Thinking Like a Vervet

How Monkeys See the World. Inside the Mind of Another Species. DOROTHY L. CHENEY and ROBERT M. SEYFARTH. University of Chicago Press, Chicago, 1990. x, 377 pp., illus. $24.95.

In this splendid book Cheney and Seyfarth tackle a question that has perplexed philosophers, little children, and even the rest of us through historic times: How much do animals understand about themselves and their world? *How Monkeys See the World* does not pull any punches: it offers robust answers. Far from concluding, in the manner of W.V.O. Quine or Thomas Nagel, that we can never grasp the meaning of *gavagai* or what it is really like to be a bat, Cheney and Seyfarth feel that with cautious reasoning and careful experiment we can find out a great deal about what it is like to be a vervet monkey.

Above all, they offer both a floor and a ceiling for the complexity of vervets' minds. Most books in this field give only half the argument: the counter-case to an imaginary opponent who is pictured as an uptight, oversimplifying behaviorist or else as a gushing anthropomorphizer. Cheney and Seyfarth show that monkeys are much more complex than we used to think, in their use of vocalizations and in their treatment of social companions. However, the monkeys have surprising gaps in their understanding of their environment, even of the behavior of their own predators. Monkeys' intelligence, Cheney and Seyfarth argue, is domain-specific, much better developed in the social sphere than in general associative ability. Even in the monkeys' forte of social behavior, Cheney and Seyfarth conclude that monkeys do not attribute mental states to other monkeys. Unlike humans, perhaps even unlike chimpanzees, vervets do not have, in the usage of Premack and Woodruff (*Behav. Brain Sci.* **1**, 515 [1978]), a "theory of mind."

The authors' primary experimental tool has been playbacks of recorded vervet vocalizations to wild monkeys in Amboseli National Park, Kenya, over ten years of field study. There is a hilarious description of the frustrations of this technique. Once the authors even tested the wrong species: analyzing the ringing of Masai cattle bells as a cue for approaching human danger, they stampeded a couple of panicked rhinoceroses from a nearby bush. In up to 70% of some experimental sequences they went through all the preparations for a playback and then decided not to play the call, which meant that the monkeys had little chance of connecting the rare actual playbacks with the experimenters' activities.

Many vocalizations of vervets turn out to have clear external referents. Alarm calls indicate whether a predator is leopard, eagle, snake, or unfamiliar human. Different grunts address dominant or subordinate animals or members of other groups. These calls are not just indexes of degree of arousal or fear. They mean something in the outside world; they include which direction to look in or where to run. There is an audience effect: calls are given when there is someone appropriate to listen. As has been predicted by Peter Marler, monkey calls are far more than mere involuntary expressions of emotion.

Monkeys are also excellent primatologists. They deal with relations such as transitivity: if A dominates B and B dominates C, they can deduce that A will dominate C. (Not all monkey societies are so straightforward, but those of the vervets are.) They generalize kin relations: if monkey A attacks monkey B, one of B's kin may retaliate by attacking one of A's kin. Vervet females, played a juvenile's distress call, will look at the mother of that juvenile.

However, although "monkeys seem to be experts at reading each other's behavior, . . . we have little evidence that they [can] read each other's minds." Monkeys so far have rarely displayed an ability to attribute to others knowledge or ignorance that differs from their own. For instance, Cheney and Seyfarth showed mother macaques an adjacent cage where a tester either cut up an apple and left it in a box or hid behind a screen in the garb of that dreaded laboratory predator, the white-coated veterinarian. Mothers did not increase either their food calls or their alarm behavior to help or to warn an offspring who was ignorant of the situation. In the wild, mothers carry disabled or dying infants, but they do not treat them much differently from healthy infants. Cheney and Seyfarth argue that there is no indication that monkeys feel true compassion or empathy. They almost never imitate truly novel actions, and they never actively teach.

Sometimes, indeed, monkeys deceive other monkeys (see Byrne and Whiten, *Machiavellian Intelligence*, Oxford University Press, 1989). Does deception necessarily mean that the monkeys can conceive others' differing viewpoints? Cheney and Seyfarth concede that it probably does. Even there, they feel that the monkeys only teeter on the edge of getting it right. A male vervet, Kitui, gave leopard alarms when challenged by a rival male, causing the other male to flee up a tree. However, to reinforce his point, Kitui descended from his own tree and walked across open ground toward his rival, still calling the equivalent of "Run for the trees." Cheney and Seyfarth compare this to a human three-year old who with crumbs all over his face denies having raided the cookie jar. Chimpanzees, in contrast, seem to be much closer to having a "theory of mind." Chimpanzees aid, share, inform, and deliberately misinform. There are cases of aid to disabled kin, and even rare deliberate teaching. Even there, Chency and Seyfarth question whether chimpanzees show true empathy, for instance, for a companion's grief.

The attribution of emotions, beliefs, and knowledge to others would allow more accurate and more complex prediction of others' behavior than merely reading the behavior itself. Dennett, as Cheney and Seyfarth note, pointed out that such a skill may be more important to chimpanzees and humans, with our fission-fusion societies, than to troop-living monkeys like vervets (*The Intentional Stance*, MIT Press, 1987). "Since most monkey species do everything as a group, they live such a relentlessly public existence that there is not much novel information to impart, no secrets to reveal or withhold." Cheney and Seyfarth warn, however, "It is . . . possible that we have misidentified our chicken and egg and that the ability to attribute states of mind to others is what *permits* social groups to become more fluid."

Cheney and Seyfarth conclude by linking their arguments for monkeys as specialists in social intelligence with the question of consciousness and the attribution of mental states. They believe that "monkeys do not know what they know." In spite of their evolved skills, "much of monkeys' knowledge is highly compartmentalized and inaccessible to them." This means that it cannot be generalized to relations with the environment, or to the minds of other monkeys. "We attribute motives, plans and strategies to the animals, but they, for the most part, do not."

Not everyone will agree with Cheney and Seyfarth's conclusions. However, anyone who now seriously intends to disagree will have to read this book.

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Cognition as Search

Unified Theories of Cognition. ALLEN NEWELL. Harvard University Press, Cambridge, MA 1990. xx, 549 pp., illus. $39.95. The William James Lectures, 1987.

For cognitive scientists, the William James lectures by Allen Newell were the sensation of 1987. The videotapes circulated widely and there were seminars and discussions everywhere. This book version, though intensely personal, provides an unparalleled view of the outlook, accomplishments, and aspirations of information-processing psychology and the articulating aspects of computer science.

Remarkably, after nearly 40 years Newell's sense of wonder and excitement is palpable. The book opens by celebrating the idea of the universal computer that can simulate arbitrary problems coded in symbolic form. But Newell's core concern has always been the prospect of explaining the human mind using the conceptual tools of computer science. The thesis of the book is quite explicit: the best approach to understanding human cognition is the construction of unified theories based on abstract information-processing concepts. The central notion is that all of cognition can be viewed as "search in an appropriate problem space." Particular domain theories are to be expressed as collections of rules written in a uniform notation and interpreted by an "architecture" whose properties constitute the tenets of the general explanatory theory. These ideas are made concrete through the example of Soar, an architecture that Newell and his students have been developing for about a decade.

Soar is an evolving collection of simple but powerful information-processing constructs. All of the knowledge in Soar is represented as situation-action rules of the form: if *this* is in working memory then do *that*. Any computation can be expressed this way, and the notation is used in many applied expert systems. What is unique in the Soar architecture is the way in which the rules are controlled, particularly in the case where two or more of them conflict. In Soar, all applicable rules (even contradictory ones) can operate simultaneously, but all they can do is add new tentative information to the working memory. If this does lead to conflicting data being placed in working memory, Soar treats this impasse as a subproblem to be solved next. The system has strategies for choosing subgoals and completing or abandoning them. One other fundamental feature is a simple learning mechanism called "chunking." Under appropriate conditions, a chain of rule applications is chunked into a single new rule, often in a generalized form. Since most of Soar's strategies are expressed as rules, these also benefit from chunking.

For Newell, Soar helps achieve unified theories in two ways: it provides coherence through the use of a uniform notation and of a fixed architecture. Ideally, all of the rules for different domains would cohere, forming a model of intelligence that would be greater than the sum of its parts. This is an attractive prospect and is essentially the vision that launched the information-processing movement in cognitive science. The program has, however, recently come under attack for its detachment from any underlying physical reality.

Obviously enough, the Soar architecture is too abstract to be mapped directly to brain structure even at a very coarse grain. Newell's move here is brilliant. Instead of trying to ground the theories in brain structure, he focuses on human performance, particularly timing. Taking the millisecond-range computing time of neurons as basic, Newell constructs a hierarchy of timed processing levels, assuming that each level takes about ten steps of the level below. The resulting time estimates are used in constraining particular theories to be consistent with the wealth of chronometric experimental data on some tasks. The hierarchy also provides the argument that human cognition is best modeled at the knowledge level independent of implementation details.

With the framework laid out, the remainder of the book supports the case for unified theories by modeling as many phenomena as possible in the paradigm. A complete task model requires input and output analysis, and this forces Newell to apologetically introduce black-box theories of perception and motor control. He can then exhibit models of well-studied immediate response tasks such as typing and the Sternberg item-recognition task. Moving to a somewhat higher level, he outlines the Soar approach to memory and learning. The most detailed analysis, of nonsense-syllable recall, illustrates how chunking can be specialized for a specific task and how Soar can be used to recreate classical models. There is also a nice discussion of why Soar chunking is consistent with the ubiquitous power law of practice. The next chapter focuses on three complex problem-solving tasks: cryptarithmetic, logical reasoning, and a very simple sentence-verification task. Each is used to illustrate a different general aspect of Newell's theory of cognition as search.

As the author states, these modeling efforts have varying degrees of depth, success, and coverage. But taken as a whole they constitute the most impressive treatment by far of such a wide range of findings. Some readers will find the results unsatisfying because there is still no notion of how the brain actually does all these wonders. But the challenge of unified theories at the knowledge level has been laid down. More biologically oriented theoreticians will have to do better or will need to map Soar to more brain-like architectures. Taking this challenge seriously will lead to significant advances in cognitive science.

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Left Brain, Right Brain

The Decline and Fall of Hemispheric Specialization. ROBERT EFRON. Erlbaum, Hillsdale, NJ, 1990. xvi, 117 pp., illus. $19.95.

The current popular obsession with the "left brain, right brain" duality is not a new phenomenon. There was a similar wave, now largely forgotten, in the latter part of the 19th century following discoveries that the psychological effects of brain injury depended very much on which side of the brain was injured (see A. Harrington, *Medicine, Mind, and the Double Brain*, Princeton University Press, 1987). Then, as now, speculation owed more to enduring myths about left and right than to the empirical evidence.

The new wave began in the 1960s when testing of the so-called "split-brained" patients, who had undergone commissurotomy for the relief of intractable epilepsy, again dramatically revealed the brain's functional asymmetry. As a consequence, notions of hemispheric duality have spread far beyond the scientific journals and into popular culture. If history is to be our guide, this new wave must also soon come to an end, and the volume under review reflects a growing skepticism about the importance and validity of hemispheric specialization.

In spite of its title, however, Efron's slim book will not slay the beast and may strike no more than a glancing blow. It consists of only three chapters, based on a series of invited lectures delivered in 1989 at the University of Alberta. Efron deals with only