tivity described in earlier chapters. Dobson and Rose should be applauded for this gallant and productive exercise.

In summary, *Models of the Visual Cortex* is highly recommended for its provocative discussion of philosophical and methodological concerns in the neurosciences and its wide-ranging account of current research on brain and visual behavior. The latter will be appreciated by the nonspecialist and is greatly facilitated by the book's glossary and innovative associative index. The ultimate success of the authors' prescription for model building will be measured by the degree of discussion and application it stimulates among neuroscientists. A passage from the chapter contributed by Eric Schwartz aptly captures the allure of the book and our discipline: "Perhaps it is the clash of paradigms which both demonstrates the immaturity of brain science as well as provides a part of its excitement" (p. 155).

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Cognition as Intuitive Statistics

By Gerd Gigerenzer and David J. Murray. Hillsdale, NJ: Erlbaum, 1987. 214 pp. Cloth, $19.90.

Cognitive scientists are devoting increasing attention to the nature of the process of studying mind, in addition to normal psychological science. Central to the conjunction of these domains of inquiry are mental metaphors and the rationality or optimality of behavior. Seldom is the history of psychology included as an important part of inquiry, even though those ignorant of it are doomed or fortunate to repeat it. A collaborative effort by a German and a Canadian psychologist has mixed these three ingredients into a delicious dish of engaging issues. The European tradition, the collaboration, and the experience of an interdisciplinary year have resulted in a successful meal to be savored for some time, although it might be digested too hastily by most.

The tools-to-theories thesis of this book is that psychologists not only failed to understand sufficiently the statistical tools of their trade, but both knowingly and unknowingly used these tools as metaphors for human behavior. The metaphors of interest are inferential statistics, and the behavior is cognition. Psychology, as most disciplines, was influenced by the shift from a deterministic framework for science to a probabilistic framework. In the former, there is no room for the uncertainty and variability that the latter framework permits. It is surprising for social scientists to learn how long the physical sciences remained deterministic, and how fascinated physical scientists have become with variability (for example, fractals and chaos theory in physics and mathematics).

The book begins by documenting the emergence of statistical inference with the seminal work of Sir Ronald A. Fisher and the revision of the

Fisherian method by Jerzy Neyman and Egon S. Pearson. Fisher believed that he had a formal method of inductive inference that was implemented by null hypothesis testing. Our statistics classes remain true to Fisher's dogma in that we remind the undergraduates that experimentation and statistical tests can disprove the null hpothesis, but never prove it true. The authors correctly point out that Fisher's tenet contradicts Sir Karl Popper's falsification strategy, because Fisher has us disproving the null whereas Popper has us disproving our research hypothesis. They fail, however, to note John Platt's strong inference strategy of scientific inquiry and how it goes beyond both Fisher's and Neyman/Pearson's frameworks.

The authors summarize Fisher's logic by three principles: Scientific knowledge comes only from inductive inference, which is disproving null hypothesis, and should be the aim of all scientists. Neyman and Pearson took issue with Fisher's asymmetrical testing by specifying the consideration of an alternative hypothesis. More important, these theorists criticized Fisher's idea of a formalized method of inductive inference. Their point, not repeated often enough over the years, is that the null can always be disproved by having a sufficiently large sample. Neyman and Pearson viewed scientific inquiry as requiring both statistical theory and decision making. That these two are not equivalent or that the former cannot be substituted for the latter is one important message of the book. The authors go on to document how statistics became an indispensable component of psychological investigation. A hybrid of the two approaches was adopted as *the* objective method, with primarily negative consequences. Although the negative consequences have been acknowledged throughout the short history of statistics in psychology, the authors' reminder instills the guilt that it should. The rationalization for its popularity is that statistics provided the illusory objectivity and determinism required by good science.

With these preliminaries, the authors examine how statistical metaphors permeated research and theory. The metaphors repeated and continue to repeat the errors inherent in the statistical model. Four substantive areas of inquiry discussed by the authors are detection and discrimination, perception, memory, and thinking.

The influence of the inference revolution is most apparent and most familiar in the area of detection and discrimination. Fechner's thresholds, although probabilistic, offered the hope of a direct relationship between stimulus and response, with the observer providing only a passive reflection of the environment. The theory of signal detectability (TSD) took statistical hypothesis testing as the analogy for how humans detect signals. There is a direct isomorphism between the Neyman/Pearson theory of hypothesis testing and the TSD description of how an observer detects a weak signal against background noise. The conceptual insight, given this metaphor, is that more than sensory factors are involved in detection. More important, the statistical analogy of a decision criterion offered a method to disentangle sensory factors from nonsensory factors, such as attitudes.

In the chapter on perception, the authors begin with a valuable discussion

of Brunswik's contribution and his view of the perceiver as an intuitive statistician. The evolution of Brunswik's ideas and their relation to the statistics metaphor and alternative perceptual theories provide a valuable coverage of a neglected theorist. The authors then discuss three obvious frameworks for the study of perceptual function: Gibson's direct-realist view, Gregory's hypothesis-testing view, and Anderson's cognitive algebra. Against Gibson, they observe that it is unlikely that complete information about the visual world is available and even if it were, having the information available does not necessarily mean that it is used. An issue for Gregory is to take a stand on the nativist-empiricist controversy. One criticism of Anderson's approach is that the analysis of variance model biases "proving" whatever was put forward as the null hypothesis. For example, if a weighted averaging of two cues predicts no statistical interaction in the results, failure to find an interaction is taken as evidence for weighted averaging—analogous to proving the null hypothesis. This observation is an important one, and it is more pervasive than might be expected in psychological inquiry. For example, the Sternberg additive factor method also has a bias of asymmetrical hypothesis testing. Lack of an interaction is not simply taken as failure to reject the null hypothesis, but as evidence for two independent stages of processing. In fairness to researchers who might be viewed as proving the null hypothesis, it should be pointed out that most of them acknowledge that the results are only consistent with it, and that the null hypothesis is attractive as a theory because it is usually the most parsimonious explanation of the observed results. One solution, not explicitly advocated by Gigerenzer and Murray, is to test among alternative models of performance, using a strong-inference strategy of research endeavor in which alternative models are formulated and tested against the results. This procedure precludes any asymmetrical hypothesis testing, and provides a quantitative measure of the goodness-of-fit of each model.

The discussion of memory appears to add little that is new, other than documenting the widespread use of the signal detection framework. The chapter on thinking exploits the richest use of inference and probability as metaphors for behavior. These metaphors explain how we *do* think in terms of normative models of how we *should* think. Before the inference revolution, thinking was not conceptualized as calculation, but viewed as association, insight, restructuring, or perception. After the revolution and to this day, psychologists seem to be more concerned with whether we are optimal, as defined by normative theory, rather than how we think and decide.

In the chapter on thinking, the authors review the findings that people are more conservative than what would be predicted from Bayes's theorem. They then present Tversky and Kahneman's program of research, and offer the idea that representativeness is *not* an alternative to probabilistic thinking. That is, to say that the subject uses a representativeness heuristic is equivalent to saying that the subject uses the likelihood in Bayes's theorem, but not the prior probability. In this light, the explanation reduces to a redescription of the phenomenon. The authors correctly conclude that we need to un-

derstand how thinking works rather than simply whether thinking is rational or not.

In summary, there is now an engaging treatment of the influence of the tools of our trade on the theories we entertain. Being aware that it is easy to lie with statistics does not preclude having statistics distract us from the important questions.

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