

Variances and Anomalies

Sex-Related Differences in Cognitive Functioning. Developmental Issues. MICHELE ANDRISIN WITTIG and ANNE C. PETERSEN, Eds. Academic Press, New York, 1979. xviii, 378 pp., illus. \$24.50. Academic Press Series in Cognition and Perception.

In the preface to his *Dictionary* (1755), Samuel Johnson said, "I am not so lost in lexicography as to forget that words are the daughters of earth, and that things are the sons of heaven." Psychological research may have revealed more than a glint of truth in this remark. Females, on average, surpass males in several language skills, including articulation, comprehensibility, "fluent production," use of verbal information in a learning task, and rapid production of symbolic codes or names. The sex difference is sharpened in clinical populations, with stammering, reading disability, and other language-related problems being more severe and far commoner in males than in females. Females also show greater sensitivity to the non-verbal dimensions of communication such as those involving gesture, intonation, or facial expression. In contrast, males' "thing-orientation," as indeed it has been called by some psychologists, is shown in their superior performance on a variety of visual-spatial tasks—for example, copying intricate geometric designs with blocks, solving mazes, disembedding geometric figures from complex backgrounds, labeling one's left and right movements through a spatial layout, and mentally rotating representations of two- and three-dimensional shapes in order to compare them with standard figures. Males also excel in mechanical and mathematical skills, which, perhaps significantly, have visual-spatial components resembling those found in some of the aforementioned tasks.

Historically, attempts to explain these sex differences have ranged broadly, the stress shifting over time between the classical poles—biology at one end, the workings of culture and socialization at the other. Currently, the direction of the shift is again toward biology, as is evidenced in this collection of new review papers.

In the biological camp, genetic models

have long been prominent, and editor M. A. Wittig thoughtfully discusses theoretical and methodological issues in genetic analysis. S. G. Vandenberg and A. R. Kuse then evaluate a particular genetic model of spatial ability—the X-linkage model, according to which spatial ability is enhanced more frequently in males than in females through inheritance of a recessive, X-borne "spatial" gene. The model thus predicts both the distribution of spatial ability within the population and the direction of correlations of spatial ability within families. The verdict: case for X-linkage unproven. The authors, however, take note of tentative support for the model for at least certain visual-spatial tasks by a new and superior method—modified linkage analysis, which compares correlations on tests of visual-spatial ability in siblings who are also concordant on a known X-linked marker (for example, a certain blood group) with the correlations in siblings who are discordant for that marker (D. R. Goodenough *et al.*, *Behavior Genetics* 7, 373 [1977]).

The X-linkage model pertains only to visual-spatial ability. More ambitious in scope, and now winning wide attention, are neuropsychological hypotheses that suppose that sex differences in both visual-spatial and language functioning are rooted in cortical organization. One body of evidence in neurologically normal individuals shows that lateral perceptual asymmetries in vision and audition are stronger in men than in women. There also are clinical data that indicate quite remarkable sex differences in the pattern of cognitive deficits after unilateral cortical injury. Men show the classical pattern—impaired verbal performance after left-sided lesions, impaired spatial performance after right-sided lesions. In women with left lesions, however, language deficits are significantly less severe (aphasia in fact being relatively infrequent), and impaired spatial performance is as likely to follow lesions on either side. It therefore has been proposed that language is more nearly bilaterally organized in females than in males—that is, that in females the right hemisphere has relatively greater secondary commitment to language, thereby providing a sparing function after left-

brain injury at the cost of compromising its own primary capacity for visual-spatial processing. M. P. Bryden discusses the evidence, confining his attention primarily to studies of familial right-handers, the vast majority of whom have primary speech representation in the left hemisphere. In left-handers, a cortically more heterogeneous population, the relationship between sex and cognitive functioning is less clear, though perhaps not quite so murky as L. Carter-Saltzman's review would suggest.

If sex differences in cortical organization underlie sex differences in cognitive functioning (at least in the agreeably simpler-minded righties), whence come the cortical differences? D. P. Waber proposes that they begin as differences in the rates of functional maturation of the cerebral hemispheres, with faster development on the left in females and faster development on the right in males. This is why, in the "mechanical aspects of speech and language" and in such tasks as "rapid automatized naming," girls significantly lead, particularly between 6 and 7 and 10 and 11 years of age, when, in Waber's view, sex differences in such differential maturation are maximal. The sex differences, however, do not always appear in overall skill differences; sometimes they emerge only in subtler, usually unnoted features of behavior. For instance, Waber and J. Holmes have discovered stylistic variations in copies of the Rey-Osterreith Complex Figure by normal right-handed 5- to 13-year-olds. At the youngest age, girls drew more internal details and more of the discrete parts, whereas boys concentrated more on the external configuration. At 11 years, boys drew their designs in "long, sweeping, continuous lines," whereas girls "drew theirs part by part." Could these differences, as Waber suggests, indicate sex-related individual differences in involvement of the cerebral hemispheres in processing of complex visual-spatial information, and might the waxing and waning of the sex differences be timed to sex differences in neuromotor maturity? Fascinating questions for further research.

Because maturation rate is under endocrine control, the different maturational schedules of left- and right-hemisphere systems in males and females presumably are under the control of the sex hormones. The sex hormone (androgen-to-estrogen) ratio, or balance, also has been proposed to affect sex differences in cognitive functioning directly by influencing the action of neurotransmitter mechanisms. This is a controversial idea, and A. C. Petersen, the second editor, gives

a good account of recent evidence bearing on it. Among the most consistent findings are those which, like Petersen's own, infer endocrine status from somatic characteristics. The results are surprising: In 13- to 18-year-old normal children, spatial scores are lower (relative to "fluent production" scores) in less androgenized, more "feminine" girls and higher in more androgenized, more "masculine" girls. In boys, however, it is the less androgenized who have the higher spatial scores. Inferring endocrine status from somatic characteristics is problematic, of course, but given this limitation the implication is that within the normal range of androgenization there is some middle range, where more males than females fall, within which spatial ability is maximized and beyond which spatial ability is depressed.

Hormonal effects also have been studied by analyzing intraindividual changes in performance on cognitive tasks as a function of cyclical changes in hormonal balance. The subject of choice here has been the menstruating female. A. J. Dan discusses recent research and concludes that while there are changes in activity levels, sensory thresholds, and moods, changes in cognitive performance have not been consistently demonstrated. Another clue to the role of hormones in cognitive functioning in normal persons is in evidence presented by hormonally anomalous individuals. J. M. Reinisch, R. N. Gandelman, and F. S. Spiegel mention several possible conclusions warranted by the evidence, one being that either too much or too little prenatal estrogen negatively influences spatial-perceptual skills. But how might any such influences be mediated? The authors' interesting suggestion is that male and female endocrine differences, during peri- and postnatal as well as prenatal periods, initiate differential sensitivities to, and perhaps differential processing of, sensory information.

This much said for biological contributions to cognitive sex differences, what of socialization and culture? S. C. Nash suggests that the sex typing of the domain of achievement is a potent factor. Boys thus may excel at mathematics because, beginning at age 12, boys but not girls predict that science and mathematics will be relevant to their work as adults. Gender preference is important too, male preference being associated with superior spatial performance in both boys and girls. In the context of Petersen's work, one wonders about the physical characteristics of the children in question.

L. H. Fox, D. Tobin, and L. Brody

conclude that mathematical skills are especially affected by family and teachers, who reinforce the stereotype that mathematics is a male domain and thereby breed greater self-confidence for achievement in boys than in girls.

Finally, C. A. Dwyer notes the consistent and "extremely stereotyped depictions of female and male roles" in questions on standard achievement and aptitude tests. Such practices may "alter test-taking motivation for some individuals" and may have a "subtle and long-term adverse impact." Dwyer's chapter is entitled "The role of tests and their construction in producing apparent sex-related differences," which seems misleading given her conclusion that there is "no research to date indicating that sexist practices have any observable effect on item or test psychometric characteristics or that they affect group scores in any way." Dwyer's primary concern, for that matter, does not seem to be with the particular visual-spatial, linguistic, or neuropsychological tasks on which the evidence for sex differences mainly rests and which, relatively speaking, are free of the problems she mentions. Consequently, if group scores are not significantly affected on blatantly sexually stereotyped tests, we presumably have still greater reason to trust results on tests that are more fairly constructed. One wishes that Dwyer had addressed this point more directly.

Individually, nearly all the papers are at least adequate to their aims, and some are quite fine. Their collective value, however, is compromised through what I believe was a mistaken, if well-intentioned, editorial decision to leave unresolved "some instances of disagreement between chapter authors." The editors explain that the recency of much of the research leaves room for differing interpretations, but several of the disagreements seem less to reflect a dispute over interpretation of data than a lack of agreement on what the data are to begin with. Resolution might have been simple in these instances. In any case, disagreements should have been identified to aid those who, unlike a reviewer, do not read each chapter with scorecard in hand.

One potentially confusing issue pertains to the size and reliability of the sex differences. The editors say that sex accounts for "relatively little of the variance in cognitive scores"; and coeditor Petersen later writes of spatial test performance that "at most" the difference is "small." Waber, however, calls the difference in spatial test scores "one of the clearest and most frequently repli-

cated," and Vandenberg and Kuse conclude that it has been "documented extensively." They also report males' having achieved nearly 100 percent higher scores on mental-rotation tests than females at every age from 14 to 53 years—very robust differences indeed.

One can see that adjectives like "large," "small," and "relatively little" are meaningless in the absence of actual scores plus variance estimates (only rarely provided by the contributors) and such qualifying information as sample size and characteristics, psychometric details of tests, and referent points ("large," "small," or "relatively little" compared with what?). Finally, whether we call a difference large or small may depend on whether our chief concern is scientific-theoretic (in which case a small but reliable difference can be of immense significance) or social-practical (in which case the same difference may be of little consequence). These issues should have been more systematically addressed.

Authors also disagree about when the sex differences appear. This issue is directly relevant to theoretical concerns. For instance, Nash's emphasis on the influence of sex role and sex typing evidently rests largely on the conclusion from an earlier review (Maccoby and Jacklin's *The Psychology of Sex Differences*, Stanford University Press, 1974) that sex differences in cognitive functioning are not significant until adolescence. Nash thinks this is because adolescence is when sex-role requirements are most augmented. Perhaps, but this takes no account of the language and figure-drawing scores in preadolescent children reported by Waber; nor does it consider new studies with the WISC Block Design Test, cited by Vandenberg and Kuse, showing significantly better performance by boys than girls across the full age range from 6 to 16 years.

Nash also suggests that because other types of sex-role behaviors are temporary, declining after adolescence, so may the "exaggerated, cognitive sex-related differences, emergent after adolescence" be "age bound and ephemeral." But they are not. The book also includes D. Cohen and F. Wilkie's summary of new research on the elderly, which shows that the sex differences in visual-spatial and verbal skills continue through the life-span, though overall performance has declined in the elderly. One wishes the editors had given Nash the opportunity to take account of the newer findings inasmuch as they suggest important qualifications for her otherwise persuasive thesis.

The damaging effect of this isolation of

chapters also is seen in Fox, Tobin, and Brody's paper on mathematics, which inexplicably makes no reference to the probable involvement of visual-spatial ability in mathematics achievement, even though this point is made elsewhere and, in fact, has long been suggested. If it is involved, and if both biological and social factors underlie the male's superior visual-spatial ability (an inescapable conclusion, I think), then Fox *et al.*'s exclusively sociocultural analysis of male mathematical superiority cannot stand.

No more than we can assume that socialization factors act on an essentially neutral biological substratum can we assume that hard-wiring explanations mean that there is some simple input-output relationship between the hard wiring and certain cognitive skills—as though one automatically gives rise to the other without intervening steps. (Oddly, the authors of the biological chapters are far more forthcoming in acknowledging this first principle than are the authors of the chapters emphasizing socialization.) Some points of mutuality are quite obvious. For example, if males are more cortically lateralized than females, the proximate cause of sex differences in visual-spatial skill is most reasonably conceptualized as arising from the cognitive strategies and attentional biases which this neurological difference may predispose in the context of the individual's entire cognitive and social-developmental history. Given their earlier and superior linguistic abilities, it is conceivable that females, more than males, tend to code visual-spatial information linguistically—and, consequently, less efficiently in many instances. In other cases, however, an obvious tension exists between the sociocultural and biological models. For instance, the data on androgenization and cognitive ability are easily compatible with a socialization hypothesis for *females* if we assume that girls who are more sex-stereotypic in appearance will be more sex-stereotypic in cognitive performance; but, as Petersen notes, how then explain the inverse relationship found for boys?

The aforementioned disagreements and potential points of theoretical integration presumably are among those that were to have been addressed in the last paper—an epilogue by C. N. Jacklin. By way of integration, however, Jacklin offers little, and on the areas of disagreement her remarks are more confusing than clarifying. For instance, she unqualifiedly calls the sex difference in cognitive functioning “trivially small” and concludes that the search for explanatory mechanisms therefore “may

be an exercise in futility.” But as evidence she cites the near-zero variances accounted for by sex in studies of “achievement via independence” and “intellectual efficiency,” neither of which she defines or relates to the particular cognitive skills of major concern to the other contributors.

Jacklin also proffers an explanation why current attention has turned to biological factors: Socialization research has less prestige, and it is slow to carry out, making payoff slow in terms of publication. The “prestige” reason may be correct (psychologists have long been enamored of the “harder” biological sciences); but the speed-and-payoff reason surely is mistaken, and I wonder why Jacklin seems to hold so uncharitable a view of her colleagues' research efforts. If sociocultural models are losing interest, perhaps it is because greater promise is being seen in models that recognize and are beginning to try to measure the embeddedness of sociocultural influences in biological foundations.

In summary, this collection of papers is well worth reading and careful study, although it needlessly falls short of its outstanding potential. A final note: the term “opposite sex,” used by several contributors, should be forever retired. As the evidence shows, neither in any physiological nor in any psychological sense are males and females “contrary or antithetical in nature or tendency; diametrically opposed, or altogether different.” On occasion, of course, they will be “across from or facing.”

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The Power Industry in Britain

Electricity before Nationalisation. A Study of the Development of the Electricity Supply Industry in Britain to 1948. LESLIE HANNAH. Johns Hopkins University Press, Baltimore, 1979. xvi, 468 pp. \$28.50. Johns Hopkins Studies in the History of Technology.

Leslie Hannah has provided a superb analytical case study of modern technology and public policy in this monograph commissioned by the British Electricity Council. The book is, in many respects, a retrospective technology assessment that examines carefully the dynamic interaction of government, public, and private enterprises, including the economic and ideological context that affected the decision-making process. Hannah documents the relative inef-

fectiveness of moral persuasion in resolving conflicts between interest groups or in promoting voluntary energy conservation by the public except during wartime. The extraordinary technological diversity that resulted from localism and divided ownership helped to frustrate early efforts to reform and rationalize the electric power industry and should serve as a warning against simplistic comparisons with other nations. Hannah's study is suggestive of the difficulties of formulating and implementing energy policies and should be required reading by those now engaged in contemplating alternative energy policies for the future. As Thomas P. Hughes observes in the foreword, the technology of electric supply “was not only compounded by politics, but it involved economics, science, geography, sociology, psychology, contingent circumstances, and history” (p. vii).

A central theme of the book is the conflict between the more than 600 municipal and privately owned utilities that were established prior to 1948 and the efforts by political leaders, national commissions, and boards to mitigate the adverse impacts of the conflict. Although the municipals gained a significant advantage from legislation passed in the 1880's, the private utilities employed technical innovations in power generation and distribution as a “favourable battleground in their attempt to turn back the municipal tide” (p. 24). By creating large regional supply systems, firms such as Charles Merz's Newcastle-upon-Tyne Electric Supply Company demonstrated that “efficiency and cheapness was a most effective ambassador to the consumer” (p. 32). A radical reorganization of the industry was proposed by a committee chaired by Sir Archibald Williamson in 1917 as the wartime experience with management of supply “gave an indication of what could be achieved under duress” (p. 56). The resulting Electricity Act of 1919 created an Electricity Commission headed by Sir John Snell but did not establish the District Electric Boards with strong executive authority recommended by the Williamson committee. The Commission's reliance on “exhortation and common sense” proved relatively ineffective “within a system where the incentives were not to reach agreement” (p. 86). The apparent failure of the “policy of persuasion” (p. 91) led to the creation of another select committee chaired by Lord Weir in 1925. The Weir committee managed to diffuse opposition by recommending that existing utilities retain control of generating plants and local distri-