The Problem of Irrationality

Patterns, Thinking, and Cognition. A Theory of Judgment. HOWARD MARGOLIS. University of Chicago Press, Chicago, 1988. xii, 332 pp., illus. $45; paper, $15.95.

Why are people so stubbornly and extravagantly irrational, so often ignoring not only sound logic but also solid self-interest? This age-old philosopher's sigh is the departure point for Howard Margolis's stimulating, synthetic work on the psychology of thinking in general and of scientific discovery and persuasion in particular. Margolis advances a strikingly original view about how the mind works: in contrast to fashionable psychological approaches that draw analogies between thinking and computer programs, Margolis insists that all thinking and judgment can be "reduced to pattern recognition" (p. 1). Rules, algorithms, computation, and logic play no role in this "*P*-cognition," although the incessant shuttling back and forth between situational cues and our stored repertoire of patterns may ultimately produce all of these. But however logical and rational its incidental products (p. 94), the brain itself is, on Margolis's account, "a-logical and a-rational" (p. 4).

Margolis's answer to the venerable problem of irrationality is an evolutionary one: we are irrational because we are made that way. In successful species, cognition balances between the advantages of efficiency and of careful attention to particular situations. *P*-cognition, suitably disciplined by "checking," has the virtues of speed tempered by a modicum of caution. It also has the vices of those virtues: the more entrenched a pattern, the more efficiently it can be triggered in a new situation—and the more difficult it will be to correct as a truly new situation will demand. We err, be it by succumbing to cognitive illusions or through conservatism in the face of scientific novelty, because we apply the wrong patterns, misled by the ambiguity of cues, the tyranny of mental habit, or both. Thus, the same processes that are responsible for our cognitive successes—"our facility in handling patterns in faces, languages, places, and even entirely artificial things like chess and concert music" (p. 105)—are also to blame for our cognitive failures.

Margolis is largely mute on how we acquire the patterns of *P*-cognition, how we select among the many such patterns in our repertoire and what exactly pattern recognition entails. And wisely so, for his brief attempt (chapter 4) to clarify this last plunges him into contradiction. How to reconcile Margolis's analogy between *P*-cognition and a computer curve-fitting program with his earlier insistence that cognition has nothing to do with rules, algorithms, and calculations? Or with his evolutionary "cognitive ladder," which ascends from "simple feedback" through reasoning, with calculation as the most recent and most tenuously established achievement (p. 44)? The fatal attraction of the computer curve-fitting analogy for Margolis seems to be its openness to inspection and analysis, and the clarity these promise (Margolis himself is an admirably clear writer).

Margolis hopes that the evolutionary outlook of *P*-cognition will prove its worth by yielding new interpretations of old problems in the psychology of cognitive illusions and in the history of scientific revolutions. What can *P*-cognition tell us about hotly debated cognitive illusions produced, for example, by the Wason selection task and the Kahneman and Tversky cab problem? Margolis suggests it is equally wrong to conclude from these experiments that the brain is, on the one hand, incapable of heeding modus tollens or base rates, or, on the other, that the laws of thought are the laws of logic. Rather, subjects in these experiments react to ambiguities in language and "scenario" by applying otherwise valid patterns to the wrong situation: they give the right answers to the wrong questions. Thus far, Margolis's interpretation persuasively challenges theorists from Piaget to Fodor to L. J. Cohen who liken thinking to logic and calculation, replacing these implicit logical rules with "habits of mind" prompted by context.

However, Margolis nonetheless insists that these context-cued judgments deserve to be called "illusions," because misreading admittedly ambiguous cues still counts as irrationality to him. This view is in turn anchored in the conviction that, for example, the cab problem has only one "right answer" as far as statisticians are concerned, however much philosophers and psychologists who "should know better" may bicker about it (p. 306). But here it is Margolis who is deluded by his own preoccupation with cut-and-dried standards of rationality: there are in fact perfectly respectable alternative solutions to the cab problem, for example those using Neyman-Pearsonian statistical methods. Some, indeed most, situations are genuinely ambiguous. Unfortunately, this is no passing slip, for it seriously handicaps Margolis's attempts to analyze cognitive illusions in *P*-cognitive terms, leading him to emphasize his unconvincing accounts of how scenario ambiguities produce illusions over his convincing accounts of how language ambiguities do—presumably because subjects can hardly be judged irrational for misconstruing equivocal wording. In his interpretation of the cab problem, for example, this preference for scenario ambiguities obliges Margolis to make the dubious claim that reasoning from causes to effects is more habitual than reasoning from effects to causes.

What can *P*-cognition tell us that we didn't already know about such well-researched episodes in the history of science as the Copernican Revolution? Margolis contends that Aristotelian physics, religious qualms, common sense, and (most surprisingly) the equant played at best a secondary role in inhibiting the initial heliocentric insight and its subsequent spread. Rather, the tenacious pattern of contiguous, "nested" spheres that allowed Ptolemaic astronomers to order the planets and estimate the relative distances between them (albeit somewhat arbitrarily, especially in the case of the inferior planets) blocked both Copernicus's Arab predecessors and his immediate successors from grasping the (for Margolis) patent advantages of coherence offered by heliocentrism. On this account, both Tycho's shattering of the heavenly spheres and his compromise system are a grand anticlimax—far more decisive was "the mere passing of time" between 1543 and the 1580s, allowing a new generation of astronomers to "come to maturity always aware of the Copernican possibility" and to find that "the Copernican argument explains so much so neatly that it can hardly be wholly wrong" (p. 257).

Alas, there is scant evidence to support this pattern-centered account, and a considerable amount that contradicts it. On the iconographic evidence of the sort Margolis mostly invokes, the famous diagram in 1.10 of *De revolutionibus* strongly suggests that Copernicus himself still clung to the contiguous sphere scheme, although it was no longer necessary to compute relative planetary distances. Neither Copernicans nor their adversaries made much of the nested spheres issue, and Kepler displayed a near lunatic affection for cozy nested patterns in his ardently Copernican *Mysterium cosmographicum*. At a deeper level, Margolis's reading of the Copernican revolution betrays the same crippling preoccupation with wrong and right answers that distorts his

interpretation of cognitive illusions. Although he struggles to see the past in its own terms, he cannot resist reproaching early opponents of Darwin and of Copernicus for their cognitively explicable but rationally indefensible failure to embrace the new theories—Lyell's resistance to natural selection is "cognitively not much different from (not much more logical than)" resistance to wearing hockey helmets (p. 192), just as subjects in psychological experiments are "stubborn" and "downright stupid" in not applying modus tollens or Bayes's theorem.

In both cognitive psychology and the history of science, this normative *idée fixe* prevents Margolis from posing more interesting descriptive questions about how we cope with ambiguity and how the standards for explanation, not just this or that explanation, change in science. Although an abiding concern with rationality motivated Margolis's study, there seems to be nothing in his *P*-cognition view *per se* that would commit him to such a narrow normative stance. Margolis believes his account will prove itself by its empirical applications in fields like cognitive psychology and history of science. We believe, on the contrary, that the results of these initial empirical applications are largely disappointing, but that the general Darwinian outlook of *P*-cognition so ably developed by Margolis will prove of enduring value.

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Microbial Ecology

Microbial Mats. Physiological Ecology of Benthic Microbial Communities. YEHUDA COHEN and EUGENE ROSENBERG, Eds. American Society for Microbiology, Washington, DC, 1989. xviii, 494 pp., illus. $79; to ASM members, $59. From a seminar, Eilat, Israel, Sept. 1987.

Layered microbial communities, and the complex and intense biogeochemical interactions that occur within them, constitute a type of community structure that is fast becoming an important paradigm for the understanding of microbial ecology. Such communities, within which are included microbial mats, often remain poorly appreciated or understood even by those in the field, however. For this reason alone, *Microbial Mats: Physiological Ecology of Benthic Microbial Communities* is highly recommended. This interesting and informative book presents the results of a 1987 symposium: its rather tardy publication is a pity, but much of the material contained in it is excellent and not at all outdated.

As expected, there is variation in style and quality among the papers, but the volume includes well-written contributions from many of the major laboratories involved in microbial mat research. In coverage it ranges from the basic physiology of mat organisms, to isotopic and molecular genetic methods for the study of mat populations, to chemical and paleomicrobiological methods of looking at present and past mat communities.

The book includes excellent descriptions of a variety of different mat environments (hot springs, hydrothermal vents, and hypersaline ponds and lakes). There are discussions of the structure, function, and chemistry of these environments, including redox chemistry, oxygen gradients, carbon cycling, and light penetration and quality, along with presentations of techniques used to study these features. These include discussions of microelectrodes and new chemical approaches and an intriguing chapter on the use of fiber optic light guides for the measurement of spectral quality in mat communities, by B. B. Jorgensen. There is an entire section devoted to the physiology and biochemistry of some of the major mat-building organisms and techniques used to study them and another to their evolution and phylogeny, including an informative discussion of methods of molecular phylogeny by Turner *et al.* The final section deals with chemical and paleobiological studies of modern and ancient mats, concluding with an excellent chapter by Andrew Knoll discussing the paleomicrobiology of ancient mat communities. Knoll's concluding statement, "Limits to the interpretation of Proterozoic sedimentary successions . . . will not be reached until we know more about the present," provides a strong rationale for the study of the modern mat communities discussed elsewhere in the book. In fact, reading this chapter first might well provide the reader with a valuable perspective for many of the other studies reported here.

In this regard the lack in the book of an overview of the subject is troublesome. Apart from a preface by Cohen little or no effort is made to introduce either non-experts or students, who might potentially use this book, to the broader picture of the types of mats, the factors that define them, variations found in extant mats, and the short-term and long-term significance of mat communities. For example, comparison of mat communities with other layered microbial communities, such as those found in fjords, marine and freshwater sediments, and stratified lakes would have been welcome. The book will, even so, be a valuable addition to the libraries of microbial ecologists and others interested in organismal interactions, the evolution of microbial communities, and biogeochemistry. It should be a valuable teaching aid at the graduate level and will provide thought-provoking and informative material for years to come.

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Topics in Astrophysics

Astrophysics of Gaseous Nebulae and Active Galactic Nuclei. DONALD E. OSTERBROCK. University Science Books, Mill Valley, CA, 1988. xviii, 408 pp., illus. $36.

In 1864 William Huggins aimed his spectroscope at nebulae and discovered that some showed emission lines (hence "gaseous nebulae"), whereas others showed starlike spectra. In 1974, when appeared Osterbrock's now classic textbook on the optical spectroscopy of photoionized gas, *Astrophysics of Gaseous Nebulae*, its subject still dominated the fields implied by the title. Like many of my contemporaries, I learned the physics of photoionized gas from the 1974 book. My opinions on this revised version thus reflect gratitude to a reference tattered by a decade of use, compromised by an undergraduate's desire for revenge on an opaque textbook.

As an introduction to the physics of photoionization, line transfer, and optical diagnosis of diffuse atomic gas, it remains without peers. The first nine chapters are largely unchanged. The discussion of charge-exchange reactions has been updated, and it is now publicly confessed that HII regions may not be homogeneous, spherical, or similar to the sun in abundances of elements. References to the recent literature are given, and the tables incorporate modern data. An infuriating number of misprints infested the first edition; many but by no means all of these have been corrected. Three new chapters have been added. One describes the optical line emission from nova and supernova shells, and two briefly review diagnostics and classification of the emission-line regions of active galactic nuclei. The reader is introduced to Seyferts 1.8 and 1.9 but is spared further significant figures.

The subject matter is fundamental to all of astrophysics, and being without serious competition this book will appear on the desks of astronomers at all stages of their