text, two-way linkages with applications in technology, agriculture, and medicine, and political aims of the systems that support science, notably governments. Taking all these aspects into account is a tall order, and few of the essays in this book do so. Michael Worboys's study of British tropical medicine is exemplary, as are the studies of British radio astronomy by Nigel Gilbert and by Michael Mulkay and David Edge. (Edge and Mulkay have since published a much longer account in *Astronomy Transformed*; for a review see *Science* 13 May 1977, p. 774.) Worboys shows how the Colonial Office fostered a kind of holistic medical science that was not in favor in medical schools, with their more biological ideals. Mulkay and Edge show how and why distinctive research programs, along with distinctive administrative structures and styles, evolved at Jodrell Bank, which depended on research grants, and at Cambridge University. They show, in short, how intellectual and institutional innovation occurred in particular places at particular times. They begin to sort out the roles of individual scientists, technical imperatives, and institutional policy in shaping innovation and growth in science.

In the life cycle of research specialties periods of expansiveness are often followed by concentration on a few important and fruitful questions. In 1974 an eclectic approach was a useful corrective to sociological reductionism. The next stage, one hopes, will be a winnowing of grain from chaff. There are some indications here of what the future might bring to the study of specialties. First, it is clear that the study of science in national contexts will be increasingly fruitful as linkages to national institutions are more deeply explored. Second, the problem of the symbiosis of ideas and social structure will become more precisely defined. As the editors point out, none of these essays show that social organization directly shaped the content of science; rather, its influence was on the direction of science, the selection of certain problems over others. This distinction clarifies what the study of specialties can and cannot be expected to do. The influence of social structure on content is probably best studied in larger social aggregates, even Western culture as a whole. It is a problem for the sociology or anthropology of science. (Several studies of the place of science in the culture of professionalism have appeared recently.)

The study of specialties will probably be more and more explicitly concerned with ways in which certain scientific subjects are selectively developed by particular institutions and social and political trends. I suspect that increasing attention will be paid to the ways in which institutions mediate between professional aims and social demands. The size and complexity of modern public science and the practical problems of directing and managing the system will ensure that the study of specialties and disciplines will have meaning—perhaps even utility—to scientists and administrators of science as well as to sociologists and historians.

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Archeoastronomy

Native American Astronomy. Papers from a symposium, Hamilton, N.Y., Sept. 1975. ANTHONY F. AVENI, Ed. University of Texas Press, Austin, 1977. xviii, 286 pp., illus. $15.95.

As the urban night sky becomes increasingly invisible and both literacy and physical intuition decline from lack of exercise, most Americans cannot believe that pre-Christian societies were capable of astronomical sophistication. We are often blinded by the heritage of Rome, which propagated a vigorous anti-intellectualism for over a millennium. Astronomy was not discovered by the European renaissance but was reintroduced by the Muslim invaders who had guarded the discoveries of classical Greece while Europe slept. Neugebauer has demonstrated the marvelous planetary calculations of the Mesopotamian astronomer-priests, Stephenson has translated detailed Chinese records of the same era, and Hawkins has made us believe that even the primitive Celts could build analog astronomical computers of stone. Both primitive and sophisticated astronomy existed in pre-Columbian America as well, and this book is one of the evidences that a serious effort to advance American archeoastronomy is under way.

Unfortunately, there are severe problems. The Spanish invaders so efficiently destroyed the pagan culture that now no one can read the hieroglyphs of the advanced cultures, and no sufficient oral tradition survives from the priest class, of either the advanced or the primitive groups. There is no Rosetta stone for the Americas. At the moment, one can only compare poorly understood texts, search for known astronomical correspondences, and interview relatively non-Europeanized remanent populations. At this stage, native American astronomy is largely conjecture. The papers in this book run the gamut from well-argued, reasonable inference to incomprehensibility and physical error.

As a fundamental astronomer, I have a prejudice in favor of clearly stated mathematical inferences, with their associated uncertainties also stated, numerically when possible. I find the discussions of the calendric systems of the Maya (by Gibbs) and of the Inca (Zuidema) particularly satisfying in this respect. It is evident that these two cultures had developed empirical systems to the point not only of sophistication but of byzantine complexity; no wonder only priests were keepers of the calendar. This realization makes Remington's fieldwork among the present-day Maya all the more poignant. Similarly, the investigations of apparent observational sites used by more primitive North American tribes, reported by Eddy (Great Plains medicine wheels) and Williamson *et al.* (Anasazi observatories), seem to be astronomically sound and well documented.

At the other extreme is the commentary by Kelly on Mayan texts and inscriptions, which appears to be a mixture of numerology and error. There are masses of numbers, largely Mayan dates that a nonspecialist can neither understand nor verify, used in arithmetic attempts to find correspondences with astronomical phenomena. There is an erroneous Julian-calendar-Julian-day number correspondence (p. 59), a geometric error in supposing a lunar eclipse at new moon (p. 63), and either a calculational or a typograhical error (4352 instead of 4532, p. 66). Three of Kelley's tables, though attractive as art, fail to convey information to this astronomer. Finally, Kelley gives great weight to supposed eclipses, which are alleged to be possible within 18 days of a lunar nodal passage. In fact, the moon passes through a node every 13.7 days, so it is *always* within Kelley's limit; according to this, there should be one or two eclipses every month! In reality, no eclipse is ever possible more than about 33 hours from a node crossing; thus many of Kelley's comments on probable or certain eclipses are simply false, which considerably damages his entire argument.

In part, this is an exaggerated case of a larger problem. The use of astronomy and statistics is sometimes superficial. Wedel objects that Eddy demands observational uncertainties, but one finds confusions between "exactly" and "within reasonable certainty," between "exactly" and "observably," and also be-

tween "observable once in 1974" and "observable generally." The sky changes, and people are fallible observers. Also, one sees possible contamination from personal preconceptions, either of the calendar or of cultural astronomy or stemming from inexperience with the real sky. Remington uses the phrase "western cognitive category of astronomy," in which (gobbledygook aside) "western" is probably equated with European. She also infers a naked-eye observation of comet Kohoutek when it was far past maximum brightness, and maybe invisible. Wedel patronizes the Pawnee for calling Cassiopeia "turkey foot" because of a "fancied resemblance"; any fool can see that it looks like a queen on a throne! He also commits two geometric errors that are less important, but not negligible.

Still, I do not wish to leave a negative impression of *Native American Astronomy*; I have dwelt on the negative aspects because of space limitations only. This book is an important step in the process of raising archeoastronomy of the Americas to the "critical mass" needed for significant progress. It is a very interesting and engaging statement of the current status of the endeavor. I hope it will attract the attention of more astronomers, because there is much to be done here.

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Mnemonic Processing

Perspectives on the Development of Memory and Cognition. ROBERT V. KAIL, JR., and JOHN W. HAGEN, Eds. Erlbaum, Hillsdale, N.J., 1977 (distributor, Halsted [Wiley], New York). xiv, 498 pp. $19.95.

In this comprehensive review of research on the development of memory, various authors interpret memory more or less broadly, but all subscribe to the view that it is not a unitary or simple process and that it cannot be separated from the rest of cognition. Indeed, Kail and Siegel equate mnemonic processing with cognitive processing in general, and Trabasso, in a chapter on transitive inferences, lists encoding, representing, recoding, transforming, ordering, listing, scanning, matching, and retrieving, "to name a few," as processes that fall under the rubric of memory. This broad conception is probably healthy, for "memory" is a common language term, not a theoretical one, and it also gives the book a wider scope than it would otherwise have had.

In spite of the broad view of what memory is, the experimental paradigms in the first half of the book are for the most part limited to free recall of lists of words, verbatim recall of serial order, and paired-associate learning. Paris and Lindauer, however, describe some of the early work on comprehension and memory for prose and other contextually rich materials, an area of research that is becoming increasingly important. The second half of the book branches out into more general aspects of cognition. Especially recommended are Cole and Scribner's chapter on cross-cultural studies, which by indirection suggests the narrowness of much American research, and Meacham's chapter on Soviet investigations of memory, work that is theoretically important and relatively unknown to the American audience.

There is surprisingly little Piaget in these pages considering his dominant role in developmental psychology, perhaps because the translation of his work on memory is relatively recent. Also, as Liben notes in her chapter on the few American attempts to investigate the Piagetian claims for qualitative changes in the memory code, the Genevan emphasis on developmental changes in the structure of memory is not in the mainstream of American studies, which have stressed the development of skills (read strategies). The emphasis on process, as opposed to structure, is evident throughout the book. Belmont and Butterfield are vehemently antistructuralist, whereas Campione and Brown suggest that without better theory structural changes are difficult to define, let alone measure. Interestingly enough, the emphasis on process tends not to be reflected in the theoretical views of memory within which most of the authors interpret developmental phenomena. There is more talk of transfer between short- and long-term stores than of depth or elaborateness of processing or the growth of semantic networks. Refreshing exceptions are the Meacham chapter and Moely's discussion of organizational factors in memory.

The emphasis on process is reflected in the major theme of the book: memory development is primarily due to the growth of deliberate mnemonic strategies. The assumption that strategies are consciously used is explicit in Flavell and Wellman's chapter on metamemory and implicit elsewhere. Not only does this emphasis underrate the importance of growth in the size and elaborateness of semantic memory, it tends to ignore the fact that strategies, as evidenced by systematic performance within and between tasks, are often carried out without awareness. Too much of our encoding and retrieval is automatic (or at least takes place without conscious monitoring) for a strategy-based view to tell the whole story of developmental improvements. Nevertheless, the book accurately reflects the theory and research of the past ten years. It is a sophisticated and interesting collection, well worth reading.

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Books Received

The Alchemists. F. Sherwood Taylor. Granada Publishing, New York, 1976. 192 pp., illus. + plates. Paper, $3.95. Reprint of the 1952 edition.

Alternative Energy Strategies. Constraints and Opportunities. John Hagel, III. Praeger, New York, 1976. xiv, 190 pp. $17.50. Praeger Special Studies in International Economics and Development.

Anaerobic Bacteriology. Clinical and Laboratory Practice. A. Trevor Willis. Butterworths, Boston, ed. 3, 1977. x, 360 pp. $19.95.

Animals and Men. Their Relationship As Reflected in Western Art from Prehistory to the Present Day. Kenneth Clark. Morrow, New York, 1977. 240 pp., illus. $19.95.

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