

SD2 and SA2 tasks, on which the claimed correlations chiefly depend. The *maximum* for any task was 84 trials on Memory Scan (i.e., 12 trials per span length!). This makes the data uninterpretable because:

(a) When so few observations are made, differences in mean RTs are uninformative because they mainly reflect differences in the variance and kurtosis of RT distributions. Often volunteers' *fastest* responses differ little, or not at all, between groups or conditions so that differences in means are determined entirely by isolated slow responses.

(b) In an unfamiliar task the first one to ten responses a person makes on an unfamiliar task may be two to six times slower than those produced when verbal instructions have been worked through in terms of their physical implementation. The more difficult the task and, no doubt, the less sophisticated the volunteer, the longer this settling-down period will take. This raises the fundamental question of what the differences between Vernon's tasks really measured, differences in the times taken to come to terms with quite complex instructions or differences in information-processing speed?

(c) This in turn raises the more general question of precisely what claim Jensen intends. Even very modest amounts of practice reduce mean RTs by 100 to 300%. Improvement with practice continues after periods of 25 days or more. A finding that differences in ASVAB scores predict differences in times taken to learn unfamiliar tasks in a strange social context is not very informative. To test a claim that differences in *g* reflect functional, even perhaps neurophysiological, differences, we must compare groups at asymptotic performance. Neither this nor any other study Jensen quotes separates the trivial from the interesting possibility.

Among many lapses of logic and questionable assumptions, the following are notable because they appear in other studies than those cited here:

(a) Where the outcome favours his hypothesis, Jensen punctiliously adjusts correlations to take account of gross differences in ranges of scores (e.g., in the penultimate paragraph of the section "Information-processing capacities and psychometric *g*"). He makes no adjustments for what must have been gross increases in variance between the difficult tasks (e.g., SD2 and SA2 over the easiest tasks 1, 2, 3, 4, and 6; cf. Figure 10). His argument depends entirely on this putative difference.

(b) Though "reaction time" is *measured* in constant units of milliseconds it is not *functionally* an equal interval scale; that is, a shift between mean RTs from 180 to 280 msec is not *functionally* equivalent to one from 1000 to 1100 msec. Plots of RT against condition difficulty sometimes appear linear over a brief range (e.g., Sternberg 1969) but more often accelerate or decelerate to an asymptote. Interpretation can be made only in the light of functional models after careful task analysis.

With these points in mind it seems supererogatory to go on to inspect the actual data; however:

1. Why are intercorrelations between the tasks, and their possible variance across groups, not given? It seems likely that the reading-based tasks (SD2 and SA2) would correlate rather poorly with the others.

2. Why does Jensen find it reassuring that the ASVAB "coding speed test" correlates only weakly with his battery? In my own experience this test predicts performance well on a variety of visual search tests and other measures of information-processing speed. To my mind the absence of a correlation validates objections to Jensen's methodology.

3. Correlations with the ASVAB *g* factor are unimpressive for tasks 1, 2, 3, 4, and 6. Do we count this as a failure of replication of correlations of 0.4 and above, for task 1, cited in Jensen (1981; 1982d)?

4. The overall correlations evidently depend substantially on tasks (SA2; DT3 words) similar to those which Hunt and associates have shown to be related to verbal ability. Why are excellent experimental series such as Hunt, Lunneborg & Lewis

(1975); which are unfavourable to the pure *g* hypothesis, not cited?

5. Why is Jensen excited by dual task correlations with ASVAB *g*, since these are no better than those obtained when component tasks are administered in isolation? (cf. the near parity of 3 and 4, of 5 and 6, and of 7 and 8 in Figure 10.) This *failure* to find increased correlations between task performance and *g* scores in complex tasks, involving overall superordinate control of processing, is very unfavourable to Jensen's argument and to Vernon's methodology. It also strongly hints that the relatively high correlations between "ASVAB *g*" and SD2 and SA2 scores, whether they appear as tasks in isolation or components in dual tasks, reflect their verbal content rather than any intrinsic information-processing difficulties they entail.

This is not a convincing paper. Excellent reviews by Cooper and Regan (1982), Hunt (1978), and R. Sternberg (1982) show that mapping psychometric models and concepts onto process models developed by cognitive psychologists may now be one of the most important goals for cognitive science.

Differential K theory and group differences in intelligence

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The difference between blacks and whites in the United States on measures of intelligence has remained at approximately one standard deviation for the last 70 years (Loehlin, Lindzey & Spuhler 1975). Jensen's detailed and scholarly treatment is important because it convincingly addresses the nature of this difference. This commentary builds on his discussion of group differences to include Asians, countries beyond the United States, and traits in addition to intelligence. At the conclusion, "differential K theory" is described to organize the observations within an evolutionary framework.

Intelligence. Some Asian people score higher on tests of intelligence than Europeans. Despite peasant background and initial discrimination, on average the Chinese and Japanese in Canada and the United States have reached higher educational and occupational levels than Euro-Americans, and they score higher on tests of intelligence (Vernon 1982). Other studies document the higher intelligence of the Japanese in Japan (Lynn 1982, but see Flynn 1984; Misawa, Motegi, Fujita & Hattori 1984). People of African descent, however, score lower than Europeans on measures of intelligence elsewhere in the world, including Britain (Scarr, Caparulo, Ferdman, Tower & Caplan 1983), and such postcolonial African countries as Nigeria, Tanzania, and Uganda (Lynn 1978). If the cultural attainments of Asians, Europeans, and Africans on their home continents are examined (e.g. by dating such inventions as written language, numbering systems, calendars, astronomical systems, codified rules of law, domestication of plants and animals, and metal technology), the rank ordering remains the same (Baker 1974).

Activity level. Newborn Chinese-Americans, on average, are quieter and more readily soothed than Euro-Americans who, in turn, are less active than Afro-Americans (Freedman 1979). One measure involves pressing the baby's nose with a cloth, forcing it to breathe with its mouth. Whereas the average Chinese baby appears to accept this, the average Euro- or Afro-American baby fights it immediately. Subsequent studies have replicated these findings in other countries with quite different measures and samples. The Navajo Indians of the southwestern United States, for example, stoically spend much of their first six months of life wrapped to a cradleboard. Attempts to get Euro-American infants to accept the cradleboard have met with little success (Freedman 1979). The Navajo are like the Chinese in being classified as belonging to the Mongoloid population.

Behavioral restraint. A large number of studies have tested the personality of the Chinese and Japanese both in their homelands and in North America (Vernon 1982). On questionnaires, Asians are, on the average, more introverted and anxious and less dominant and aggressive than Europeans. These differences are manifest in play behavior, with Asian children being quieter, more cautious, and less competitive and aggressive than Euro-Americans. Eskimos, who are also Mongoloid, are likewise behaviorally restrained (LeVine 1975). African-descended people, on the other hand, tend toward the extraverted end of the continuum. Individual differences in anxiety, behavioral restraint, and extraversion have been linked to the inhibitory system of the brain (Gray 1982). [See also Zuckerman: "Sensation Seeking" *BBS* 7(3) 1984.]

Developmental precocity. In the United States, blacks have a shorter gestation period than whites. By week 39, 51% of black children have been born, while the figure for whites is 33%; by week 40, the figures are 70% and 55%, respectively (Niswander & Gordon 1972). This precocity continues throughout life. In terms of physical coordination, Freedman (1979) found that, unlike Europeans and Asians, many African as well as Afro-American newborns can hold their heads erect. Concomitant differences are found in skeletal maturity, as measured by growth of ossification centers throughout the first years of life (Eveleth & Tanner 1976). Afro-American children also walk at an average age of 11 months, compared with 12 months in Euro-Americans, and 13 months in American Indians (Freedman 1979). Afro-Americans are also more precocious sexually, as indexed by age at menarche (Malina 1979), first sexual experience (Weinrich 1977), and first pregnancy (Malina 1979).

Differential K theory. In the discussion above, Europeans fell midway between Asians and Africans. The ordering raises interesting theoretical questions, especially since there is evidence for the heritability of the traits discussed, including intelligence (Bouchard & McGue 1981), activity level (Willerman 1973), behavioral restraint (Floderus-Myrhed, Pedersen & Rasmuson 1980), rate of growth (Wilson 1983), age at menarche (Bouchard 1982) and age of first sexual experience (Martin, Eaves & Eysenck 1977). Differential K theory has been proposed to help order these and other biosocial differences found between people (Rushton 1984a; b; 1985).

It is postulated, on the basis of concepts from evolutionary biology, that the degree to which an individual engages in a "K" reproductive strategy underlies multifarious characteristics related to life history, social behavior, and physiological functioning. K refers to one end of a continuum of reproductive strategies organisms can adopt, characterized by the production of few offspring with a large investment of energy in each. (K is a symbol from population biology, standing for the carrying capacity of the environment, or the maximum population a species can maintain under certain fixed conditions.) At the opposite extreme is the r strategy in which organisms produce numerous offspring, but invest little energy in any one. (r is also a symbol from population biology and stands for the maximal intrinsic reproductive rate, or the natural rate of increase in a population temporarily freed from resource limitations.) Oysters, producing 500 million eggs a year, exemplify the r strategy, while the great apes, producing only one infant every five or six years, exemplify the K strategy. Across-species comparisons demonstrate that a variety of life history features correlate with these reproductive strategies, including litter size, birth spacing, parental care, infant mortality, developmental precocity, life span, intelligence, social organization, and altruism (Wilson 1975).

As a species, humans are at the K end of the continuum. Some people, however, are postulated to be more K than others (Rushton 1985). The more K one is, the more one is likely to be from a smaller-sized family, with a greater spacing of births, a lower incidence of dizygotic twinning, and more intensive

parental care. Moreover, one will tend to be more intelligent, altruistic, law abiding, behaviorally restrained, maturationally delayed, lower in sex drive, and longer lived. Thus diverse organismic characteristics, not apparently otherwise related, are presumed to covary along the K dimension. With respect to group differences, Asians are hypothesized to be more K than Europeans, who, in turn, are hypothesized to be more K than Africans. This ordering accords well with data on multiple birthing, which can be taken as an index of litter size. For example, the dizygotic twinning rate per 1,000 births among Asians is 4; among Europeans, 8; and among Africans, 16 (Bulmer 1970). Similarly, a comparison of the incidence of triplets and quadruplets shows a higher frequency among Africans than Europeans (MacGillivray, Nylander & Corney 1975). A parallel ranking in longevity has been found (Bengtson, Kasschau & Ragan 1977). Numerous other indices of K correlate both between and within populations (Jensen 1984d; Rushton 1985). The nature of black-white differences in g may belong in a broader evolutionary context than has been considered to date.

Neural adaptability: A biological determinant of g factor intelligence

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This commentary addresses Jensen's statement that "little, if anything is, as yet, known about the physiological and biochemical substrate of g."

Our studies of evoked cortical potentials have identified significant brain electrical activity differences that could account for human variability in g factor intelligence (Schafer & Marcus 1973; Schafer 1982; Schafer 1984). The working hypothesis for these studies has been that individual differences in the cognitive modulation of evoked potential amplitude will relate to individual differences in behavioral intelligence.

In the 1982 study, auditory evoked potentials (EPs) were obtained from 109 normal and 52 mentally retarded adults under three stimulation conditions (periodic, self, and random) designed to manipulate temporal expectancy. The normal adults showed a strong temporal expectancy effect on their EPs, giving smaller than average EPs to expected inputs and larger than average brain responses to unexpected stimuli. In contrast, the retarded adults failed to show a temporal expectancy effect on their EPs, indicating a deficit in cognitive neural adaptability. A measure of neural adaptability derived from EP amplitude ratios correlated .66 with WAIS IQ scores obtained on 74 normal adults, indicating a definite association between neural adaptability and behavioral intelligence. This correlation rose to .82 when corrected for the restricted range of IQ (98 to 135) in the sample. People who gave larger than average EPs to unexpected inputs and smaller than average EPs to stimuli whose timing they knew tended to have higher IQs. Results suggested that the brain that efficiently inhibits its response to insignificant inputs and that orients vigorously to unexpected, potentially dangerous stimuli is also the brain that manifests high behavioral intelligence. Neural adaptability as indexed by the temporal expectancy effect on evoked cortical potentials appeared to provide a biological determinant of g factor psychometric intelligence.

If the EP temporal expectancy index is a good measure of g factor intelligence, then WAIS subtests having high g factor