 1978; Falconer, 1981; Plomin et al, 1980). This estimate of genetic contribution is often referred to as a heritability coefficient and represented as  $h^2$ . Procedures in animals include selective

breeding studies using crossfostering to control for upbringing. In humans, adoption studies provide one method for separating and assessing the relative effects of heredity and environment. Correlations may also be calculated between scores on the trait in question and the degree of relatedness within the family, the best known example being twin studies. Given the relevance of the twin method to the present investigation, as well as the controversy sometimes associated with this technique, some detailed discussion is warranted.


Identical or monozygotic (MZ) twins share 100% of their genes while fraternal or dizygotic (DZ) twins share, on average 50%, the same amount shared by non-twin siblings. The heritability of a particular trait can be estimated by comparing MZ twin correlations with DZ twin correlations. If the MZ correlations are higher than the DZ correlations, the difference can be attributable to genetic effects. (While this is the conceptual essence of twin designs in its most rudimentary form, actual methodologies are usually much more sophisticated; see Cattell, 1982; Claridge, 1973; Loehlin, 1977; much of the following discussion is based on these sources). The complete twin method involves the comparison of MZ twins raised together, MZ twins raised apart, DZ twins raised together, and DZ twins raised apart. In actual practice, however, 95% of all twin studies compare only MZ twins raised together and DZ twins raised together, a method referred to as the partial twin method. (Most studies employ the partial method rather than the complete method out of

necessity, separated twin pairs being so rare that it is usually impossible to find a sufficient number to satisfy statistical requirements.)

The twin method in general has been subjected to considerable criticism and debate, the most common complaint being that the method assumes equal within-family environmental variance for both zygositys. Critics have argued that this assumption is not valid, as MZ twins are exposed to more similar environments and are treated more similarly by parents, teachers, and peers. Thus, the greater similarity observed between MZ pairs for a particular trait might be attributed to environmental influences rather than genetic ones. The results of several studies do, in fact, suggest that MZ twins are exposed to more similar environments than DZ twins (Scarr, 1968; Smith, 1965). Scarr, however, turned this argument around and suggested that it is the similarity between MZ twins that elicits the similarity in treatment. In other words, the genetic resemblance itself leads to the twins being exposed to more similar environments. To support this argument, Scarr presented data from families in which the parents had incorrectly classified zygosity, that is, mistakenly believed MZ pairs to be DZs and DZ pairs to be MZs. Parents who mistakenly believed their MZ twins to be DZ tended to treat the pairs more like MZ pairs, and parents who believed their DZ twins were MZ pairs, similarly treated the twins more like DZ pairs. Thus actual genetic relatedness determined how twin pairs were treated rather than parental

beliefs about the relatedness.

Other defenses of the twin method have been offered suggesting that the criticisms have limited importance. Loehlin and Nichols (1976), for example, showed that when measures of the differences that do exist in the treatment of twins are correlated with personality and other scores, there was no evidence that differences in treatment had any effect. Perhaps most importantly, the findings from studies employing twins raised together have been fairly precisely confirmed by other methods. Thus, from twins raised together, heritabilities for personality variables have typically been .50, based on a MZ intraclass correlation of .50 and a DZ intraclass correlation of .25. (Bouchard, 1984; Goldsmith, 1983; Loehlin and Nichols, 1976; Rushton, 1984; Tellegan, Lykken, Bouchard, Wilcox, Segal and Rich, in press). Many smaller adoption studies, however, reported heritabilities of .20 to .30, thereby spurring a debate as to whether twin studies overestimated heritabilities, or adoption studies underestimated them (e.g., because of the confounding effects of differences among siblings and parents not found in twin studies. Subsequent well controlled studies of MZ and DZ twins raised apart (a special kind of adoption study with age effects removed) show that the twins raised together have provided better heritability estimates than the adoption studies). Monozygotic and DZ twins raised apart show exceedingly similar degrees of congruence to each other (MZ correlations .50, DZ correlations .25), values which are not



significantly different from those found for twins raised together (Tellegan et al., 1986).

One surprising implication of the above findings is that very little, if any, of the variance in personality and social behaviour is due to twins' common family environment. Almost all the variance is due to genetic effects (making siblings both similar and different from one another), and specific (rather than common) environmental effects, that is, distinct individual experiences (making siblings different from one another). While these findings conflict with most current theories of personality development within the family (which stress between-family common environment effects), they are remarkably robust observations, having been confirmed for numerous traits and with very large samples (Martin, Eaves, Heath, Jardine, Feingold, and Eyseck, 1986; Rushton, Littlefield, and Lumsden, 1986; see also Plomin and Daniels, 1987 for extended discussion).

The heritability of individual differences or traits relatable to K theory have been documented by researchers independently of sociobiological theorizing. When studies employing the methodologies described above have been carried out, a significant degree of genetic influence has been detected for a wide range of relevant biological and behavioural variables. Stunkard et al. (1986), for example, investigated the heritability of body mass (fatness) using a large sample of adult adoptees. Comparisons were made between each adoptee and his or her adoptive mother and father, and

his or her biological mother and father. While significant relationships were found between adoptees and their biological parents, no relationship was found between adoptees and their adoptive parents. The authors concluded that body mass was largely determined by genetic influences and that early family environment had no apparent effect at all. Similar studies have been conducted on behavioural phenomena. Mednick, Gabrielli, and Hutchings (1984), for example, studied criminality in a sample of 14,427 children separated from their parents at birth. Children were found to be at risk for criminal conviction if their biological parents had been convicted, but not if their adopting parents had been. Moreover, siblings and half-siblings adopted into different homes tended to be concordant for convictions. Additional studies have found significant degrees of genetic influence for such diverse traits as activity level (Scarr, 1966), altruism and aggression (Rushton, Fulker, Neale, Nias, and Eysenck, 1986), intelligence (Bouchard and McGue, 1981), sociability (Eaves and Eysenck, 1975), and values and vocational interests (Loehlin and Nichols, 1976).

Of particular relevance to K theory are findings demonstrating the heritability of sexual/reproductive behaviours. Both family size and incidence of multiple birthing (as mentioned, a measure of "litter size") have been shown to be heritable (Bulmer, 1970). Moreover, the onset of puberty and menopause, age at first coitus, and strength of sex drive have also been shown to be genetically influenced

(Eysenck, 1976; Martin, Eaves, and Eysenck, 1977), as have a range of other time-related sexual experiences (Wilcox, Segal, Bouchard, Bohlen, and Sanderson, in press). One further piece of evidence linking genes and reproductive variables comes from investigations of individuals affected with a genetic abnormality known as the fragile X syndrome. One of the clinical features of affected males is macro-orchidism (abnormally large testes), the average testicular volume of such individuals being twice that of unaffected males (Willatt and Bartlett, 1986). Extremely high fertility is one of the clinical features of females so affected. The twinning rate in populations of these females is three to four times higher than in comparable unaffected populations (1:35 for carriers as compared to 1:80 to 1:140 in unaffected Caucasians; Rhoads, 1984). One further clinical feature of affected males and females is mental subnormality, a finding of possible interest from the r/K perspective.

#### Summary and Predictions

It appears that the first two conditions -- individual differences in K-related variables and the heritability of these characteristics -- have been reasonably established. The following two studies were conducted to determine (1) whether a sizable single factor underlies a number of biological, reproductive, and social behaviours in the manner predicted by Rushton (1985), and (2) the extent to which individual differences in positioning along this axis are

heritable. The general predictions derived from Differential K theory may be summarized as follows: (a) higher K individuals should have had a heavier birthweight, a larger body size, and be generally healthier than less K individuals; (b) higher K individuals should reach sexual maturity at an older age, be older at first coitus, have sex less frequently and with fewer partners than low K individuals; (c) for females, as K increases, age at first pregnancy and age at first childbirth should be later and the number of pregnancies and miscarriages should decrease; (d) high K individuals should have fewer children, greater birth spacing, and a lower incidence of multiple birthings; (e) intelligence, as estimated by educational attainment, and occupational level should increase with K; and (f) with regard to personality, extraversion should decrease with K, and conservatism and altruism should increase with K. All of these variables are predicted to be intercorrelated to some extent and should cohere to define an r-K dimension. It should be noted here that neither Rushton (1985) nor others have made explicit predictions for some of the variables included in this analysis (psychoticism, neuroticism, and conservatism). The rationale for including conservatism was discussed above (p. 21) in relation to correlations reported elsewhere in the literature. One further reason for predicting a relationship between conservatism and K derives from the fact that the habitat of K-selected species is stable and predictable. To the extent to which "conservatism" as measured here reflects a



desire for such stability, it is expected that this measure will increase with K. It is more difficult to determine in what ways psychoticism and neuroticism relate to a reproductive strategy, and they are not, therefore, variables for which "strong" predictions are made. The sexual behaviours associated with neuroticism, for example, are suggestive of a K strategy, whereas the somatic complaints and poor mental health aspects of this dimension might easily be construed as representing more of an r-type strategy. Thus, their inclusion is in the spirit of "exploration" rather than "confirmation".

#### Experiment 1

The first study was conducted using a large data set from the Australian Twin Registry, which Professor Nicholas G. Martin of the Queensland Institute of Medical Research, Australia, kindly made available. While this data set was not collected with any regard to the theory, so many theoretically important biological, reproductive, social, and personality variables were included that a test of the proposed r-K dimension was possible. These data have the further advantage of being collected on twins, thus permitting the heritability of the proposed dimension to be assessed. The following variables were predicted to load positively on a K dimension: (1) birth weight; (2) height; (3) weight; (4) ponderance (body mass); (5) age at menarche; (6) length of menstrual cycle; (7) age at first pregnancy; (8) birth spacing; (9) health; (10)

education; (11) occupation; (12) conservatism; and the following negatively; (13) age at first pregnancy; (14) number of pregnancies; (15) number of miscarriages; (16) family size; (17) incidence of twinning; and (18) extraversion.

Any theory, and especially a theory of this breadth, cannot be "proven" or "disproven" in any absolute sense by a single study. In the unlikely event that all predictions are confirmed or no predictions at all are confirmed, then assessing the success of the theory might be easier. However, it is reasonable to expect that there will be strengths and weaknesses with the theory, and that the data from this experiment may help point out where those strengths and weaknesses lie.

#### Method

##### Subjects

Subjects for the experiment were 3810 twin pairs from the Australian Twin Registry, a number which represents 10% of all twins in Australia. Of this total, 47.3% were monozygotic twin pairs and 52.7% were dizygotic pairs, a proportion slightly atypical of volunteer twin registers, where there is usually a 3:2 ratio of MZ to DZ (Lykken, Tellegan, and DuRubeis, 1978). The sample included 4874 females and 2746 males, ranging in age from 17 to 88 years old (mean = 34.4, SD = 14.2). The sex ratio in this sample was more typical of such registries, which usually show a 3:2 ratio of females to males. The age

distribution was positively skewed (+1.03), with younger twins being more highly represented (modal age = 19.0; median age = 30.5). Two-thousand, seven-hundred and ten (35.6%) of the subjects were single, 180 (2.4%) were widowed, 4061 (53.3%) were married, 204 (2.7%) were living common law, 93 (1.2%) were separated, 163 (2.1%) were divorced, and 209 (2.7%) were remarried. Virtually all of the twins in this sample were raised together (98.3%), a further 1.3% were separated for five or less years, and the remaining 0.4% (15 pairs) had been separated for six or more years. Zygosity had been determined by means of questionnaire items concerning physical features, similarities in childhood, and whether or not one twin was often mistaken for another by significant others. This procedure was subsequently validated by blood-typing subsamples of each zygosity.

#### Measures and Procedure

The Australian Twin Registry Questionnaire (ATQ), which included the Eysenck Personality Questionnaire (EPQ), and Wilson-Patterson Conservatism Scale had been completed by each individual twin (questionnaires are included in Appendix A). The Australian Twin Registry Questionnaire contains a 64-item, self-report battery assessing various life cycle characteristics such as family background, general health and life-style, reproductive history, educational attainment, personal habits, and current life situation. The Eysenck Personality Questionnaire (Eysenck and Eysenck, 1975) is a 90-item, self-report measure of personality which assesses

three bipolar traits: introversion-extraversion, emotional instability-emotional stability (neuroticism), and toughmindedness-tendermindedness (psychoticism). The Wilson-Patterson Conservatism Scale (Wilson and Patterson, 1968) is a self-report instrument consisting of 50 one- and two-word attitudinal statements such as "Divorce" and "Capital Punishment". Subjects respond by indicating whether they agree, disagree, or are uncertain about each item. A conservatism score is calculated by summing over the 50 responses.

All subjects volunteered to participate in the study by forwarding their name and address to the Australian Twin Registry. They then received the three questionnaires and a covering letter with instructions through the mail. The questionnaires were completed at home and returned to the Twin Registry. The subjects were explicitly requested not to discuss any of their answers with their co-twin.

#### Data Reduction and Analysis

Twin pairs were split into two samples to provide for replicability analyses and separate analyses were conducted on males and females. The following variables were selected from the data set and incorporated in all analyses: (1) birth weight in oz; (2) height in cm; (3) weight in kg; (4) ponderance index (height in cm x 10/weight in kg cubed); (5) family size (number of biological offspring); (6) incidence of multiple births; (7) birth spacing (the average number of years separating the birth of each biological child); (8) good

health (a composite standardized measure incorporating amount of medication taken, number of past and present illnesses, the number of operations undergone, and number of days ill during the past year); (9) education (measured on a seven point scale where 1 = less than seven years, 2 = eight to ten years, 3 = 11 to 12 years, 4 = apprenticeship, 5 = technical school or teachers college, 6 = university graduate, and 7 = postgraduate university); (10) occupation (seven point scale as above with 7 reflecting the highest occupational level); (11) extraversion; (12) psychoticism; (13) neuroticism; and (14) conservatism. For females, the following additional variables were included: (15) age at menarche; (16) length of menstrual cycle (days); (17) age at first pregnancy; (18) number of miscarriages; and (19) number of pregnancies.

Means and standard deviations of these variables were first calculated for each of the four sub-samples. Test-retest reliabilities for each variable were calculated on a sub-sample of 96 repeaters. Correlation coefficients among these variables were then calculated with the effects of age partialled out, separate matrices being generated for each sex. Missing values were deleted in a pair-wise fashion. Next, principal component analyses were conducted on these two matrices. Aggregate scores were then constructed for each case by summing Z-scores for variables predicted to increase with K and subtracting scores for variables predicted to decrease with K. Such aggregates of multiple measures provide more stable and representative estimators than any single

measure, as has been shown by Rushton, Brainerd, and Pressley (1983) for human data and Ossenkopp and Mazmanian (1985) with data from animals. Heritability estimates were calculated for two such aggregates, one which included all variables except neuroticism and psychoticism, the other which included only those variables loading in the predicted directions. For both of these measures, separate analyses were conducted allowing either zero, one, or two missing values per twin (missing values for a variable were converted to a z-score mean of 0).

The heritability estimates were calculated for factors and individual variables using Falconer's  $h^2$  formula,

$$2(r_{MZ} - r_{DZ})$$

where  $r_{MZ}$  is the correlation coefficient between MZ twin pairs, and  $r_{DZ}$  is the correlation coefficient between same-sexed DZ pairs (Cattell, 1982; Falconer, 1981). Pearson product-moment correlation coefficients rather than intra-class coefficients were used in the above calculations owing to the large number of instances where data were missing for one member of a pair. The obtained product-moment correlations were almost identical to the intra-class correlations when comparisons could be made (i.e., on those variables with few missing values), which suggests that the product-moment correlations were relatively good estimators of what the intra-class correlations would have been, had it been possible to calculate them. Cattell (1982, pp. 68, 267) has remarked that product-moment correlations are only slightly biased at any rate, and are often used in practice. The

slight bias arises from the fact that product-moment correlations omit the double entry, that is, twin 1 with twin 2 and twin 2 with twin 1. The other difference is conceptual: intra-class correlations are derived from comparisons of within-group and between-group variances and are stated as variance ratios. See also Loehlin and Nichols (1976, p. 143) for additional remarks on difficulties which may sometimes arise in calculating intraclass correlations.

### Results

Means and standard deviations of the variables used in the analyses are presented in Table 2 for males and Table 3 for females. As can be seen in the tables, the means for each twin sample are very congruent within each sex. As would be expected, the males tend to have heavier birth weights, and are taller and heavier than the females. They also tend to report being in better health and to have a higher education and occupational status. The average family size of 1.1 children for males and 1.5 children for females appears to be slightly lower than what one would expect from an average sample. (49.3% of the cases reported 0 children, 8.3% one, 19.1% two, 13.4% three, 6.1% four, 2.3% five, and the remaining 1.5% six or more). This anomaly might be attributable to the young age of most of the respondents, half of which were under 30 years old at the time of completing the questionnaire. The remainder of the means, however, are quite within the normative range. Test-retest reliabilities for these variables, calculated on a sample of 96 cases, are

Table 2. Means and standard deviations of the variables used in the analyses (males only).

	Twin 1		Twin 2	
	Mean	SD	Mean	SD
Birth Weight (oz)	93.70	(23.86)	92.45	(21.84)
Height (cm)	177.12	(6.79)	176.87	(6.72)
Weight (kg)	72.98	(13.32)	72.97	(13.14)
Ponderance Index	424.93	(13.30)	424.63	(13.82)
Family Size	1.10	(1.47)	1.10	(1.50)
Twinning	0.04	(0.20)	0.03	(0.24)
Birth Spacing (yrs)	2.77	(1.48)	2.83	(1.67)
Good Health <sup>1</sup>	0.43	(2.27)	0.49	(2.10)
Education	3.98	(1.54)	3.92	(1.50)
Occupation	3.81	(1.42)	3.78	(1.44)
Extraversion	12.97	(4.86)	12.82	(5.07)
Psychoticism	4.17	(2.64)	4.14	(2.73)
Neuroticism	8.99	(5.08)	9.23	(5.19)
Conservatism	44.97	(13.10)	45.43	(13.33)

<sup>1</sup> Aggregated Z-scores



Table 3. Means and standard deviations of the variables used in the analyses (females only).

	Twin 1		Twin 2	
	Mean	SD	Mean	SD
Birth Weight (oz)	87.75	(21.14)	85.96	(22.78)
Height (cm)	162.74	(6.68)	162.63	(6.56)
Weight (kg)	58.95	(9.06)	58.61	(9.38)
Ponderance Index	419.93	(20.56)	420.23	(20.77)
Menarche (yrs)	13.14	(1.39)	13.15	(1.43)
Menstrual Cycle (days)	28.05	(4.32)	28.21	(4.68)
First Pregnancy (yrs)	23.69	(4.17)	23.57	(4.02)
Number of Pregnancies	1.79	(1.93)	1.81	(1.99)
Number of Miscarriages	0.25	(0.54)	0.26	(0.56)
Family Size	1.47	(1.65)	1.46	(1.63)
Twinning	0.04	(0.21)	0.03	(0.20)
Birth Spacing (yrs)	2.82	(1.74)	2.87	(1.52)
Bad Health <sup>1</sup>	0.30	(2.55)	0.30	(2.60)
Education	3.33	(1.35)	3.31	(1.36)
Occupation	3.55	(1.11)	3.53	(1.13)
Extraversion	12.52	(4.89)	12.37	(5.04)
Psychoticism	2.81	(2.01)	2.79	(2.04)
Neuroticism	11.34	(5.23)	11.31	(5.17)
Conservatism	48.88	(12.29)	49.13	(12.32)

<sup>1</sup> Aggregated Z-scores

Table 4. Test-retest reliability coefficients for the variables used in the analyses (96 cases).

Variable	r
Birth Weight (oz)	.97
Height (cm)	.95
Weight (kg)	.97
Ponderance Index	.91
Menarche (yrs) <sup>1</sup>	.81
Menstrual Cycle (days) <sup>1</sup>	.45
First Pregnancy (yrs) <sup>1</sup>	.81
Number of Pregnancies <sup>1</sup>	1.00
Number of Miscarriages <sup>1</sup>	.71
Family Size	.96
Twinning	.62
Birth Spacing (yrs)	.97
Good Health	.67
Education	.83
Occupation	.82
Extraversion	.83
Psychoticism	.71
Neuroticism	.85
Conservatism	.90
Mean	.83

<sup>1</sup> Females only

Table 5. Correlation coefficients for males (Twin 1, age partialled out).<sup>1</sup>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. B-weight	22*	16*	01	04	03	-04	01	04	04	02	-03	05	04	-01
2. Height		52*	35*	06*	01	-09*	-02	08*	12*	-04	04	-03	02	
3. Weight			-61*	17*	04	-15*	-07	-00	02	05	07	02	08	
4. Ponderance Index				-13*	-03	06	04	06	09*	-10*	-03	-05	-06	
5. Family Size					25*	-27*	-15*	-05	01	-00	03	-03	08*	
6. Twinning						-32*	01	-02	01	05	02	-02	00	
7. Birth Spacing (yrs)							07	-07	-11*	04	-02	07	01	
8. Good Health								03	05	04	-03	-24*	00	
9. Education									59*	-03	-07*	-05*	-24*	
10. Occupation										-01	-04*	-11*	-20*	
11. Extraversion										01	-19*	-03		
12. Psychoticism											13*	-14*		
13. Neuroticism														-05
14. Conservatism														

<sup>1</sup> Decimals omitted

\* p < .05

Table 6. Correlation coefficients for males (Twin 2, age partialled out).<sup>1</sup>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. B-weight	24*	20*	-01	-01	-01	06	-01	03	03	03	01	04	-02	00
2. Height		49*	36*	06*	04	-11*	01	05*	.13*	-04	01	-02	-02	-01
3. Weight			-63*	12*	02	-12*	-02	02	02	02	03	01	-01	00
4. Ponderance Index				-08**	01	03	03	02	02	09*	-09*	01	-00	-02
5. Family Size					21*	-26*	-06*	-02	04	04	-00	04	00	08*
6. Twinning						-20*	-01	-06	-05	01	-00	06	06	03
7. Birth Spacing (yrs)							-08	-08	-18*	14	-03	-06	05	
8. Good Health								-00	05	09	-09	-22*	03	
9. Education									57*	-04	-05*	-06*	-29*	
10. Occupation										-02	-09	-13*	-17*	
11. Extraversion											07	-19*	-02	
12. Psychoticism											08*	-20*		
13. Neuroticism														-01
14. Conservatism														

<sup>1</sup> Decimals omitted \* p < .05

Table 7. Averaged correlation coefficients for males (Twin 1 and 2, age partialled out).<sup>1</sup>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. B-weight	23*	18*	00	01	01	01	01	-00	04	03	-01	05	01	-01
2. Height		51*	36*	06*	03	-10*	-01	07*	13*	-04	03	-03	01	
3. Weight			-62*	15*	03	-14*	-05	01	02	04	04	01	04	
4. Ponderance Index				-11*	-02	05	04	04	09*	-10*	-01	-03	-04	
5. Family Size					23*	-27*	-11*	-04	03	-00	04	-02	08*	
6. Twinning						-26*	-00	-04	-03	03	01	02	02	
7. Birth Spacing (yrs)							-01	-08	-15*	09	-03	01	03	
8. Good Health								-02	-05	-06	06	23*	-02	
9. Education									58*	-04	-06*	-06*	-27*	
10. Occupation										-02	-07	-12*	-19*	
11. Extraversion											04	-19*	-03	
12. Psychoticism												11*	-17*	
13. Neuroticism														-03
14. Conservatism														

<sup>1</sup> Decimals omitted \* p < .05

Table 8. Correlation coefficients for females (Twin 1, age partialled out).<sup>1</sup>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
1. B-weight	21°	14°	03	-02	01	-05	01	-01	03	01	00	00	-00	01	00	04°	-01	-01	03		
2. Height	42°	42°	12°	-02	07	01	-00	02	-00	02	-04	-04	-02	07°	07°	02	00	-05°	-01		
3. Weight	-64°	-07°	03	-03	03	09°	05	08°	01	01	01	07°	-04	01	01	02	-01	-03	03		
4. Ponderance Index	10°	-05	10°	-05	09°	09°	-07°	-05	-06°	00	-03	-08°	08°	05°	-01	02	-02	-04	03		
5. Menarche	04	01	02	03	02	03	02	01	03	03	03	03	03	03	-05°	07°	00	03	03		
6. Menstrual Cycle	00	01	01	00	00	00	00	00	00	00	00	00	00	00	-01	-06	-01	-00	05		
7. Age at First Pregnancy	-40°	-14°	-39°	-01	-10°	-09°	29°	32°	02	-09°	-00°	-04	09°	16°	-11°	03	05	04	09°		
8. Number of Pregnancies	48°	86°	10°	-17°	-09	16°	-11°	-03	05	04	09°	17°	04	01	-10°	-02	04	01	07°	03	-07
9. Number of Miscarriages	23°	-24°	-06	-19°	-15°	-03	03	13°	03	13°	23°	-24°	-06	-19°	-15°	-03	03	03	13°	13°	
10. Family Size	-25°	01	-06	-00°	-02	03	01	02	03	01	02	-25°	01	-06	-00°	-02	03	01	02	02	
11. Twinning	00	00	01	02	00	02	00	02	03	03	00	00	00	01	02	00	02	03	03	03	
12. Birth Spacing (yrs)	03	01	-01	-05	-20°	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	
13. Good Health	57°	04°	01	-19°	-22°	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	
14. Education	-02	-03	-22°	-13°	09°	-14°	-12°	12°	-10°	05	05	05	05	05	05	05	05	05	05	05	
15. Occupation	09°	-14°	-12°	12°	-10°	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	
16. Extraversion	09°	-14°	-12°	12°	-10°	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	
17. Psychoticism	12°	-10°	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	
18. Neuroticism	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	
19. Conservatism	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	

<sup>1</sup> Declared omitted p < .05

Table 9. Correlation coefficients for females (Twin 2, age partialed out).<sup>1</sup>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. B-weight	21°	10°	-02°	00°	02°	-04°	05°	03°	05°	03°	00°	00°	00°	-00°	-01°	07°	01°	-07°	-01°
2. Weight	41°	39°	00°	-03°	03°	02°	00°	03°	04°	00°	01°	05°	05°	05°	07°	02°	02°	-07°	-01°
3. Weight	-66°	-13°	02°	-00°	09°	01°	10°	00°	-00°	-07°	-03°	-05°	06°	04°	-04°	04°	-04°	02°	
4. Ponderance Index	20°	-03°	09°	-00°	-01°	-08°	-01°	-08°	04°	07°	06°	00°	-02°	-02°	-00°	-02°			
5. Menarche	03°	05°	-04°	-01°	-04°	-01°	-04°	-01°	06°	09°	-01°	-00°	05°	02°	-00°	03°			
6. Menstrual Cycle	02°	01°	-02°	03°	-01°	00°	03°	03°	03°	02°	-02°	-03°	00°	-02°					
7. Age at First Pregnancy	-37°	-20°	-39°	-01°	-13°	12°	27°	22°	02°	-10°	-14°	-04°							
8. Number of Pregnancies	55°	04°	06°	-14°	-03°	-16°	-10°	-00°	02°	03°	07°								
9. Number of Miscarriages	22°	-01°	-00°	-09°	-06°	-06°	02°	06°	06°	-03°									
10. Family Size	17°	-26°	01°	-17°	-11°	-02°	00°	09°											
11. Twinning	-21°	-01°	-03°	-06°	02°	02°	-01°	-00°											
12. Birth Spacing (yrs)	-02°	05°	-01°	01°	04°	09°	-11°												
13. Good Health	03°	05°	01°	-05°	-25°	01°													
14. Education	55°	04°	01°	-13°	-24°														
15. Occupation	01°	-01°	-14°	-16°															
16. Extraversion	00°	-20°	-10°																
17. Psychoticism	12°	-25°																	
18. Neuroticism																			
19. Conservatism																			

<sup>1</sup> Decimals omitted \* p < .05

Table 10. Averaged correlation coefficients for females (Twin 1 and 2, age partialled out).<sup>1</sup>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. B-weight	21 <sup>a</sup>	16 <sup>a</sup>	01	-01	.02	-05	03	01	04	02	00	04	01	00	06	00	00	-04	01
2. Height	42 <sup>a</sup>	41 <sup>a</sup>	10 <sup>a</sup>	-03	05	02	00	03	02	02	-06	02	06 <sup>a</sup>	06 <sup>a</sup>	05	01	-06 <sup>a</sup>	-01	
3. Weight	-65 <sup>a</sup>	-10 <sup>a</sup>	03	-06	09 <sup>a</sup>	03	09 <sup>a</sup>	03	09 <sup>a</sup>	01	-04	-07 <sup>a</sup>	-03	-02	04	02	-04	03	
4. Ponderance Index	19 <sup>a</sup>	-04	09 <sup>a</sup>	-08 <sup>a</sup>	-03	-07 <sup>a</sup>	-02	01	08 <sup>a</sup>	07 <sup>a</sup>	07 <sup>a</sup>	-02	00	-01	-03				
5. Menarche	04	03	-01	01	-01	01	05	06	-02	-07 <sup>a</sup>	-06 <sup>a</sup>	05	02	03					
6. Menstrual Cycle	01	01	-01	02	-01	04	02	02	02	-01	-04	-02	00	03					
7. Age at First Pregnancy	-39 <sup>a</sup>	-17 <sup>a</sup>	-39 <sup>a</sup>	-01	-16 <sup>a</sup>	11 <sup>a</sup>	28 <sup>a</sup>	27 <sup>a</sup>	02	-10 <sup>a</sup>	-11 <sup>a</sup>	-04							
8. Number of Pregnancies	52 <sup>a</sup>	05 <sup>a</sup>	00 <sup>a</sup>	-16 <sup>a</sup>	-06	-16 <sup>a</sup>	-11 <sup>a</sup>	-02	04	00 <sup>a</sup>									
9. Number of Miscarriages	20 <sup>a</sup>	02	01	-10 <sup>a</sup>	-04	-01	02	07 <sup>a</sup>	04 <sup>a</sup>	-05									
10. Family Size	20 <sup>a</sup>	-25 <sup>a</sup>	-03	-10 <sup>a</sup>	-13 <sup>a</sup>	-03	02	02	11 <sup>a</sup>										
11. Twinning	-23 <sup>a</sup>	-00	-05	-07 <sup>a</sup>	00	03	00	01											
12. Birth Spacing (yrs)	05	-03	00	02	02	06	-07												
13. Good Health	03	03	-00	-05 <sup>a</sup>	-27 <sup>a</sup>	02													
14. Education	56 <sup>a</sup>	04 <sup>a</sup>	01	-16 <sup>a</sup>	-23 <sup>a</sup>														
15. Occupation				-01	-02	-18 <sup>a</sup>	-15 <sup>a</sup>												
16. Extraversion	09 <sup>a</sup>	-17 <sup>a</sup>	-11 <sup>a</sup>																
17. Psychoticism																			
18. Neuroticism																			
19. Conservatism																			

<sup>1</sup> Decimals omitted . . . p. 05



Table 11. Factor loadings for confirmatory two factor solution (males) and one-factor solution (females), and solutions suggested by the eigenvalue > 1 rule

	FACTOR 1	FACTOR 2	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
BMEI01T	03401	04403	02203	00701	00774	01387	04428	03009
HT	15313	13094	04614	11516	49424	00552	63719	00293
LITTER	14223	03522	04174	03410	63750	00600	06638	00394
SPACE	09120	51404	02234	50804	12231	03784	09974	04124
STCK	10494	43041	05924	45804	01399	00162	03274	03003
EDACH	07582	57182	13288	57434	04284	04139	01407	01893
DCC	72483	07498	03288	03779	07498	32329	04098	06270
EA	77043	05930	80857	03641	00447	00948	03522	05742
M	01834	15473	05377	07426	08442	08724	03448	01783
CUNSER	12343	04894	09331	04294	02868	31515	04859	10742
	27801	02434	08544	02437	01461	65889	07780	40478
		01372	74871	03031	04579	00401	05835	50145

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8
BMEI01T	04594	00480	22787	01332	00834	00094	03946	01940
HT	01129	33140	93170	04271	07803	00492	04380	01049
LITTER	15090	69992	69990	03782	00041	02880	04499	02282
SPACE	09223	60278	04474	18470	01971	00520	00062	02928
STCK	03557	19702	04444	15910	01942	00431	03498	03111
EDACH	00740	03687	00157	01609	04797	01914	00176	04932
EA	47636	02955	01822	32268	18434	07740	10974	04932
M	91005	04131	05222	06086	14161	93118	03374	07783
CUNSER	24152	00199	00421	00758	02402	69237	08033	08230
LITTER	15384	00413	06909	08714	31097	04348	00973	03800
SPACE	14292	04493	00913	04799	71401	03374	00123	03800
STCK	10339	07668	00399	01524	03899	07732	00976	08370
EDACH	32208	01527	00182	72300	01532	02387	36340	06430
DCC	27801	03473	00928	75292	04513	02384	07302	00482
EA	04217	00293	06633	02742	02107	02784	21070	25926
M	04614	02124	00973	02712	00878	01040	13798	44313
CUNSER	13329	01547	01842	30889	04224	01902	69022	00230
			01540		04677	02278	00178	48192

Table 12. Correlation coefficients between monozygotic (MZ) twins and same-sexed dizygotic (DZ) twins, and heritability estimates (Falconer's  $h^2$ ) for aggregates and individual variables. Values in parentheses are corrected for reliability.

	$r_{MZ}$	$r_{DZ}$	$h^2$
Aggregate 1	.64 (.77)	.42 (.51)	.43 (.52)
all variables)	.61 (.73)	.38 (.45)	.47 (.56)
	.66 (.80)	.39 (.47)	.54 (.65)
Aggregate 2	.56 (.67)	.40 (.48)	.32 (.39)
load as predicted)	.57 (.69)	.42 (.50)	.31 (.38)
	.64 (.78)	.45 (.54)	.40 (.48)
Birth Weight	.71 (.73)	.69 (.71)	.04 (.04)
Height	.87 (.92)	.44 (.46)	.95 (.93)
Weight	.78 (.80)	.34 (.35)	.88 (.90)
Ponderance	.75 (.82)	.38 (.42)	.74 (.80)
Menarche	.65 (.80)	.19 (.24)	.92 (.95)
Menstrual Cycle	.37 (.32)	.14 (.31)	.47 (.21)
First Pregnancy	.43 (.53)	.33 (.41)	.19 (.24)
Number of Pregnancies	.58 (.58)	.51 (.51)	.14 (.14)
Number of Miscarriages	.20 (.28)	.12 (.17)	.17 (.22)
Family Size	.64 (.67)	.54 (.56)	.19 (.22)
Twinning	.06 (.10)	.03 (.05)	.06 (.10)
Birth Spacing	.09 (.11)	.11 (.11)	.00 (.00)
Good Health	.44 (.66)	.28 (.42)	.33 (.48)
Education	.68 (.82)	.46 (.55)	.43 (.54)
Occupation	.63 (.77)	.47 (.57)	.33 (.40)
Extraversion	.53 (.64)	.18 (.22)	.70 (.84)
Psychoticism	.38 (.54)	.24 (.34)	.29 (.40)
Neuroticism	.50 (.59)	.22 (.26)	.55 (.66)
Conservatism	.69 (.77)	.57 (.63)	.23 (.28)

- 1 0 missing values allowed (nMZ = 119, nDZ = 41)  
 2 1 missing value allowed (nMZ = 617, nDZ = 317)  
 3 2 missing values allowed (nMZ = 1315, nDZ = 750)

presented in Table 4. Test-retest intervals ranged from one to ten months, the mean and modal intervals being three months and two months, respectively. Thus it would seem that this data set demonstrates sufficient reliability and validity to warrant confidence in analyses based on them.

Age-partialled correlation coefficients among the variables for males are presented in Tables 5 (twin 1) and 6 (twin 2). The averaged correlations for the two samples are presented in Table 7. In these and the subsequent correlations for females, a coefficient is reported as statistically significant only if the level of significance was less than .05 for both twin samples of that sex. As can be seen in Table 7, birth-weight did not correlate with any variables other than the subjects' current height and weight. Height was highly correlated with both weight and ponderance (unsurprisingly), and rather more modestly with family size, education and occupation. A low but significant negative correlation was found between height and birth spacing. Aside from ponderance, to which it is a contributing variable, weight correlated positively with family size and negatively with birth spacing. Ponderance was negatively correlated with both family size and extraversion, and positively correlated with occupational level. In addition to the body size measures reported above, family size was also positively related to incidence of twinning, poor health, and conservatism. Birth spacing correlated negatively with family size, twinning, and occupational level. Poor health was found

to be related to larger family size and high scores on the neuroticism scale. As might be expected, a strong correlation was found between education and occupational level. The personality measures tended to be most related to education and occupation, and each other, rather than the more biological variables, with the few small exceptions noted above.

Correlation coefficients for the female twins are presented in Tables 8, 9, and 10. As was the case for males, these coefficients are only reported as significant if the probabilities are less than .05 in both twin samples. As can be seen in Table 10, which presents the averaged coefficients, the pattern of correlations among birth-weight, height, weight, ponderance, and family size, are virtually identical to the pattern reported for males. Age at menarche was positively correlated with height, ponderance, and extraversion, and negatively related to weight and occupation. Age at first pregnancy correlated with almost every measure, the strongest relationships being with number of pregnancies and family size (negative), and education and occupation (positive). High positive correlations were found among number of pregnancies, number of miscarriages, and family size, and these variables tended to be strongly and inversely related to birth spacing. Education, occupation, and the personality measures tended to be correlated among themselves. Unlike the male twins, however, these variables tended to be moderately correlated with a number of the biological

measures.

The age-partialled correlation matrices were first subjected to confirmatory-type factor analyses where one-factor solutions were forced (eigenvalues and variance accounted for the factors are included in Appendix B). Weight was not included in the male analysis, as the communality estimates and loadings for this variable exceeded one. Examination of the loadings for the forced one-factor male solution revealed an education-occupation or socioeconomic status (SES) dimension accounting for 14.2% of the total variance, rather than a reproductive dimension. A two-factor solution was then forced and a family-size or reproductive dimension emerged as a second factor, accounting for an additional 12.0%. Seven of the eleven loadings for the second factor are in the directions predicted by r/K theory, the exceptions being birth weight, height, extraversion, and conservatism, all of which had loadings of less than .10. Of the three variables with loadings of .25 or greater, all were in the predicted direction. None of the social or personality variables had loadings greater than .10. The pattern of loadings for the female solution is very similar to that for the second male factor. This first component reflects, in order of magnitude, number of pregnancies, family size, age at first pregnancy, number of miscarriages, educational attainment, occupational level, and accounts for 14.1% of the total variance. Twelve of seventeen of the variables load in the directions predicted by K theory, the exceptions being

birth weight, weight, length of menstrual cycle, and once again, extraversion and conservatism. Of the variables with loadings greater than .25, six out of six were in the predicted directions. As was the case for the male solution, most of the variables for which the predictions were not met had trivial loadings of less than .10. For both the male (II) and female (I) solutions, the variables loading most highly were those directly related to reproduction. This was especially so for females. The personality variables, however, almost uniformly failed to load as predicted. Neuroticism and psychoticism did not appear related to the reproductive dimension at all.

In order to further explore the structure of this data and to examine the role of certain logical dependencies, 96 additional factor analyses were conducted. Two-factor through eight-factor unrotated and VARIMAX rotated solutions for both males and females were examined. The six-factor VARIMAX rotated solution (males) and the eight-factor solution (females) suggested by an eigenvalue  $> 1$  rule are presented in the right panels of Table 11. As might be expected, these additional small factors reflected the remaining relationships in the data, such as height-ponderance-birth-weight, bad health-neuroticism, and so on. This pattern was similar for females. Number of pregnancies was dropped from several female solutions to examine the role of logical dependency. Loadings for education and occupation increased in this solution, though the reproductive measures still loaded highly

in the predicted directions (education = .66, occupation = .61, age first pregnancy = .50, family size = -.39, ponderance = .23). Dropping occupation, psychoticism, and neuroticism from the male analyses removes the SES first factor and a very strong reproductive factor emerges accounting for 17.3% of the total variance. These various analyses suggest two things: (1) the factors which emerge reflect the existing relationships among the remaining variables; and (2) while removing extremely dependent variables influences the magnitude of loadings in predictable ways, a dimension reflecting reproduction invariably emerges.

Correlation coefficients between MZ twin pairs and DZ twin pairs for aggregates and individual variables are presented in Table 12 (the values in parentheses are corrected for the reliability of the item). Correlations were calculated separately for each sex and the reported coefficients are weighted averages. In addition, only same-sexed DZ pairs were included in these calculations, this being regarded as a more conservative approach to such comparisons for inclusion of opposite-sexed twins typically lowers the DZ correlations and consequently raises all of the heritability estimates (Cattell, 1982). As can be seen from the table, the two aggregates and all of the individual variables, with the exception of birth weight and birth spacing, demonstrate some degree of genetic influence. Aggregate 1 includes all of the variables for which predictions were made (i.e., all except neuroticism and

psychoticism) whereas Aggregate 2 includes only those variables which loaded in the predicted directions on the reproductive factor.

#### Discussion of Study 1

In terms of the absolute number of predictions confirmed, these results provide initial, but qualified support for the application of the r/K continuum to humans. Nineteen of 28 predictions (68%) were confirmed overall. This proportion is significantly greater than a chance proportion of 50%, using the normal curve approximation of the binomial test ( $z = 1.91$ ,  $p < .028$ , one-tailed). If one considers only the more biological and reproductive variables, all except birth weight (and height for males) load as predicted on the reproductive factor. Family size, which might be considered one of the most theoretically important variables, was among the highest loaders in both the male and female solutions. This dimension, moreover, was shown to be under some degree of genetic influence. The predictions for the personality variables, however, were uniformly not confirmed. In addition, for males, a dimension of education and occupation emerged as the first factor and accounted for slightly more variance (2.2%) than did the reproductive dimension. On the basis of these findings, one might tentatively entertain the notion of a heritable reproductive dimension underlying a number of biological and reproductive variables, but apparently unrelated to personality, or at least for those personality measures included in this analysis. These data



further suggest that this reproductive dimension might be stronger for females, although this could be an artifact of there being fewer reproductive measures for males in the data set.

There are, however, several caveats concerning even the more narrow interpretation presented above. The first of these concerns the amount of variance accounted for by the reproductive dimension, which is only between 12 and 14 per cent. The second problem involves what might be called logical dependencies in the data, both in the present data set and in any life history data set. As twinning rate increases, for example, so too must family size. The number of pregnancies and family size must similarly be inter-dependent, as would any variety of body size measures. While these logical dependencies do not threaten the logical validity of K theory (as indeed, one would expect them), their presence does make empirical analyses and interpretations more difficult. Analyses with certain of the interdependent variables removed still provided support for K theory, however.

Another set of caveats are concerned with explanations for the data presented. Alternative "social" theories for the present findings must be considered. In their most simplified form, such theories would maintain that wealthier people, because they can afford more food of better quality, increased medical care, higher education, and so forth, would tend to be taller, healthier, more intelligent, and have access to better jobs. They could, in addition, intentionally limit their

family size in accord with the current ethos, and, either actively or passively instill similar behaviours and beliefs in their progeny through mechanisms of social learning.

Although the results of the present study cannot rule out these possibilities, the fact that many of these phenomena are known to be genetically influenced reduces the power of exclusively social arguments. (From the perspective of K theory, of course, greater wealth is a predicted consequence of a K strategy rather than a cause.) In any case, it is worth noting that Differential K theory does not claim that all of the variance in bio-social phenomena is genetically determined, only that a proportion of the variance is so attributable.

On the other hand, the relatively weak effects in the data may be due to artifacts which have biased the results against K theory. Restriction of range, for example, is one such bias, especially for the birth spacing measures. By definition, a family must have at least two children in order for a score to be obtained and included in calculations. This would exclude, of course, those families with zero or one child and thus reduce any correlations between this measure and other K-related variables. Compounding this problem is the fact that dates of birth for children in families with more than six children were not recorded in the present data set, thereby also removing cases from the r end of the continuum.

## Experiment 2

The second investigation was conducted to replicate and extend the first study while redressing some of its shortcomings. In particular, a number of pertinent new variables were added. A questionnaire was developed in which respondents provided information on age at onset of puberty (males as well as females this time), family background, including size and marital stability, and an account of their sexual history and current sexual behaviour. In addition, the questionnaire included a self-report measure of altruism and attitudinal measures for a number of K-related domains. The study was conducted using a large sample of university undergraduates.

A number of the predictions from the first experiment were retested in this data set. Once again the central prediction was that the bio-social variables included in the analyses would load on a single first factor in the manner predicted by Rushton (1985). Specifically, the following variables were predicted to load positively on the first factor: (1) height; (2) weight; (3) birth spacing; (4) family stability; (5) age at puberty onset; (6) age at first coitus; (7) academic achievement; and (8) altruism. Negative loadings were predicted for the following variables: (9) number of siblings; (10) extended family size; (11) the number of different sexual partners in the respondent's lifetime; (12) number of sexual partners during the past year; (13) frequency of sexual intercourse; (14) maximum number of orgasms (this

prediction was relevant for males more so than females, although insofar as it is a measure of sex drive, the same direction was predicted for females); and (15) extraversion. With regard to the attitudinal measures (predicted directions in parentheses), high K persons were predicted to report wishing to marry at a later age (+) and to desire a smaller number of children (-). They were also predicted to strongly agree with statements on the importance of faithfulness to one's marriage partner (+), the desirability of long-term, monogamous relationships (+), and the undesirability of premarital and extramarital sex (-). As an additional precaution, two validity scales were embedded in the questionnaire: social desirability and infrequency. While these scales were included primarily as measures of response style and test-taking attitude, one could speculate that desirability, as a substantive construct, should load positively, and infrequency negatively.

## Method

### Subjects

Two-hundred and fifty undergraduate students at the University of Western Ontario participated in the study. This sample included 123 females and 127 males whose mean age was 20.5 years old (range = 18.2 - 41.9; mode = 19.5). Two-hundred and forty-two (96.8%) of the subjects were never married, five (2%) were currently married, one (0.4%) was divorced, and two (0.8%) did not respond to that item.

Participants were informed of the sexual and personal nature of many of the questions before volunteering and received one credit toward their introductory psychology course requirements for their time.

#### Measures and Procedure

Each subject completed a thirteen-page questionnaire consisting of an academic performance scale, several personality scales, and a personal history inventory (see Appendix C). The academic performance scale is a 5-item measure for which respondents provide their grade 12 average, grade 13 average, their Christmas grades for university courses taken in the current year, and yearly grade-point averages if this was not their first year at university. The personality measures included the extraversion scale from the Eysenck Personality Questionnaire (Eysenck and Eysenck, 1975), the infrequency and social desirability scales from the Personality Research Form (Jackson, 1974), and the Self-Report Altruism Scale (Rushton, Chrisjohn, and Fekken, 1981). The infrequency and desirability scales are 16-item, self-report instruments in true/false format, and assess careless or nonpurposeful responding and the tendency to respond in a socially desirable or undesirable fashion, respectively. Items from these two scales were embedded randomly with the extraversion items. The Self-Report Altruism Scale is a 20-item measure designed to assess pro-social or helping behaviour. Respondents are required to rate the frequency with which they have engaged in behaviours such as giving

money to charity and donating blood, using the categories "never", "once", "more than once", "often", and "very often". Finally, the personal history inventory is a 71-item measure, portions of which are modified after Eysenck (1976), for which respondents provide background information about themselves and their families, their past and current dating behaviour, their past and current sexual behaviour, and their attitudes toward marriage and sex.

Subjects completed the questionnaire in groups during the last half of the second (winter) university semester. Males and females were tested in separate groups and were seated in a maximally-dispersed fashion to prevent others from inspecting their responses. No identifying information of any sort was collected and care was taken to emphasize, both verbally and in the written instructions, the subjects' right to discontinue their participation at any time without loss of credit and their right to refuse to answer any questions. The entire testing session took between 40 and 50 minutes, including debriefing, which occurred immediately following completion of the questionnaire (a copy of the debriefing sheet is included in Appendix C).

#### Data Reduction and Analysis

The following variables were included in the analyses: (1) height in cm; (2) weight in kg; (3) the number of biological siblings, including any who are deceased; (4) an extended family-size measure which included number of biological siblings of the respondent as well as the number of

biological siblings for the respondent's biological mother and father; (5) average birth-spacing in years for the respondent and biological siblings; (6) a family-stability measure in which the number of separations and divorces for each of the respondent's biological parents was subtracted from zero; (7) age at puberty onset (age at menarche in years and months for females and a composite Z-score for males which incorporated age at first shaving, age at growth spurt, age at appearance of pubic hair, and an estimate of whether they entered puberty "much earlier", "a little earlier", "about the same time", "a little later", or "much later", relative to their peers.

Unlike females, whose passage to reproductive maturity is marked by a relatively sudden and noteworthy event, it is much more difficult to estimate the age at which viable sperm are first produced in males, especially so long after the fact.

Since no single acute and reliable marker exists for males, this composite measure may serve as the best estimate of reproductive maturity.); (8) age at first coitus, (9) the number of different sexual partners during their lifetime; (10) the number of different sexual partners during the past twelve months; (11) the maximum number of orgasms during a single sexual encounter; (12) average frequency of sexual intercourse during the past year; (13) an academic achievement score equally reflecting their marks in grade 12, grade 13, and their average at university, or Christmas average in the case of first year students; (14) extraversion; (15) desirability; (16) infrequency; (17) altruism; (18) age at

which respondent would like to get married, if currently single; (19) desired number of children; the extent to which the respondent agrees or disagrees with the statements "I cannot imagine myself ever being unfaithful to a marriage or long-term partner" (#20); "Finding or having a long-term or steady partner is what I desire most, even if I could have as many different sexual partners as I wanted" (#21); "I believe that premarital sex should not occur" (#22); and "I believe that extramarital sex should never occur" (#23). Scores for the last four attitudinal measures were on 7-point scales where 1 was "strongly disagree" and 7 was "strongly agree".

All analyses were conducted separately for each sex. Data from any subjects who reported being "exclusively" or "predominantly" homosexual were not included in any analyses. This restriction resulted in the elimination of data from three males. Partial correlations were calculated among the variables with the effects of age removed and separate principal component analyses conducted on the matrices.

### Results

The means and standard deviations of the variables used in the analyses are presented by sex in Table 13. As can be seen in the table, males are both taller and heavier, on average, than females. The only other apparent sex difference is the number of different sexual partners. The variance for males is more than twice that for females on this measure -- a predictable difference in relation to the body-size dimorphism mentioned above, and one that is in accord with



Table 13. Means and standard deviations of the variables used in the second experiment.

	Males		Females	
	Mean	SD	Mean	SD
Height (cm)	179.56	(11.78)	166.76	(8.67)
Weight (kg)	76.49	(11.60)	57.45	(11.69)
Siblings	2.35	(1.24)	2.51	(1.80)
Extended Family Size	11.15	(4.20)	10.95	(4.49)
Birth Spacing (yrs)	3.15	(2.39)	3.78	(4.34)
Family Stability	-0.78	(1.65)	-0.37	(1.34)
Puberty Onset <sup>1</sup>	0.01	(1.65)	13.28	(1.43)
Age at First Coitus	16.66	(1.67)	16.98	(1.58)
Sexual Partners (life)	6.97	(11.07)	3.17	(4.22)
Partners (past year)	2.18	(2.73)	1.42	(1.63)
Frequency of Intercourse	6.13	(6.48)	5.19	(7.40)
Maximum Orgasms	3.59	(2.39)	2.39	(1.90)
Academic Achievement	76.97	(6.90)	78.02	(6.72)
Extraversion	16.11	(3.41)	17.07	(3.48)
Desirability	9.97	(2.66)	10.63	(2.44)
Infrequency	0.41	(0.85)	0.25	(0.54)
Altruism	56.44	(10.48)	55.57	(10.18)
Preferred Marriage Age	26.84	(2.75)	25.79	(2.56)
Desired Number Children	2.76	(1.15)	2.67	(1.18)
Faithfulness	5.45	(1.69)	5.96	(1.53)
Long-Term Partner	5.37	(1.72)	5.76	(1.71)
Premarital Sex	1.84	(1.37)	2.33	(1.75)
Extramarital Sex	5.80	(1.53)	6.29	(1.42)

<sup>1</sup> years for females and composite z-scores for males

Table 14. Correlation coefficients for males with age pertained out.<sup>1</sup>

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Weight	.44	-.26	-.31	.09	-.06	-.09	.16	-.07	.05	.01	-.15	.02	-.05	.07	-.29	-.05	-.06	.11	.01	-.08	-.16	.19
2. Height	-.22	-.20	-.02	.04	-.25	-.10	-.02	-.01	.06	-.10	-.04	.04	.00	-.16	.13	-.10	.07	.17	-.07	-.19	.06	
3. Siblings	.02	.31	-.20	-.10	-.13	.21	.00	.11	.10	-.16	.05	-.17	-.04	.22	.12	.21	.00	-.03	.04	.11		
4. Extended Family	.12	-.09	.01	.04	-.02	-.09	-.02	.17	.04	-.02	-.10	.10	.06	.04	.04	.02	.00	.06	-.04			
5. Birth Spacing	.00	-.22	.11	.27	-.11	-.11	-.10	.17	.25	-.21	.05	.13	-.10	-.16	.09	-.01	-.22	.13	-.10			
6. Family Stability	.03	.10	-.09	-.03	-.16	.05	-.06	-.09	.13	.16	-.11	.07	-.06	.15	.01	-.10	-.02					
7. Puberty Onset	.25	-.07	-.00	-.01	-.06	.01	-.06	.05	.26	-.16	-.02	-.11	.02	.25	.10	.06						
8. Age at First Coitus	-.50	.31	-.17	-.22	.22	-.00	.09	.10	-.27	-.31	.07	.20	.27	.01	.06							
9. Sexual Partners (life)	.79	.16	.19	-.24	.10	-.20	-.05	.15	.01	.02	-.20	-.29	-.19	-.03								
10. Partners (past year)	.20	.14	-.22	.23	-.13	-.03	.10	.27	.01	-.20	-.19	-.19	-.01									
11. Frequency of Intercourse	.41	-.11	.10	.03	.06	.10	-.11	.19	-.24	-.02	-.27	-.11										
12. Maximal Orgasms	-.00	.14	.07	.03	.10	.06	-.01	-.17	-.05	-.07	-.36											
13. Academic Achievement	-.06	.17	-.03	-.17	-.03	-.11	-.12	.00	.22	-.05												
14. Extraversion	.20	-.15	.21	-.07	.15	-.12	.00	-.14	-.07													
15. Desirability	-.00	.15	-.10	.03	.22	.10	-.01	.10														
16. Infrequency	-.10	.06	-.11	.00	.13	.20	-.01															
17. Altruism	-.02	.12	-.00	-.00	.16	-.06																
18. Preferred Marriage Age																						
19. Desired Number of Children																						
20. Faithfulness																						
21. Long-Term Partner																						
22. Premarital Sex																						
23. Extramarital Sex																						

<sup>1</sup> Decimals omitted \* p < .025

for the female solution, where several attitudinal measures loaded higher. Both of these solutions might fairly be interpreted as representing a sexual/reproductive dimension, especially in view of the high loading for the sexual variables. In terms of the proportion of confirmed predictions, 19 out of 23 loadings were in the predicted directions for the male solution, and 15 of 23 for the female solution. All of the sexual/reproductive measures loaded as predicted. Seven out of eleven of the social, personality and attitudinal measures loaded in the predicted directions for the male solution, and eight of eleven for females. Most of the variables not loading as predicted were of a trivial magnitude.

To further explore the structure of these data and to once again examine the role of logically dependent variables, an additional 66 factor analyses were conducted. Two-factor through eleven-factor, unrotated and VARIMAX rotated solutions were examined for both males and females. The nine-factor solutions suggested by an eigenvalue  $> 1$  rule for males and females are presented in the right panel of Table 16. The first factor consistently remained sexual-reproductive in nature. In the two-factor solutions, a height-weight second factor emerged for males, and an extraversion-altruism second factor for females. The two most logically dependent variables in this data set were number of sexual partners in the respondents' life-time, and number of partners during the past year. Accordingly, an additional analysis was conducted

Table 16. Factor loadings for confirmatory one factor solution (left) and solutions suggested by the eigenvalue of rule (male) top panel, females bottom.)

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8	FACTOR 9
MT	02533	61439	06194	02788	17471	27000	27473	10849	05126
MT	03948	45303	10128	40433	04203	07031	08213	08141	01397
BISS	18643	70067	05983	13348	13053	02448	30917	02344	08096
PARA	04739	33373	01293	00121	04464	08066	04013	01310	04484
PARA	10453	12759	00834	03159	04107	07634	14073	04904	13431
PARA	05478	07642	15234	03159	11123	05302	35289	19164	03934
PARA	01820	00430	04243	34806	20749	03443	02153	01498	00398
PARA	53014	04163	08026	40073	01998	08114	04373	32782	11144
PARA	64713	08446	08132	08487	01347	02847	11908	01192	03302
PARA	82319	11231	17123	04986	15323	02847	44742	12432	15337
PARA	65968	10003	14611	01446	11993	57113	11742	12189	01817
PARA	30309	24810	14611	01446	11993	11348	04433	04938	10074
PARA	33432	04887	14939	10384	12182	11348	11877	15175	34070
PARA	20878	02610	13074	11348	12182	11348	13479	02129	47831
PARA	24347	13068	23441	02012	10924	12068	04474	07744	21933
PARA	19373	08813	00001	45739	01087	15402	11437	30309	27934
PARA	24900	11894	05450	20948	00238	14834	17853	02309	27934
PARA	34087	41878	01276	03792	05443	02355	27147	08422	11934
PARA	00707	04640	16484	04444	01083	07517	08188	04044	14448
PARA	30491	00430	00447	02076	01022	00916	18288	08240	04333
PARA	35018	03134	33507	34914	00984	00816	18288	44034	04761
PARA	19880	10773	02316	17380	08772	00816	00473	44034	02784
PARA	19450	04248	32837	06731	06920	30732	21377	08321	07398

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8	FACTOR 9
MT	00445	05922	06744	02424	05645	14306	01632	64701	14743
MT	15343	01063	00393	23148	04407	05109	08373	22314	04374
MT	18002	96018	04049	11023	02912	01324	00632	05335	00374
BISS	17098	30820	01049	00743	08745	07342	09241	11834	00049
PARA	06191	34434	15206	14003	08844	03749	14310	14333	04049
PARA	18406	18215	30445	05373	02393	01844	14334	13332	10407
PARA	13524	04174	08034	04436	01076	14377	20334	30400	20389
PARA	50034	04922	07101	14337	18279	03108	49440	00349	10873
PARA	92350	07632	01399	14117	10970	04726	30338	01748	12436
PARA	74614	03119	04782	13237	07892	13897	00300	00300	03130
PARA	23034	00979	00364	10998	04953	07897	01093	00134	28140
PARA	38044	02335	08899	10722	04411	07821	17242	00013	04844
PARA	08421	07303	09321	16016	04391	10374	04924	17374	04303
PARA	07645	07880	89744	08804	00024	03803	10885	00118	17004
PARA	23403	04617	41434	04804	10371	03803	10885	00118	31791
PARA	10448	04871	09018	04864	07248	08019	10442	14144	24211
PARA	02416	08340	39184	13384	07043	04244	04942	14144	04844
PARA	36437	00494	04933	01234	84043	04244	00308	02313	04144
PARA	38804	04894	04139	10379	47398	03373	20308	04373	04144
PARA	15004	00098	05443	82173	05443	04373	04470	04373	10482
PARA	45084	02414	04329	12432	19244	04373	19414	04373	10482
PARA	18408	01304	00339	12432	04741	04373	01711	04373	23804
PARA	27314	06098	12711	14377	01742	04373	01787	08377	23804

sociobiological theory. Interestingly, the male means are also greater than the female means for number of sex partners, a finding common to many similar surveys (e.g., Snyder, Simpson, and Gangestad, 1986). The subjects, in general, tended to come from small families and were rather intelligent, as might be expected for university students. (Any university sample such as this would be expected to represent the K end of the r-K distribution.) Most reported wishing to marry in their mid-twenties and desiring between two and three children. Relevant data not presented in the table include the proportion of respondents who have had sexual intercourse. Overall, 79.6% of the subjects reported having had sexual intercourse at least once in their lives, the proportion for males (85.5%) being somewhat greater than that for females (73.6%). This proportion is slightly higher than that recently reported by Snyder et al. (1986; 79.6% as compared to 63%), but this difference is likely attributable to the fact that the subjects in the present study were almost one year older, on average, than those in that study.

Partial correlation coefficients for males are presented in Table 14. Coefficients are reported as significant only if the level of significance was less than .025. As can be seen from the table, height was inversely related to the number of siblings in the immediate family, extended family size, and the maximum number of reported orgasms in a single sexual encounter, as well as positively related to an unfavourable attitude toward extramarital sex. Height was negatively

correlated with infrequency scores. Weight was negatively correlated with number of siblings, extended family size, age at puberty onset, and an unfavourable attitude toward premarital sex. In addition to height, the number of siblings was positively related to extended family size, birth spacing, the number of different sexual partners, altruism, and the desired number of children, and negatively related to family stability. In addition to the above, birth spacing correlated positively with age at first coitus, academic achievement, and preference for a long-term, monogamous relationship.

Most of the sexual behaviour measures tended to covary consistently in the predicted directions. Persons who reached puberty at a younger age were also younger at first coitus. Those who began having sex at an earlier age also tended to have had sex with more different people and reported having a greater maximum number of orgasms. Such persons also tended to be less academically achieving and reported preferring to marry at a younger age. A number of other correlations, however, were either not present or were in directions opposite to that predicted. While age at puberty onset did correlate with age at first coitus, it did not correlate with other measures, such as number of partners or frequency of intercourse. Extraversion was positively related to the number of different sexual partners, but was uncorrelated with the other sexual behaviour measures. Altruism, moreover, failed to correlate as predicted with many of the K variables and correlated in the opposite to predicted direction for

number of siblings and age at first coitus.

As can be seen in Table 15, the pattern of relationships was similar for females, although fewer correlations reached an acceptable level of significance. A number of the correlations were in the predicted directions, but others were either not found, or were in the direction opposite to what was predicted. None of the predictions for the body-size measures were confirmed, with the single but noteworthy exception of height and age at menarche. Similarly, family size and birth spacing measures failed to correlate with other measures, with the exception of family stability, and were correlated with each other in the direction opposite to what was predicted. While age at puberty onset correlated as predicted with age at first coitus, it did not correlate with the other sexual measures, although all were in the predicted direction. Extraversion and altruism failed to correlate as predicted. While a number of the attitudinal measures were significant in the predicted direction, a similar number were not.

Factor loadings for confirmatory-type one-factor solutions for males and females are presented in Table 16. The factor accounts for 14.4% and 14.1% of the total variance, respectively. The highest loading variables for both solutions were the number of sexual partners in both the past year and in total, and age at first coitus, especially for males. Maximum number of orgasms and frequency of intercourse also load highly in the male solution, but somewhat less so

for the female solution, where several attitudinal measures loaded higher. Both of these solutions might fairly be interpreted as representing a sexual/reproductive dimension, especially in view of the high loading for the sexual variables. In terms of the proportion of confirmed predictions, 19 out of 23 loadings were in the predicted directions for the male solution, and 15 of 23 for the female solution. All of the sexual/reproductive measures loaded as predicted. Seven out of eleven of the social, personality and attitudinal measures loaded in the predicted directions for the male solution, and eight of eleven for females. Most of the variables not loading as predicted were of a trivial magnitude.

To further explore the structure of these data and to once again examine the role of logically dependent variables, an additional 66 factor analyses were conducted. Two-factor through eleven-factor, unrotated and VARIMAX rotated solutions were examined for both males and females. The nine-factor solutions suggested by an eigenvalue  $> 1$  rule for males and females are presented in the right panel of Table 16. The first factor consistently remained sexual-reproductive in nature. In the two-factor solutions, a height-weight second factor emerged for males, and an extraversion-altruism second factor for females. The two most logically dependent variables in this data set were number of sexual partners in the respondents' life-time, and number of partners during the past year. Accordingly, an additional analysis was conducted



on the male data, with the number of partners during the past year removed. Once again, a sexual-reproductive first factor emerged. Interestingly, not only were the magnitude of loadings more in keeping with K theory, every biological, family, and sexual variable loaded in the predicted direction.

#### Discussion of Study 2

In this second study, a sufficient number of predictions confirmed to suggest tentative success of the theory (34 of 46, or 74%;  $z = 37.25$ ,  $p < .0006$ , one-tailed). The dimensions reported in this study were similar to those reported in Study 1, both in terms of the direction of loadings and their magnitude, and thus provides a conceptual replication. The fact that the sexual-reproductive measures were among the highest loading variables lends credence to the notion that this dimension is assessing an underlying reproductive strategy. Furthermore, the majority of the new variables included here loaded as predicted, and these variables had been chosen specifically for their relevance to K theory. For females, however, height, weight, and birth spacing again failed to load as predicted, as did the family size measures. As in the first study, however, the results are stronger for the biological and sexual-reproductive measures (19 of 24, or 79%), and less so for the personality and attitudinal variables (10 of 16, or 63%). While extraversion loaded in the predicted direction in both the male and female solutions (albeit trivially for females), altruism --theoretically perhaps the most critical personality variable-- loaded in the

direction opposite to what was predicted in both. The majority of the attitudinal measures, though, loaded as predicted. The notable exceptions here were preferred age at marriage and desired number of children, both of these being directly related to the putative reproductive strategy. This finding could possibly be attributable to the restricted range of this university sample. Most subjects reported wishing to marry between the ages of 24 and 28, a rather late age relative to the general population. Similarly, most desired between two and three children. The extent to which these self-reported attitudes might ultimately translate into behaviour is, of course, subject to debate, as well. So too is the question of whether the reported sexual behaviour would remain the same if contraception were not available. Both of these last points serve to increase the difficulty of assessing a reproductive dimension in a currently constituted university sample.

#### General Discussion

The results of the two studies reported here provide a reasonable degree of initial but qualified support for the extrapolation of the r/K continuum to humans. Overall, 53 of 74 (72%) of the predictions were confirmed ( $z = 3.79$ ,  $p < .0001$ , one-tailed). If the personality and attitudinal measures are excluded, the proportion increases to 78%. While portions of the theory stand in need of reformulation (the personality variables), the proportion of confirmed

predictions warrant further thought and empirical testing of the theory. Factor solutions for four separate analyses on data from two widely disparate samples yielded dimensions somewhat in keeping with the proposed r-K continuum. This dimension, moreover, was demonstrated to be moderately heritable in the first study. When these results are subjected to a more stringent criterion, that is, examining only factor loadings above a specified cut-off point, the criteria were still met, often to an even greater extent. Examination of the magnitude of the loadings revealed that the sexual-reproductive measures were among the highest loading variables in all four solutions. The bulk of the evidence supporting K theory came, as might be expected, from the biological and sexual-reproductive domains, where the findings were stronger and more consistent. Supplementary analyses suggested that these findings were not artifacts of logical dependencies. Little or no support was evidenced in the personality domain, however. In addition, the amount of variance accounted for by this dimension, though a remarkably consistent 14%, was rather less than originally anticipated.

Three alternative conclusions may be advanced to explain these results: (1) K-theory is invalid and the pattern of results obtained can be explained solely in terms of the logical dependencies of the variables or the influence of purely environmental influences; (2) K theory is largely correct and a single, heritable, reproductive dimension underlies numerous bio-social variables, up to, but not

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including personality; and (3) K theory is largely correct and does extend to the personality domain, but either an inappropriate selection of personality variables was examined, or appropriate personality variables were examined but were not measured suitably. In other words, the constructs were not operationalized broadly enough originally so as to capture those components of the construct with evolutionary or biological significance.

With regard to the first possibility, certain of the logical dependencies may indeed be problematic, but this is almost inevitable given the bio-social phenomena under consideration. Moreover, as a counter-argument, a large number of the inter-relationships predicted by K theory which were confirmed in these two studies, are not logically dependent. Thus, even if logically dependent variables are excluded from consideration, a sufficient number of predicted relationships remain to still offer considerable support to the theory. In the second study, moreover, the data were even more supportive of the theory with the greatest logical dependency removed. As to the social theories which could explain the pattern of results obtained in the present studies, the demonstrably heritable nature of the majority of variables examined, as well as the heritability of the overall dimension must, to some extent, reduce the power of these alternative accounts. Furthermore, most of the predictions derived from K theory, especially those concerning biological and sexual-reproductive phenomena, were a priori in nature,

based on existing inter- and intra-species comparisons. And, as I stated previously, K theory does not deny the role of environmental factors as proximate influences on behaviour. It may be quite possible for individuals to vary the degree to which they adopt a K strategy, depending upon the perceived predictability of their environment or differential socialization processes, as suggested by Weinrich (1977), Weigel and Blurton Jones (1983), and Reynolds and Tanner (1983). This could, of course, account for differences in family size and birth spacing, to a degree, but it is less clear how one could intentionally "adopt" a later age at maturity, greater height, and better health, all of which appear inter-related to the more directly reproductive measures. In any event, these phenomena are likely complex, interactive in their effects, and multiply-determined; and so any attempts to delineate separate effects absolutely would be arduous and perhaps not even meaningful. Finally, it can be argued that since the social arguments deny any genetic influence, whereas biological theories like Differential K are interactive, the greater burden of proof may rest with the exclusively social theorists. In any event, they have the remaining 85% of the variance to explain.

The second and third possible conclusions will be discussed jointly, as there is considerable overlap. As mentioned above, these conclusions are that (a) Rushton's (1985) proposed extrapolation of the r/K framework is largely correct, but in a more restricted sense, the dimension

underlying biological, sexual-reproductive, and some social phenomena but not personality, or (b) the theory potentially does extend to the domain of personality, but the choice of traits was inappropriate or problems with the construct validity of the scales employed obfuscated any existing relationship. On the basis of the evidence from the present studies, far greater support exists for the first conclusion, and minimal support exists for the latter. In fact, few of the predictions for biological-reproductive variables were not confirmed, and in such cases the factor loadings were of a trivial magnitude. As mentioned previously, this problem may, in part, be attributable to the necessary exclusion of high K families, that is, those with only one child or no children at that point in time. Or perhaps reliable contraception and a societal push for "family planning" have simply overpowered any potential genetic influence. One measure of contraceptive use (the birth-control pill) was available for the female twins in Study 1. When this data were examined, 66.3% of the subjects reported using this method at some time in their lives. Such usage would influence many of the variables examined in that study, especially length of menstrual cycle, number of pregnancies, family size, and birth spacing. Contraceptive use would also lower the heritability estimates for these variables. There is, on the basis of the present studies, no clear explanation for some of these anomalies.

The question of whether K theory can potentially integrate personality variables, as formulated by Rushton

(1985) or myself, may be tentatively answered with a "no" on the basis these two studies. Several points should be made, however, before that possibility can be discarded with finality. First of all, no strong, theoretically-based predictions were made for psychoticism and neuroticism and, in fact, none were explicitly hypothesized by Rushton (1985). Thus, the failure of these variables to relate in any way to a reproductive dimension should not count too heavily against the theory. This is less true for the predictions for extraversion, conservatism, and especially altruism, as these were more soundly grounded, either theoretically or empirically. In the case of conservatism, for instance, it will be recalled that I argued that the hypothesized selection pressures favouring the development of a K-strategy included the ability to successfully compete for limited resources in a stable, predictable habitat. Insofar as the reproductive biology of human K-strategists would, theoretically, be geared to these environmental circumstances, one might expect such individuals to behave in a fashion so as to maintain an environmental status quo and try, so far as possible, to prevent radical change. That is, K-strategists might be expected to create predictable societies. Yet, conservatism was consistently found to be negatively related to other presumed measures of K in the first study reported here. On the surface, one is at a loss to explain this finding from an evolutionary life-history perspective. The possibility exists, however, that the "conservatism" assessed by the

measure employed in Study 1 is more of an "ideological" conservatism and less of the sort of "stability maintenance" conservatism implied in an r-K framework. "Conservatism" in this latter sense might be better operationalized by measures of (low) risk-taking, (high) harm-avoidance, home-ownership, low frequency of relocations, and long-term financial investment.

The findings for extraversion were equivocal. The predictions for this variable were not confirmed in the first study, but were in the second. One obvious possible explanation for this finding is that it is attributable to differences between the two samples (twins of all ages and social classes as compared with young, middle to upper class university freshmen). There is no way of determining, short of further research, which of the two findings is the most valid. The bases for the original predictions for extraversion were very strong. Eysenck (1976, p:12), for example, has stated that "extraverts are genetically predisposed to seek strong stimuli, to get bored by repetition of identical or similar stimuli and to be less likely to be inhibited from searching for such strong and novel stimuli by social taboos", which is very suggestive of an r-type. Extraverts are also described as being, among other things, impulsive, active, and carefree, which is further suggestive of r. Perhaps the strongest basis for postulating a link between extraversion and reproductive strategy was derived from Eysenck's reported relationships between extraversion and a number of sexual behaviors; these



including an earlier age at first coitus, concurrent involvement with more than one sexual partner, considering absolute faithfulness in marriage to be silly, and very high sex drives in general. It appears, therefore, that considerably more research would be necessary before any firm conclusions about this variable could be made.

Altruism was the one "personality" variable with a clear analog in species other than humans, and here the predictions were strongest. Rushton (1985), in fact, speculated that altruism might be one of the best indices of  $K$ , yet the predictions for this variable were not confirmed. There is one potential explanation for these findings, and this centers on the measurement of this variable in the present studies. As I have mentioned in the introduction, most evolutionary accounts of altruism are based on the notion of inclusive fitness and kin selection. Thus one would expect that altruism should be most common among close kin and progressively less common as the genetic distance between helper and recipient increases. This is indeed the case for many non-human species, and --more importantly-- especially so for humans as well (Barash, 1982). Examination of the altruism scale employed in this study, however, reveals that 19 of the 20 items comprising that scale are explicitly concerned with helping strangers. A single item assesses whether the respondent has helped an "acquaintance" move, and none at all deal with helping kin. These items appear to assess more of a reciprocal-type altruism, as proposed by

Trivers (1971). Even in this model, however, the variables which influence the expected degree of altruism, long lifetimes, low dispersal rates, high mutual dependence and parental care, also appear positively related to  $K$ . In any case, it is possible that if a second scale were developed which focused primarily on kin of varying degrees of relatedness, the predictions for this variable might be confirmed. (No such instrument was available when the present studies were designed.)

Several final, and very general points should be raised in regard to assessing relationships among personality variables and biological or reproductive variables. Most of the existing, measurable personality traits were explicitly derived from various theories of personality (Maddi, 1976). The theorists, however, for the most part appear to have developed their theories with scant regard to biological or evolutionary principles. It is highly improbable that human personality and social behavior spontaneously appeared independent of biological and evolutionary factors. Much more reasonable is the assumption that these behaviors slowly evolved in the service of our biology and inclusive fitness. In this sense then, most theories of personality may have "put the cart before the horse".

Hoyenga and Hoyenga (1984) discuss two related problems in this area. The first is that our current personality constructs "arise from our linguistic processes and [they] may have nothing whatsoever to do with the ways that our

body-brains actually go about organizing their business" (p. 240). Their second point is that in examining relationships between biological and psychological phenomena, we may be committing what is called a "category error". This type of logical error can result because the domains we are comparing "represent separate categories that are at different levels of abstraction" (p. 240).

In summary, the results of the two exploratory studies reported here, while certainly far from definitive, provide reasonable support for a somewhat more limited version of Rushton's (1985) Differential K theory. A single dimension was shown to underlie a large number of bio-social variables, and this dimension was demonstrably reproductive in nature and under some degree of genetic control. These findings were strongest and most consistent for biological and sexual-reproductive variables, but much less so for personality variables. Further research is clearly needed before any firmer conclusions can be drawn. In addition to examination of the points raised in the preceding paragraphs, one might further test the theory by investigating inter-relationships among gonad size, speed and quantity of sperm production in males, total lifetime ova release in females, and other presumed measures of K. Measures of parental investment --biological, material, and emotional-- would also be of direct relevance, as might variables such as length of time spent in one occupation and the frequency and distance of familial relocations. The degree to which

individuals assortatively mate on this dimension would be useful information as well. At some point, attention would have to be devoted to determining the specific mechanisms of inheritance involved. Ultimately, the validity of a global theory of this nature would have to rest upon a gradual accumulation of correlational-type evidence, as stronger tests would be as impracticable as they are unethical.

A more general contribution of the two studies reported here is the demonstration that evolutionary theory can be successfully applied to an even broader range of human behavior. The contemporary social sciences are burdened with countless theories of human behavior, many of which are mutually exclusive and some simply not testable. What is needed most in the social sciences is an underlying theoretical framework to unify core theorizing. I would argue that the present studies, in conjunction with other integrative efforts in this area (Daly and Wilson, 1981; Freedman, 1974, 1979; Rushton, 1984) all suggest that evolutionary theory might provide such a unifying framework. The advantages of such a move would be many. The social sciences would gain a stronger and clearer link with the biological sciences, where the unifying framework has long been evolutionary theory. Research in both these domains might thereby profit. Evolutionary theory would also provide a broad new range of testable predictions, thus providing a stronger empirical base for the social sciences. Unlike many competing accounts of human nature, evolutionary models have, at least, the advantage of a potential to be proven wrong.

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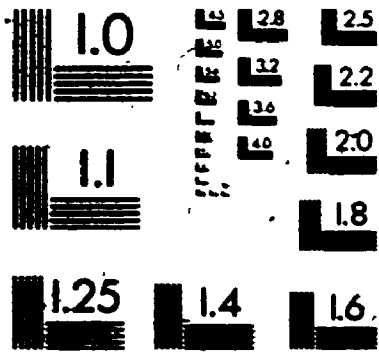
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Appendix A

Australian Twin Registry Questionnaire



GENERAL INFORMATION

(12) **MARITAL STATUS**

1	Single
2	Widowed
3	Married
4	Living together but not married
5	Separated
6	Divorced
7	Remarried

(13) How many years have you been in your present marital status?  yrs

(14) Do you have any children?  Yes  No

If YES, please give their sex (males and females), and their year of birth. Indicate if any are by a previous spouse. Indicate if any are twins.

Sex	Year of birth	Twins
1		
2		
3		
4		
5		
6		

(15) **EDUCATIONAL ACHIEVEMENT**

1	Less than 7 years schooling
2	8-10 years schooling
3	11-12 years schooling
4	Apprenticeship, diploma, certificate, etc.
5	Technical or Teachers college
6	University first degree
7	University post-graduate training

(16) **YOUR MAIN OCCUPATION - please describe in detail.**  
e.g. "Maintenance fitter in oil refinery".

	FULL TIME
	PART TIME
	UNEMPLOYED

(17) **YOUR FATHER'S MAIN OCCUPATION (before retirement)**

(18) **RELIGION**

1	No religion
2	Church of England
3	Other Protestant
4	Catholic
5	Jewish
6	Greek or Russian Orthodox
7	Other, please specify
8	Prefer not to answer

(19) How often do you attend Church (or other observances)?

1	more than once a week
2	once a week
3	every month or so
4	once or twice a year
5	rarely

(20) On average, how many cups of TEA would you drink?  cups each day

On average, how many cups of COFFEE would you drink?  cups each day

(21) If you were to drink COFFEE in the evening would it be usually?

1	always
2	usually

(22) Which of the following do you take regularly?  Yes  No

1	Aspirin, Paracetol, Vincetox, etc.
2	Sedatives or sleeping tablets
3	Tranquillizers (eg. Valium)
4	Antidepressant tablets
5	Vitamin tablets
6	Levodopa
7	Tablets for high blood pressure
8	Tablets to remove fluid (diuretics)
9	Tablets for motion (heart pain)
0	None (specify)

(23) Rate your leisure activity using the following as a guide (tick one box) or

1	Jogging, cycling to work or vigorous sport (squash, swimming etc.) 3-4 times a week
2	Play sport or exercise a couple of times a week
3	Regular exercise (eg. tennis, golf, etc.) about once a week
4	Occasional exercise (2-3 times a month) or regular light gardening
5	No leisure exercise or sport of times a week

(24) What is your height?  ft  in OR  m  cm

(25) What is your weight?  st  lb OR  kg

(26) Do you consider you have good health?  Yes  No

(27) In the past 12 months, on how many days would you have stayed home from work because of illness?  days

(28) Do you or any of your blood relatives have any of the following conditions?

Scattering	1/2	Your Self	Blood relatives (specify)
Dementia, Mild blindness, Specific learning disability, Severe reading problems	1/0		
Autism	1/0		

(29) Have you EVER been a smoker? If NO go to next page.

1	Yes
2	No

(30) At what age did you start smoking?  years

If you have stopped smoking, how old were you when you stopped?  years

Stopped cigarettes at  years

Stopped pipe at  years

Stopped cigars at  years

(31) How many CIGARETTES do (or did) you usually smoke in a day?

How many CIGARS do (or did) you usually smoke in a day?

How many PIPES of tobacco do (or did) you usually smoke in a day?

What was the LARGEST number of cigarettes, per day, that you

(33) Have you EVER taken alcoholic drinks? If NO go to next page.

1 Yes  
2 No

(34) At what age did you start drinking alcohol?

22

(35) OVER THE LAST YEAR, about how often have you usually taken any alcoholic drinks?

1 Every day  
2 3-4 times each week  
3 About twice a week  
4 About once a week  
5 Once or twice a month  
6 Less often

(36) OVER THE WEEKEND (Saturday & Sunday) would you usually drink?

1 On two days  
2 On one day  
3 Not usually

(37) DURING WEEK DAYS (Monday to Friday) would you usually drink?

1 Each day  
2 On three or four days  
3 On two days  
4 On one day  
5 Not usually

(38) IF OVER 16, how do your present drinking habits compare with when you were 15-10?

1 About the same  
2 Drink LESS now  
3 Drink MORE now

(39) On average, how many GLASSES would you drink on each day that you take some alcohol?

Please note:  
Beer glass is about 7oz.  
Wine glass is about 6oz.  
Spirits glass is about 1oz. (1 nip) (Other (specify type and amount))

	Weekdays	Weekends
Classes of beer per day		
Classes of wine per day		
Classes of spirits per day		
Classes of sherry per day		
Other (specify type and amount)		

(40) Please describe your consumption of alcohol in the LAST WEEK. Write in the chart below the number of glasses you had on each day.

	Mon	Tue	Wed	Thur	Fri	Sat	Sun
Beer	0						
Wine	0						
Spirits	0						
Sherry	0						
Other	0						

(41) During the LAST WEEK, was your consumption?

1 Typical  
2 Greater than average  
3 Less than average

(42) How OFTEN have you had any of the following? Tick each condition.

Condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Misalign/sick headaches																					
Other headaches																					
Sore throat																					
Cold sores (eg. on lip)																					
Influenza																					
Glandular fever																					
Hay fever																					
Sinus trouble																					
Bronchitis (chest cold)																					
Asthma or wheezing																					
Pneumonia																					
Tick each condition																					
Warts on skin																					
Bells or bad pimples																					
Psoriasis																					
Eczema																					
Other skin trouble																					
Allergy to dust																					
Allergy to food																					
Other allergy																					
Stiff joints in morning																					
Arthritis or rheumatism																					
Ulcers/bladder infections																					

(43) Have you had any of the following conditions? If YES please tick the left hand column. If any of your close relatives has had any of the same conditions (or died from them) BEFORE THE AGE OF 40, please tick in the appropriate columns.

Condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
High blood pressure (hypertension)																					
Heart attack (infarct or coronary)																					
Diabetes																					
Stroke (or apoplexy)																					
Thyroid trouble																					
Ulcer of stomach, duodenum or small bowel																					
Jaundice, hepatitis or liver disease																					
Piles (Hemorrhoids)																					
Diverticulitis																					
Cancer or Leukemia (including skin cancer)																					
Lump or cyst in breast																					
Rheumatoid Arthritis																					
Prostate trouble (enlarged prostate)																					

(44) OPERATIONS (Don't forget to give age)

Operation	Age	Yes	No
tonsils out?	16		
appendix out?	19		
Gall bladder removed?	31		
Thyroid gland removed?	43		
Vascular valve done?	48		
a vasectomy?	71		
a prostatectomy?	74		

Have you had:

NEC OBLI - Have you had:

(45) Do you have any SERIOUS problem-requiring medical treatment? (Please specify)

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REPRODUCTIVE HISTORY - WOMEN ONLY - HER GO TO NEXT PAGE

(35) How old were you when you had your FIRST menstrual period? \_\_\_\_\_ Months

(36) Have you EVER used a contraceptive pill? IF NO go to question 37

1 Yes \_\_\_\_\_ Months

2 No \_\_\_\_\_ Months

IF YES: How long have you taken the contraceptive pill (add up all the months) \_\_\_\_\_ Months

Are you using a contraceptive pill now? \_\_\_\_\_ Months

1 Yes \_\_\_\_\_ Months

2 No \_\_\_\_\_ Months

IF YES: Did the contraceptive pill cause any upset to you or your health? \_\_\_\_\_ Months

0 No upset \_\_\_\_\_ Months

1 Weight loss \_\_\_\_\_ Months

2 Weight gain \_\_\_\_\_ Months

3 Nausea (feeling sick) \_\_\_\_\_ Months

4 Irregular cycles (breakthrough bleeding, irregular bleeding) \_\_\_\_\_ Months

5 Acne (pimples) \_\_\_\_\_ Months

6 Feeling bloated (swollen) \_\_\_\_\_ Months

7 Depression (sadness) \_\_\_\_\_ Months

8 Irritability (easily upset) \_\_\_\_\_ Months

9 Other (specify) \_\_\_\_\_ Months

(37) Have you EVER been pregnant? IF NO go to question 38

1 Yes \_\_\_\_\_ Months

2 No \_\_\_\_\_ Months

Are you pregnant now? \_\_\_\_\_ Months

How many pregnancies have you had? \_\_\_\_\_ Months

How old were you with the first pregnancy? \_\_\_\_\_ Months

Did any pregnancy end in miscarriage or termination? \_\_\_\_\_ Months

IF YES: \_\_\_\_\_ Months

With any pregnancy have you had any of the following? \_\_\_\_\_ Months

1 High blood pressure, toxemia \_\_\_\_\_ Months

2 Difficult birth (forceps, caesarian section) \_\_\_\_\_ Months

3 Stillborn child \_\_\_\_\_ Months

4 Jaundiced baby \_\_\_\_\_ Months

5 Other birth problems (specify) \_\_\_\_\_ Months

(38) Are your menstrual periods regular? IF YES go to question 39

1 Yes \_\_\_\_\_ Months

2 No \_\_\_\_\_ Months

IF NOT REGULAR, have your periods completely stopped? \_\_\_\_\_ Months

VAS TRIS: Menopause ("natural change of life")? \_\_\_\_\_ Months

Hysterectomy (removal of the womb)? \_\_\_\_\_ Months

Other (specify) \_\_\_\_\_ Months

IF YOUR PERIODS ARE MORE OR LESS REGULAR, WHAT IS THE AVERAGE NUMBER OF DAYS OF BLEEDING? \_\_\_\_\_ Months

Are your periods? \_\_\_\_\_ Months

1 Heavy \_\_\_\_\_ Months

2 Moderate \_\_\_\_\_ Months

3 Light \_\_\_\_\_ Months

Are your periods? \_\_\_\_\_ Months

1 Very painful \_\_\_\_\_ Months

2 Moderately painful \_\_\_\_\_ Months

3 No trouble \_\_\_\_\_ Months

What is the average time between the start of one period and the start of the next? \_\_\_\_\_ Months

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS

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**PERSONALITY**

Please answer each question by PUTTING A CIRCLE AROUND THE "YES" OR THE "NO" following the question. There are no right or wrong answers, and no trick questions. Work quickly and do not think too long about the exact meaning of the questions.

PLEASE REMEMBER TO ANSWER EACH QUESTION

- Q1 Do you have many different hobbies? YES NO
- Q2 Do you stop to think things over before doing anything? YES NO
- Q3 Does your mood often go up and down? YES NO
- Q4 Have you ever taken the price for something you know someone else had really cheap? YES NO
- Q5 Are you a talkative person? YES NO
- Q6 Would being in debt worry you? YES NO
- Q7 Do you ever feel "just miserable" for no reason? YES NO
- Q8 Have you ever grieved by helping yourself to more than your share of anything? YES NO
- Q9 Do you look up your house carefully at night? YES NO

- Q11 Would it upset you a lot to see a child or an animal suffer? YES NO
- Q12 Do you often worry about things you should not have done or said? YES NO
- Q13 If you say you will do something, do you always keep your promise no matter how inconvenient it might be? YES NO
- Q14 Can you usually let yourself go and enjoy yourself at a lively party? YES NO
- Q15 Are you an irritable person? YES NO
- Q16 Have you ever blamed someone for doing something you know was really your fault? YES NO
- Q17 Do you enjoy meeting new people? YES NO
- Q18 Do you believe insurance schemes are a good idea? YES NO
- Q19 Are your feelings easily hurt? YES NO
- Q20 Are ALL your habits good and desirable ones? YES NO
- Q21 Do you tend to keep in the background on social occasions? YES NO
- Q22 Would you take drugs which may have strange or dangerous effects? YES NO
- Q23 Do you often feel "fed-up"? YES NO
- Q24 Have you ever taken anything (even a pin or button) that belonged to someone else? YES NO
- Q25 Do you like going out a lot? YES NO
- Q26 Do you enjoy hurting people you love? YES NO
- Q27 Are you often troubled about feelings of guilt? YES NO
- Q28 Do you sometimes talk about things you know nothing about? YES NO
- Q29 Do you prefer reading to meeting people? YES NO
- Q30 Do you have enemies who want to harm you? YES NO
- Q31 Would you call yourself a nervous person? YES NO
- Q32 Do you have many friends? YES NO
- Q33 Do you enjoy practical jokes that can sometimes really hurt people? YES NO
- Q34 Are you a warrior? YES NO
- Q35 As a child did you do as you were told immediately and without grumbling? YES NO
- Q36 Would you call yourself happy-go-lucky? YES NO
- Q37 Do good manners and cleanliness matter much to you? YES NO
- Q38 Do you worry about awful things that might happen? YES NO
- Q39 Have you ever broken or lost something belonging to someone else? YES NO
- Q40 Do you usually take the initiative in making new friends? YES NO
- Q41 Would you call yourself tense or "highly-strung"? YES NO
- Q42 Are you mostly quiet when you are with other people? YES NO
- Q43 Do you think marriage is old-fashioned and should be done away with? YES NO
- Q44 Do you sometimes boast a little? YES NO
- Q45 Can you easily get some life into a rather dull party? YES NO
- Q46 Do people who drive carefully annoy you? YES NO
- Q47 Do you worry about your health? YES NO
- Q48 Have you ever said anything bad or nasty about anyone? YES NO
- Q49 Do you like telling jokes and funny stories to your friends? YES NO





## Appendix B

Eigenvalues and Variance Accounted For  
(Study 1 Solutions)

Appendix B. Eigenvalues and variance accounted for male and female twin solutions.

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Factor	Eigenvalue	Percent of Variance
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Males

1	1.846	14.2
2	1.557	12.0
3	1.386	10.7
4	1.339	10.3
5	1.151	8.9
6	1.011	7.8
7	.914	7.0
8	.821	6.3
9	.709	5.5
10	.681	5.2
11	.653	5.0
12	.533	4.1
13	.401	3.1

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Females

1	2.681	14.1
2	1.736	9.1
3	1.684	8.9
4	1.459	7.7
5	1.401	7.4
6	1.242	6.5
7	1.171	6.2
8	1.024	5.4
9	.958	5.0
10	.901	4.7
11	.830	4.4
12	.793	4.2
13	.779	4.1
14	.705	3.7
15	.635	3.3
16	.494	2.6
17	.422	2.2
18	.077	.4
19	.008	.0

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## Appendix C

Life History Analysis Questionnaire  
(Study 2)

ACADEMIC PERFORMANCE SCALE

1. What was your grade in average?
2. What was your grade in average?
3. Are you in your first year at university?  No
4. If no, state the averages for your preceding years at university.
 

Year 1
Year 2
Year 3
Year 4
5. Please estimate your average grades for each course taken so far this academic year.
 

Course 1
Course 2
Course 3
Course 4
Course 5
Course 6

LIFE HISTORY ANALYSIS AND SEXUAL FUNCTIONING

INSTRUCTIONS

Please read all instructions carefully. We wish to assure you that the information gathered in this questionnaire will be kept in the strictest confidence and that your total anonymity is guaranteed. Please answer each item as truthfully and as accurately as you can. Please read each item carefully and ensure that you understand what is being asked. No questions are designed to mislead you, so please approach each item in a straightforward manner. If you are unsure of an item, please make the best estimate possible.

You will note that some of the questions are of a very personal nature. If you feel uncomfortable with any item, please feel free to leave it blank. You also have the right to discontinue your participation in this experiment at any time for any reason without loss of credit. Please do not put your name or any identifying information on the questionnaire. Thank you for your cooperation.

Researchers: Anthony Bonjart, Honours student  
 Dwight Masejian, Ph.D. Candidate,  
 Dr. M. Goodale, Professor  
 Department of Psychology  
 University of Western Ontario,  
 London, Ontario

PERSONALITY QUESTIONNAIRE

Instructions

On the following pages you will find a series of statements and questions which a person might use to describe him- or herself. Read each statement or question and decide whether or not it describes you. If you agree with the statement or decide that it does describe you circle "Y" (true). If you disagree with the statement or feel it is not descriptive of you circle "N" (false). Sentences in the form of questions should be answered by circling "Y" (yes) or "N" (no). Answer every statement either true or false and answer every question either yes or no, even if you are not completely sure of your answer.

- Y M 1 Do you have many different hobbies?
- T F 2 I am quite able to make correct decisions on difficult questions.
- T F 3 I have never bought anything in a store.
- Y M 4 Are you a talkative person?
- T F 5 I could easily count from one to twenty five.
- T F 6 I am never able to do things as well as I should.
- T F 7 I can run a mile in less than four minutes.
- Y M 8 Are you rather lively?
- T F 9 I have never talked to anyone by telephone.
- Y M 10 Can you let yourself go and enjoy yourself at a wild party?
- T F 11 My life is full of interesting activities.
- Y M 12 Do you enjoy meeting new people?
- T F 13 I usually wear something warm when I go outside on a very cold day.
- Y M 14 Do you tend to keep in the background on social occasions?
- T F 15 I make all my own clothes and shoes.
- T F 16 I believe people tell lies any time it is to their advantage.
- Y M 17 Do you like going out a lot?
- T F 18 I have never brushed or cleaned my teeth.
- Y M 19 Do you prefer reading to meeting people?
- T F 20 If someone gave me too much change I would tell him.
- Y M 21 Do you have many friends?
- T F 22 I would be willing to do something a little unfair to get something that was important to me.
- Y M 23 Things with sugar in them usually taste sweet to me.
- Y M 24 Would you call yourself happy go lucky?
- T F 25 I get along with people at parties quite well.
- T F 26 Sometimes I see cars near my home.
- Y M 27 Do you usually take the initiative in making friends?
- T F 28 I have never had hair on my head.
- T F 29 I did many bad things as a child.
- Y M 30 Are you mostly quiet when you are with other people?
- T F 31 I am glad I grew up the way I did.
- Y M 32 Can you easily get some life into a rather dull party?
- T F 33 I have travelled away from my home town.
- Y M 34 Do you like telling jokes and funny stories to your friends?
- T F 35 I often question whether life is worthwhile.
- T F 36 I have never ridden in an automobile.
- Y M 37 Do you like mixing with people?
- T F 38 I have never felt sad.

- Y P 39. I am always prepared to do what is expected of me
- Y M 48. Do you usually always have a ready answer when people talk to you?
- Y P 41. I try to get at least some sleep every night
- Y P 42. My daily life includes many activities I dislike
- Y M 43. Do you like doing things in which you have to act quickly?
- Y P 44. I am one of the lucky people who could take with my parents about my problems
- Y M 45. Do you often take on more activities than you have time for?
- Y P 46. Many things make me feel uneasy
- Y M 47. Can you get a party going?
- Y P 48. I am careful to plan my distant goals
- Y M 49. Do you like plenty of bustle and excitement around you?
- Y P 50. Sometimes I feel hungry or thirsty.
- Y P 51. I find it very difficult to concentrate.
- Y M 52. Do other people think of you as being very lively?
- Y P 53. I have attended school sometimes during my life

Instructions	Fill the category on the right that conforms to the frequency with which you have carried out the following acts	Never	Once	2-3	4-5	6-8	9-12
1	I have helped push a stranger's car out of the snow						
2	I have given directions to a stranger						
3	I have made change for a stranger						
4	I have given money to a charity						
5	I have given money to a stranger who needed it (or asked me for it)						
6	I have donated goods or clothes to a charity						
7	I have done volunteer work for a charity						
8	I have donated blood						
9	I have helped carry a stranger's belongings (books, parcels, etc.)						
10	I have delayed on a motorway and held the door open for a stranger						
11	I have allowed someone to go ahead of me in a line-up at a bank machine, in the supermarket						
12	I have given a stranger a lift in my car						
13	I have pointed out a clerk's error (e.g. a bank, at the supermarket) to another customer as far as I can						
14	I have let a neighbour whom I don't know too well borrow on loan of tools (e.g. a drill, lawn mower)						
15	I have bought charity Christmas cards deliberately because I know it was a good cause						
16	I have helped a classmate who did not know that well with a homework assignment when my knowledge was greater than 80% of theirs						
17	I have before being asked voluntarily looked after a neighbour's pets or children without being paid for it						
18	I have offered to take a handicapped or elderly stranger across a street						
19	I have offered my seat on a bus or train to a stranger who was standing						
20	I have helped an acquaintance to carry shopping						

Section 4: Dating Behavior

19. Do you consider yourself to be: (Please circle) exclusively homosexual 1 2 3 4 5 6 7 exclusively heterosexual

20. Have you ever had a date with a member of the opposite sex? (If "no" proceeds to Section 3) yes no

21. How old were you when you started dating regularly? years months

22. Have you ever dated more than one opposite-sexed individual in one day? yes no

23. If yes, how many times has this occurred in your lifetime? once twice less than 5 more than 10

24. Have you ever been involved with more than one opposite-sexed individual at one time OR dated more than one opposite-sexed individual at one time? (eg. Person A one night, person B the next, etc.) yes no

25. If yes, how many times has this occurred? once twice less than 5 more than 10

Section 3: Sexual History

26. Have you ever manipulated the genitals of a member of the opposite sex with your hand? yes no (if "no" go to 28)

27. If yes, how old were you when this first occurred? years months

28. Have you ever had your genitals manipulated by a member of the opposite sex? yes no (if "no" go to 30)

29. If yes, how old were you when this first occurred? years months

30. Have you ever had sexual intercourse with a member of the opposite sex (excluding rape)? yes no (if no go to 36)

12. a) Have either of your biological parents ever been separated? Mother yes no Father yes no

b) How many times have your biological parents been separated? Mother Father

13. a) Have either of your biological parents ever been divorced? Mother yes no Father yes no

b) How many times have your biological parents been divorced? Mother Father

14. What is your current marital status? 1. never married 2. divorced 3. separated 4. living together 5. engaged 6. married 7. widowed

15. If female, how old were you when you experienced your first menstrual period? years months

16. If male, how old were you when you (please estimate to the best of your ability) a) first shaved years months b) experienced a nocturnal emission years months (ie, a "wet dream") c) had your growth spurt years months d) began growing pubic hair years months

17. If male, how confident are you of the above estimations? (Please circle) very unsure 1 2 3 4 5 6 7 very sure

18. Relative to your peers, did you reach puberty? 1. much earlier 2. a little earlier 3. about the same time 4. a little later 5. much later



- 49. What was the largest number of orgasms you have had in one sexual encounter with a member of the opposite sex? \_\_\_\_\_
- 50. If female, have you ever been pregnant? yes \_\_\_ no \_\_\_  
(Males please go to 56)
- 51. If female, at what age did you first become pregnant? \_\_\_\_\_ years \_\_\_\_\_ months
- 52. If female, how many times have you ever been pregnant? \_\_\_\_\_
- 53. a) If female, have you ever had an abortion? yes \_\_\_ no \_\_\_  
b) How many times has this occurred? \_\_\_\_\_
- 54. If female, have you ever had any children? yes \_\_\_ no \_\_\_
- 55. If female, how many children have you ever had? \_\_\_\_\_
- 56. If male, have you ever, to the best of your knowledge, gotten a female pregnant? yes \_\_\_ no \_\_\_
- 57. If male, how many times has this occurred? \_\_\_\_\_
- 58. If male, how old were you when this first occurred? \_\_\_\_\_ years \_\_\_\_\_ months
- 59. While involved in a long-term or steady relationship, have you ever engaged in sexual intercourse with a different member of the opposite sex (ie, not your long-term or steady partner) without your long-term partner knowing about it? yes \_\_\_ no \_\_\_  
With your long-term partner knowing about it? yes \_\_\_ no \_\_\_
- 60. How many times has this occurred?  
\_\_\_\_\_ times without your long-term partner knowing  
\_\_\_\_\_ times with your long-term partner knowing

Section 4. Attitudes about sexual behavior

The following statements are concerned with your attitudes towards sexuality and related areas. Please estimate how well each statement applies to you or describes you.

- 61. I think that a person should only date one person at a time  
strongly disagree 1 2 3 4 5 6 7 strongly agree
- 62. If single, at what age would you like to get married? \_\_\_\_\_ years
- 63. How many children would you like to have? \_\_\_\_\_

- 31. If yes, how old were you when this first occurred?  
years \_\_\_\_\_ months \_\_\_\_\_
- 32. How old was your partner? years \_\_\_\_\_ months \_\_\_\_\_
- 33. How many different opposite-sexed individuals have you had sexual intercourse with in your entire lifetime? \_\_\_\_\_
- 34. During the past year, what was the average frequency of sexual intercourse during a month? \_\_\_\_\_
- 35. How many different opposite-sexed individuals have you had sexual intercourse with during the past year? \_\_\_\_\_
- 36. Have you ever stimulated the genitals of a member of the opposite sex with your mouth?  
yes \_\_\_ no \_\_\_ (if "no" go to 38)
- 37. If yes, how old were you when this first occurred?  
years \_\_\_\_\_ months \_\_\_\_\_
- 38. Have you ever had your genitals stimulated by the mouth of a member of the opposite sex?  
yes \_\_\_ no \_\_\_ (if "no" go to 48)
- 39. If yes, how old were you when this first occurred?  
years \_\_\_\_\_ months \_\_\_\_\_
- 40. Please estimate the percentage of times in which sexual intercourse has included oral contact of your or your partner's genitals. \_\_\_\_\_
- 41. Have you ever masturbated to orgasm? yes \_\_\_ no \_\_\_  
(if "no" go to 45)
- 42. How old were you when this first occurred? years \_\_\_\_\_ months \_\_\_\_\_
- 43. During the past year, what was your average frequency of masturbation to orgasm during: \_\_\_\_\_ times/week OR \_\_\_\_\_ times/month
- 44. What is the greatest number of times you have masturbated to orgasm in one 24-hour period? \_\_\_\_\_
- 45. Have you ever engaged in sexual activities with more than one member of the opposite sex at one time (ie, group sex)?  
yes \_\_\_ no \_\_\_
- 46. How many times in your life have you had sexual activities with more than one person of the opposite sex at one time (group sex)? \_\_\_\_\_
- 47. Have you ever had more than one orgasm during a sexual encounter with a member of the opposite sex? yes \_\_\_ no \_\_\_
- 48. How often has this occurred? Please estimate the percentage of encounters that have resulted in more than one orgasm. \_\_\_\_\_

Debriefing Sheet

Experiment. Life-History Analysis and Sexual Functioning

- 64. I cannot imagine myself ever being unfaithful to a marriage or long-term partner.
  - strongly disagree 1 2 3 4 5 6 7 strongly agree
- 65. Flinging or having a long-term or steady partner is what I desire most, even if I could have as many different sexual partners as I wanted.
  - strongly disagree 1 2 3 4 5 6 7 strongly agree
- 66. I believe that premarital sex (ie, sex before marriage) should not occur.
  - strongly disagree 1 2 3 4 5 6 7 strongly agree
- 67. I believe that extramarital sex (ie, sex with someone other than your marriage partner while married) should never occur.
  - strongly disagree 1 2 3 4 5 6 7 strongly agree
- 68. I believe that homosexual behavior is disgusting and is a perversion of what is natural.
  - strongly disagree 1 2 3 4 5 6 7 strongly agree
- 69. I find the thought of oral sex totally disgusting.
  - strongly disagree 1 2 3 4 5 6 7 strongly agree
- 70. I am strongly opposed to abortion.
  - strongly disagree 1 2 3 4 5 6 7 strongly agree
- 71. I believe that primary responsibility for raising children belongs to women.
  - strongly disagree 1 2 3 4 5 6 7 strongly agree

Recent experiments from a number of different academic disciplines have revealed intercorrelations among a variety of life-history characteristics in humans. These life-history characteristics include family background, individual maturation, physical characteristics, personality, social behavior, and sexual behavior. Thus far, there have been no attempts to provide a unifying theoretical framework to account for these relationships. Rushton (1985) has recently proposed Differential K Theory, which potentially systematizes these disparate findings. Rushton suggests that many of these observed relationships can be explained by extrapolating concepts from population biology and evolutionary theory to human behavior. He has proposed that individuals may inherit a certain reproductive strategy and that this strategy may in turn influence the life-history characteristics mentioned above.

The study you have participated in represents an initial empirical test of this theory. More specifically, we were interested in determining the extent to which life-history characteristics such as family size, maturation, personality, and sexual behavior may be related. Insofar as this theory has as its basis reproductive strategies, it was necessary to gather precise and thorough information regarding your sexual behavior and attitudes.

If you have in further questions regarding this study, please feel free to contact us at any time. We have provided several references below, should you wish to do further reading in this area. We thank you for your participation.

Rushton, J.P. (1985) Differential K Theory: The sociobiology of individual and group behavior. Personality and Individual Differences, 5, 461-452.

Wilson, E.O., and Bossert, W.H. (1971) A primer of population biology. Sunderland, Mass.: Sinauer.

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SEXUAL BEHAVIOR INVENTORY

Section 1: Background Information

SEXUAL BEHAVIOR INVENTORY

1. Sex: male \_\_\_\_\_ female \_\_\_\_\_
2. Age: years \_\_\_\_\_ months \_\_\_\_\_
3. How many biological (ie, blood related) brothers and sisters do you have? (This includes half-brothers and sisters but not adopted siblings.) \_\_\_\_\_  
(If you had any other siblings who are no longer living, please indicate how many \_\_\_\_\_ and their ages at death \_\_\_\_\_)
4. What are the ages of your biological (blood related) brothers and sisters? (Please list and include years and months eg: 16years, 3months; 28 years, 8months. \_\_\_\_\_)
5. Are your biological parents still living? Mother: yes \_\_\_\_\_ no \_\_\_\_\_  
Father: yes \_\_\_\_\_ no \_\_\_\_\_  
Mother \_\_\_\_\_  
Father \_\_\_\_\_
6. What are your parents ages? (If deceased, please state age of death.)  
\_\_\_\_\_ | \_\_\_\_\_  
Mother \_\_\_\_\_  
Father \_\_\_\_\_
7. How many biological brothers and sisters does your biological father have, including any that are deceased? \_\_\_\_\_
8. How many biological brothers and sisters does your biological mother have, including any that are deceased? \_\_\_\_\_
9. What is your height? feet \_\_\_\_\_ and inches \_\_\_\_\_ OR cms. \_\_\_\_\_
10. What is your weight? lbs \_\_\_\_\_ and oss \_\_\_\_\_ OR kgs. \_\_\_\_\_
11. What is the current marital status of your biological parents?  
 \_\_\_\_\_ 1. never married  
 \_\_\_\_\_ 2. divorced  
 \_\_\_\_\_ 3. separated  
 \_\_\_\_\_ 4. married  
 \_\_\_\_\_ 5. widowed

## Appendix C

Eigenvalues and Variance Accounted For  
(Study 2 Solutions)

Appendix D. Eigenvalues and variance accounted for  
(Experiment 2, male and female solutions.)

	Factor	Eigenvalue	Percent of Variance
<u>Males</u>	1	3.303	14.4
	2	2.391	10.4
	3	1.877	8.2
	4	1.739	7.6
	5	1.647	7.2
	6	1.408	6.1
	7	1.256	5.5
	8	1.112	4.8
	9	1.049	4.6
	10	.971	4.2
	11	.853	3.7
	12	.758	3.3
	13	.756	3.3
	14	.684	3.0
	15	.599	2.6
	16	.513	2.2
	17	.494	2.1
	18	.461	2.0
	19	.435	1.9
	20	.270	1.2
	21	.223	1.0
	22	.129	.6
	23	.074	.3
<u>Females</u>	1	3.238	14.1
	2	1.895	8.2
	3	1.730	7.5
	4	1.605	7.0
	5	1.576	6.9
	6	1.465	6.4
	7	1.267	5.5
	8	1.168	5.1
	9	1.055	4.6
	10	.936	4.1
	11	.885	3.8
	12	.872	3.8
	13	.829	3.6
	14	.720	3.1
	15	.633	2.8
	16	.625	2.7
	17	.522	2.3
	18	.488	2.1
	19	.440	1.9
	20	.351	1.5
	21	.326	1.4
	22	.293	1.3
	23	.081	.4

**GENERAL INFORMATION**

(12) **MARITAL STATUS**

1	Single
2	Widowed
3	Married
4	Living together but not married
5	Separated
6	Divorced
7	Remarried

(15) Do you have any children?  Yes  No

If YES, please give their sex (male or female) and their year of birth. Indicate if any are by a previous spouse. Indicate if any are twins.

Sex	Year of birth	Twins
1		
2		
3		
4		
5		
6		

(13) How many years have you been in your present marital status?  years

(14) **EDUCATIONAL ACHIEVEMENT**

1	Less than 7 years schooling
2	8-10 years schooling
3	11-12 years schooling
4	Apprenticeship, diploma, certificate, etc.
5	Technical or Teachers college
6	University first degree
7	University post-graduate studies

(16) **YOUR MAIN OCCUPATION** - please describe in detail. e.g. "maintenance fitter in oil refinery".

FULL TIME	
PART TIME	
UNEMPLOYED	

(17) **YOUR FATHER'S MAIN OCCUPATION** (before retirement)

(18) **RELIGION**

1	No religion
2	Church of England
3	Other Protestant
4	Catholic
5	Jewish
6	Greek or Russian Orthodox
7	Other, please specify
8	Prefer not to answer

(19) How often do you attend church (or other observance)?

1	more than once a week
2	once a week
3	every month or so
4	once or twice a year
5	rarely

**LIFESTYLE & HEALTH**

(20) On average, how many cups of TEA would you drink?  cups each day

On average, how many cups of COFFEE would you drink?  cups each day

(21) If you were to drink COFFEE in the evening would it be:

1	always
2	usually

(22) Which of the following do you take regularly?

1	Aspirin, Panadol, Vioctans, etc.
2	Sedatives or sleeping tablets
3	Tranquillizers (eg. Valium)
4	Acid-repressant tablets
5	Vitamin tablets
6	Diuretics
7	Tablets for high blood pressure
8	Tablets to remove fluid (diuretics)
9	Tablets for angina (heart pain)
0	Other (specify)

(23) How your leisure activity using the following as a guide (tick one box)?

1	Jogging, cycling to work or vigorous sport (squash, swimming etc.) 3-4 times a week
2	Play sport or exercise a couple of times a week
3	Regular exercise (eg. tennis, golf, etc.) about once a week
4	Occasional exercise (2-3 times a month) or regular light gardening
5	No leisure exercise or sport

(24) What is your height?  ft  in  OR  cm  mm

(25) What is your weight?  st  lb OR  kg

(26) Do you consider you have good health?  Yes  No

(27) In the past 12 months, on how many days would you have stayed home from work because of illness?  days

(28) Do you or any of your blood relatives have any of the following conditions?

Strabismus	1/2	Your Self	1/2	Blood relative (specify)
Dyslexia, word blindness, specific learning disability, severe reading problems	1/0			
Asthma	1/0			

(29) Have you EVER been a smoker? If NO go to next page.

1	Yes
2	No

(30) At what age did you start smoking?  years

(31) If you have stopped smoking, how old were you when you stopped?

Stopped cigarettes at	<input type="text"/>	Years
Stopped pipe at	<input type="text"/>	Years
Stopped cigars at	<input type="text"/>	Years

(32) How many CIGARETTES do (or did) you usually smoke in a day?

How many CIGARS do (or did) you usually smoke in a day?

How many PIPES of tobacco do (or did) you usually smoke in a day?

What was the LARGEST number of cigarettes, per day, that you