Uniquely Human

The Lopsided Ape. Evolution of the Generative Mind. MICHAEL C. CORBALLIS. Oxford University Press, New York, 1991. x, 366 pp., illus. $24.95.

"What a piece of work is a man! How noble in reason! How infinite in faculty! In form, in moving, how express and admirable! In action how like an angel! In apprehension how like a god! The beauty of the world! The paragon of animals!" So said Shakespeare's Hamlet, with whose words the psychologist Michael Corballis begins his own reflections on the nature of man. Hamlet spoke poetically; Corballis speaks the prosaic language of science, but in theme there are strong resonances between the Prince of Denmark and the psychologist from New Zealand. Both see man as unique, as different in fundamental respects from other animals. Moreover, it is a view, Corballis observes, that is increasingly taking hold in psychological thinking and practice. In his own department at the University of Auckland, "animals are slowly but surely disappearing," and today "mainstream psychology is based primarily on research with humans" (p. v). The reason, he suggests, is that we are no longer "comfortable with the assumption that results based on animals can be extrapolated to our own species." The author credits this change to the confrontations of the late 1950s and early 1960s between the radical behaviorist B. F. Skinner and Noam Chomsky, the linguist who revived the dualist, Cartesian idea that there is an unbounded quality to the human mind that is not found in other animals, in contrast to the implications of the Darwinian position that sees man as part of the animal kingdom, both physically and psychologically, and as sharing a common ancestry, not so remote, with the apes.

If we humans are so different from other apes, what makes us so? As Corballis sees it, the key difference is that we are *lopsided* apes, meaning that we have functionally asymmetrical brains. (So do other animals, as Corballis recognizes, but in humans the asymmetry is much further advanced, so a better name for us may be "*very lopsided* apes.") An asymmetrical brain, in turn, underlies what Corballis (like other observers in times past and present) regards as our singularly human attributes—handedness as a species trait (about 90 percent of us are right-handed, only 10 percent left-handed) and language (the latter also being Descartes's and Chomsky's choice).

How, then, did laterality evolve and give rise to these attributes, and what have been the larger consequences? These questions have long been the subject of intense speculation. Of several possible scenarios, Corballis emphasizes the role of physical changes initiated by bipedalism, or upright posture, which supposedly freed our hominid ancestors' arms for such actions as toolmaking and communicative gesturing. Corballis suggests that these physical and behavioral developments, in turn, spurred the development of brain asymmetry, initially by concentrating control for praxis, or skilled movement, within one hemisphere (the left hemisphere in nearly all cases). Praxis, in turn, gave rise to our extraordinary ability to execute complex skills—"to make speeches, build complex machines, and program computers" (p. 214). As with other forms of functional asymmetry, Corballis acknowledges that "this concentration of praxic control within a single hemisphere may not be uniquely human," but he argues that it is developed in humans to a level "well beyond that reached by other animals" (p. 218). But praxis alone may not be enough: "out of praxis has emerged a property that may indeed provide the key to human uniqueness" (p. 214). That property is "a special form of representation," a biological mechanism "whose most important property is *generativity*." It is this form of representation, which Corballis calls a Generative Assembling Device, or GAD, that allows us to manipulate open-ended forms of representation and provides the basis for language and manufacture as well as mathematics, reasoning, music, art, and play. It is GAD that accounts for the unbounded quality to the human mind, and GAD, Corballis declares, is ours alone.

As this synopsis only begins to suggest, *The Lopsided Ape* encompasses a wide range of topics, both empirical and theoretical, from a wide range of disciplines, including philosophy, evolutionary biology, archeology, physical and cultural anthropology, linguistics, cognitive science, and neuropsychology. The author recognizes that his attempt to cover so much ground may be uneven and that much of the material, especially that on human evolution, is highly controversial. His aim was simply to "make the best sense of the material" that he could (p. vi). As he also recognizes, the controversial material extends to two of the empirical questions at the heart of this thesis, namely, whether language and handedness are indeed uniquely human attributes.

The intensity of the debate over language is reflected in the title given to a recent letter to *Science* ("Chimp-language wars," **252**, 1046 [1991]) from Beatrix T. Gardner and R. Allen Gardner, the psychologists who inaugurated the new era of language studies in chimpanzees. Gardner and Gardner argue that the research field not only has survived early critiques but has produced significant new evidence for chimpanzee language. Corballis does not doubt that recent studies have yielded impressive demonstrations of language acquisition. He is particularly struck with the work of Sue Savage-Rumbaugh with pygmy chimpanzees, *Pan paniscus*, which, he notes, are perhaps closer to humans in their general characteristics than any other primate, including the common chimpanzee *Pan troglodytes*. Pygmy chimpanzees seem to be able to learn the symbolic use of words spontaneously, without specific, arduous training and, in particular, seem to be able to master certain aspects of syntax. Corballis admits that work of this sort, by demonstrating that these animals understand the symbolic use of words and that their language shows displacement (the ability to use words to refer to objects not physically present), "chips away at the idea that language is uniquely human" (p. 151). But he suggests that even *Pan paniscus* responds only on the basis of key words, and, like other critics, he questions whether the results demonstrate grammar of the human sort. In sum, although the ability of apes to learn the communicative use of symbols is "surprisingly good, and is improving as experimenters themselves gain in sophistication," the gap between ape language and human language "is still immense" (p. 151).

If the language gap remains immense, some researchers believe that the handedness gap has narrowed significantly in just the last few years. The gauntlet was thrown down by Peter MacNeilage, Michael Studdert-Kennedy, and Bjorn Lindblom, who argued in a 1987 *Behavioral and Brain Sciences* target article (**10**, 247) that handedness does exist at the population level in nonhuman primates but in a different form from that shown by humans (leading MacNeilage *et al.* to propose a human evolutionary scenario different from Corballis's). Compared to human handedness, however, the lateral bias showed by the data reviewed by MacNeilage *et al.* were very weak, so that although Corballis accepts that the data may allow "a glimpse of the origins of our own handedness," he still sees a "marked discontinuity" between ourselves and our nearest relatives (p. 99). Meanwhile, however, the other side has pressed on, and, in a new review in *Psychological Bulletin* (**109**, 76 [1991]), the French neuroscientists Jöel Fagot and Jacques Vauclair present further and stronger evidence for manual asymmetries at the population level in nonhuman primates. (Fagot and Vauclair are contributors to a new collection of research papers on the subject [J. Ward, Ed., *Current Behavioral*

Evidence of Primate Asymmetries, Springer-Verlag, in press]). Impressive new evidence also has been reported by the zoologist Marc Hauser and his colleagues (*Behavioral and Brain Sciences*, **14**, 342 [1991]). It is ironic that, even while, as Corballis correctly observes, "animals are slowly but surely disappearing" from mainstream psychology, they may be enjoying something of a renaissance in the rapidly growing psychology of laterality.

Given the extent to which key issues are empirically driven, no one can have the last word on the subject of discontinuity and the evolution of cerebral asymmetry and the generative mind. Corballis, however, tackles this immensely difficult and multifaceted subject in a lively and engaging way and presents his views crisply, thoughtfully, and always with a modesty and a touch of good humor. *The Lopsided Ape* is full of intellectual riches, and it deserves and, I hope, will find a wide readership.

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The Landsat Case

Viewing the Earth. The Social Construction of the Landsat Satellite System. PAMELA E. MACK. MIT Press, Cambridge, MA, 1990. xii, 270 pp., illus. $27.50. Inside Technology.

Early in the 1960s scientists and engineers familiar with military reconnaissance programs, weather satellites, and astronauts' observations recognized that there could be significant benefits from using remote sensing of the earth for assessing our planet's resources. Over the next decade and a half, NASA played the lead role in the development of this capability with its Landsat program. Space historian Pamela Mack not only delineates the creation of the Landsat system but also explains the failure of its proponents to give this technology a secure operational status in the United States during the 1980s.

Mack's book is of special interest because she presents her story as an extended case study in the social construction of technology. In her view, a narrative that focused on the technical goals and activities of the scientists and engineers who designed, developed, and operated Landsat satellites and analyzed Landsat images would be missing the most intriguing and important dimensions of this technological innovation. Siding with the avant-garde in the history of technology, Mack insists that negotiations among interest groups play the central role in establishing the characteristics, applications, and meanings of new technological systems. She consequently gives primary attention to the competing endeavors by groups in NASA, the Departments of Defense, the Interior, and Agriculture, and the Bureau of the Budget to shape the Landsat satellite system in accord with their respective interests.

Just how far Mack can go with this approach is suggested by her handling of NASA–DOD conflicts over Landsat technology. It was in 1963–64, she reports, that geologists associated with NASA's lunar program initiated an earth resources program. By 1968 NASA's planning for an earth resources satellite had progressed to the point that the agency sought partial access to the military's relatively advanced technology for reconnaissance satellites. Refusing to cooperate, the Pentagon urged NASA to drop the earth resources program on the grounds that success was bound to bring unwanted attention to space-based reconnaissance. NASA decided to go ahead on its own. DOD countered by blocking significant funding for Landsat until the space agency quietly agreed not to develop earth resources sensors having a resolution better than 20 meters. Soon NASA officials, scientists, and engineers were telling potential users that Landsat images would, at best, have a 30-meter resolution. In supporting this limit, they made little or no reference to the political compromise with DOD but rather, according to Mack, emphasized the technical difficulties of developing sensors with higher resolution, the technical and financial difficulties of coping with all the data that a high-resolution system would yield, and the technical suitability of the 30-meter scale for assessing many earth resources. These were good arguments. Indeed, without much closer attention to their origins and influence than Mack provides, one is left wondering about the relative roles of political and technical considerations in limiting the resolution of Landsat's sensors.

Though Mack quite possibly underestimates the role of technical considerations in the shaping of Landsat, her approach does much to illuminate the federal government's inability to embed this innovative technology in a viable operational system. There were, her history suggests, four main reasons why the United States failed to capitalize on its head start in remote-sensing earth resources technology, a failure that gave France the opportunity to seize leadership in this arena during the 1980s with the SPOT satellite system. First, NASA was not very successful in building a broad-based coalition of Landsat data users. The space agency was so keen to continue research and development on the Landsat system and so reluctant to guarantee the ongoing availability of standard data that many medium-sized and small users shied away from the requisite investments in equipment and training. Second, the two largest users—the Departments of the Interior and Agriculture—were continually struggling with NASA and one another over the shape, operation, and future of the Landsat system. Each bureaucracy was so wed to its own vision of the system that politically effective cooperation was impossible. Third, the benefits of the Landsat system—for geology and other earth sciences, oil and mineral exploration, agricultural forecasting and disease control, and management of natural resources—did not result in sufficient savings or revenues to turn Landsat into a potentially profitable undertaking. And fourth, the Office of Management and Budget acted on behalf of a string of administrations that were opposed to any expansion of federal services by steadfastly thwarting all efforts in the 1970s and early 1980s to put Landsat on a solid operational footing. The denouement came in the mid-1980s with the privatization of the Landsat system.

Throughout her thought-provoking analysis of the development of Landsat satellites and early applications of Landsat images, Mack makes effective use of interviews and archival holdings as well as published materials. Her book does a fine job of helping inaugurate the Inside Technology series that MIT Press is devoting to studies of the social construction of technology.

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Physics in Canada

Physics and the Rise of Scientific Research in Canada. YVES GINGRAS. McGill-Queen's University Press, Buffalo, NY, 1991. xii, 203 pp., illus. $37.50. Translated from the French edition by Peter Keating.

How did the Canadian physics community grow from the small, fragmented group of teachers it was in the 1850s to the large, cohesive body of researchers recognized and supported by society that it had become by the 1960s? To answer this question of institutional development, Yves Gingras combines historical and sociological perspectives.

Though a research ethic surfaced in universities during the decades around 1900, Gingras explains, it was the involvement of physicists in World War I that established