graders and a graduate student at a nearby university. The authors discuss the factors that distinguish classrooms where email was adopted as regular classroom practice from those where it floundered. In addition, the email excerpts provide compelling support for the authors' claim that determining the region of sensitivity for instruction 'on-line and unaided' is, at minimum, an art and perhaps magic.

As Raymond Nickerson notes in his concluding chapter, the strength of this volume lies less in the questions answered as in the questions raised. After reading this collection of papers, readers will still be seeking answers to questions Salomon raises in his preface: How do cognitions become distributed? What is distributed about them? If cognitive performance is a distributed quality, what should education's goal be? With few exceptions, most notably chapters by Cole and Engestrom and Brown and her colleagues, the book provides little concrete guidance as to how distributed cognition can be examined empirically or how the concept can be used to facilitate educational practice.

<div align="right">

SHARI ELLIS
University of Florida

</div>

Cognition in the wilderness

COGNITION IN THE WILD: Edwin Hutchins. MIT Press, Cambridge, MA. No. of pages 381. ISBN 0-262-08231-4. Price US$45.00 (Hardback).

This book presents an extraordinarily detailed ethnographic analysis of the cognitive activities of a coastal navigation team on a large ship. The analysis is at once highly informative and disappointing: informative, because Hutchins shows convincingly that much of human cognition is best studied by examining how groups of people interact with each other and with artifacts in the environment; and disappointing, because the author does not fully meet his stated aim to deliver 'a different conception of what people do with their minds' (p. 367).

Concerning the book's considerable strengths, Hutchins succeeds in presenting his case that human cognition is, in a fundamental sense, a social and cultural process that is inextricably tied to the extended history of a task. In support, Hutchins's analysis of the artifacts (e.g., nautical slide rules) used for navigational computation shows that they provide pre-computations, or 'affordances' that are the result of a continuing socio-cultural process of refinement operating throughout history. Thus, the present-day computation performed by any given navigator interacting with those artifacts is simply part of an ongoing computational process extended over the history of the task, the artifacts and society at large.

If one accepts that line of argument, and Hutchins provides much insight to suggest that one should, several questions follow from the author's thesis that deserve discussion. For example, *why* do we embody these *particular* representations in our artifacts? That is, what properties, characteristics and attributes of the human cognitive system lead us to find and construct those particular tools and structures that present us with affordances? And what new things does all this tell us about human cognition? Unfortunately, Hutchins cuts short his theoretical voyage at this point and leaves those questions unanswered. For example, concerning the nature of cognitive artifacts, it is clear that our tools are shaped by, and reflect the limits of, our minds, but Hutchins does not recognize that an examination of those limits in (seemingly) unrepresentative laboratory tasks may tell us a great deal about why we make the *particular* tools we do in the wild. Similarly, although Hutchins illustrates well how computational tasks are distributed across the navigation team, how artifacts are used, and how the team as a whole reacts flexibly and adaptively to changing circumstances, the book fails to extract from this rich environment what was, at least implicitly, promised—a cognitive task taxonomy that informs us about the tasks we do on a daily basis. While we get a great understanding of the minutiae of navigation tasks (to the extreme of noting that a watch is placed at the top of the bearing log; p. 134), we do not, in the end, get an abstraction of the task classes that make up the performance.

It is our contention that these questions must necessarily remain unanswered because of the author's inherently limited approach to data gathering and analysis. Although Hutchins compiled extensive audio and video records, which he even largely transcribed himself (p. 24), the analysis of those data remains largely anecdotal, and hence unsatisfactory. For example, a

graphical representation of the distribution of activities across team members during a single navigational fix cycle (p. 187) cannot yield the unanticipated and novel insights that are obtainable with sophisticated scaling techniques (see Vortac, Edwards and Manning, 1994, for an example involving teams of experts). Similarly, verbal protocols can be analysed with more rigor than employed here (e.g., Klahr and Dunbar, 1988).

Equally limiting is the absence of experimentation, or indeed any suggestion that an empirical approach might yield answers to the many questions arising from ethnographic observation. This omission might be related to the author's peculiar claim that many behavioral scientists engage in introspection to answer questions about what people really do (p. 287). We claim instead that most behavioral scientists engage in *experimentation* to answer those questions. We furthermore believe that any approach that eschews experimentation confines itself to raising, but not resolving, questions about cognition in the wild.

Notwithstanding these limitations, Hutchins offers a number of timely reminders to cognitive scientists about the assumptions underlying their work. In particular, he adds another dose of antidote to the belief that problem solving by heuristic search is a representative cognitive activity (e.g., Simon, 1981). As other workers in naturalistic decision-making have argued, there is little evidence in the wild that expert human decision makers engage such analytic and formal procedures—instead, experts rely very much on a process of pattern recognition (e.g., Klein and Calderwood, 1991). Yet, while symbol-processing may not be the ultimate architecture of cognition, we are undeniably processors of symbols—how we individually achieve this processing at all is the central mystery left unexplained by this study of cognition in the wild.

REFERENCES

Klahr, D. and Dunbar, K. (1988). Dual space search during scientific reasoning. *Cognitive Science*, **12**, 1–48.
Klein, G. A. and Calderwood, R. (1991). Decision models: some lessons from the field. *IEEE Transactions on Systems, Man & Cybernetics*, **21**, 1018–1025.
Simon, H. A. (1981). *The sciences of the artificial*. Cambridge, MA: MIT Press.
Vortac, O. U., Edwards, M. B. and Manning, C. A. (1994). Sequences of actions for individual and teams of air traffic controllers. *Human Computer Interaction*, **9**, 319–343.

MARK RANDELL
STEPHAN LEWANDOWSKY
University of Western Australia

Biases within biases

BEHAVIORAL DECISION THEORY: A NEW APPROACH. E. C. Poulton. Cambridge University Press: Cambridge, 1994. ISBN 0521443687.

This work represents a major contribution to methodology in the study of human decision making. It focuses principally on previously neglected, but widespread and sizeable, biases inadvertently introduced by investigators studying heuristics and biases in everyday human judgment. A more appropriate title, perhaps, might be 'Behavioral Decision Theory: Biases Within Biases'.

The book is an outstanding piece of scholarship. It is thorough and authoritative. It provides an original, penetrating, cogently-argued, challenging re-analysis and re-assessment of many of the most influential studies in the field of human judgment. In so doing, it throws light on apparent conflicts and paradoxes in the literature and it provides students and researchers with many helpful insights that will enable them to optimise the design of experiments on human judgment.

The work outlines five simple, ubiquitous biases that experimenters can, and frequently do, unwittingly generate when investigating the nature of people's quantitative judgements. In the response contraction bias, uncertainty causes people to select a response that is closer to some