The Nature of Intelligence edited by Lauren Resnick. New York: John Wiley & Sons; Halsted Press, 1976. 352 pp. $17.95.

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The stated goal of the editor and most of the authors of this book is to integrate the several disciplines that have pondered human intelligence. They are, of course, doomed to fail at that task as the proverbial blind wise men were doomed to fail in apprehending the nature of the elephant. For experimental cognitive psychology has investigated and continues to investigate the legs, psychometrics the tail(s), computer simulation the trunk, and so on. It is not clear that the organs being scrutinized are part of the same system or that factor analysis of test scores, tachistoscopic presentation of letter pairs, naturalistic observation of problem solving, analysis of language comprehension, and formal description of epistemic stages necessarily have much to contribute to one another.

Instead of logical necessity or systematic integration, the authors of these papers (prepared for a 1974 conference at the University of Pittsburgh) demonstrate admirable talents for thinking beyond their personal methodological preferences and conceptual perspectives, unsystematically but productively (sometimes even provocatively). Such an eminent set of researchers participated in the conference, and the quality of their individual contributions is so consistently high (for which one guesses the editor deserves much credit), that many readers will find the book worth the $18. It is mainly for researchers in any of the fields represented—that is, for others who hope to do what the authors are doing—and not for educators seeking guidance in the interpretation or adjudication of conflicting views. We are

wisely offered more questions for future research than conclusions from the past.

The authors' failure to accomplish the impossible "blending" of the disparate approaches to the nature of human intelligence may actually be a success of sorts. It demonstrates that intelligence has many aspects and that its understanding is not to be attained by any one path. Scientific investigation of how we think and how we come to think is apparently alive and well and has been quietly advancing while the IQ controversialists (not one of whom is represented in this book) fumed and sputtered. Without exception these authors manage to be specific and informative in the research they adduce while being general and undogmatic in their arguments. It is a refreshing balance.

The first approach treated is the psychometric one (the "testing" or "correlational" or "factor analysis" or "individual difference" approach). Surprisingly, all three authors—Leona Tyler, John Carroll, and William Cooley—argue that inferences about the structure of human intellectual processes are still possible from correlations between scores on a battery of tests. Carroll shows that tests, subtests, and subsubtests can be analyzed sensitively, but the grim truth remains: the results of factor analysis report faithfully the nature of the tests included in one's battery and prove nothing about the nature of intelligence itself. Any resemblance to the nature of intelligence depends upon the extent to which the test makers' introspections reflect their own underlying processes. I shall return to this point.

The chapters by Herbert Simon and David Klahr demonstrate a series of computer simulations of intelligent performance in specific tasks. In general, such programs seem to resemble human performance better at a formal level, in relation to the sequential products of performance, than at a functional level in terms of modeling actual mechanisms. The main justification of "simulation" models is the possibility of discovering something more in them than the formal descriptions used to create them: the computer produces a "performance" resulting from "competence" provided by the programmer. Thus the program's steps have the status of hypotheses, tested by the degree of match between "simulation" output and the behavior of real problem solvers. As Ulrich Neisser points out in his chapter, the "artificial intelligence" (AI) advocates have yet to produce a simulation of developmental processes: a program that improves qualitatively as a result of learning by experience. This is in fact the essential difference between computers and living organisms, and *vive la différence!* Yet it does not negate the possibility of using the computer hypothetico-

deductively, which seems to be Klahr's main point. Even if AI cannot simulate development realistically it can simulate the behavioral consequences of individual differences in underlying competence and thus can help confirm or disconfirm various theories.

William Charlesworth, Jacqueline Goodnow, and David Olson address their chapters to an assumption basically at odds with the notion that intelligence can be programmed: they see it as an adaptation to environmental constraints, and especially to the social environment. Goodnow is particularly sensitive to the culture-based assumptions and values inherent in the tasks used by Western psychologists to test other people. (The work of Michael Cole and his colleagues on the extent to which skills are context-specific is cited often in this book.)

Resnick and Robert Glaser discuss their studies of problem solving, which carefully employ the experimental method (systematically changing features of the problems posed) as well as detailed observation and the clinical method with prompts and probes to elucidate what their child subjects are doing at each step. John Flavel calls for more studies of this kind and introduces the notion of metacognition, referring to one's knowledge about the nature of one's own cognitive processes. It might stand as a novel definition of what human intelligence really is.

Earl Hunt, Janellen Huttenlocher, and Charles Perfetti discuss the relation between memory, language, spatial reasoning, and other kinds of symbolic process. One can discuss these relations either at the level of cognitive mechanisms in the species in general or at that of individual differences and correlation research. The consensus is that there are important distinctions (noncorrelations) at either level. However, the relations between such processes in "human intelligence" (what is true of everyone) need have little to do with their correlations in human populations (the ways individuals differ). The former has to do with universals, the latter with variance—a point insufficiently stressed by all of these authors.

Hunt's work is particularly important, as he is one of the few who have experimentally studied cognitive processing in different samples of "more intelligent" and "less intelligent" normal subjects.

Finally, all the foregoing issues (and more) are discussed in chapters by William Estes, James Voss, J. McVicker Hunt, Lloyd Humphreys, and Robert Glaser (who goes furthest toward developing educational models to apply what is known so far).

The most important theme that emerges is that all our models —whether based on tests we have made up, computer programs we have written, problems we have posed, or experimental tasks we have designed—paint cognition like Michelangelo's God, anthropomorphized in the image of the processes we are aware of. More than 15 years ago, cognitive psychologists began to think of attention, perception, memory, and learning as processes occurring in real time rather than instantaneously. At the level of milliseconds, such processes were seen to be organized in sequential phases like the processes of search, test, and recall familiar from armchair "thinking" as well as from the workings of computers that human beings had designed. It was an important step forward. Yet it remains only a general conceit, and it is time to go beyond it to specific mechanisms. We should not expect the analogies to hold up in any very detailed way—unless man has been somehow endowed with superb intuitions regarding his own intelligence.