II COGNITION AND INTELLIGENCE OF DOLPHINS

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How intelligent are dolphins? Compared with what other animals? What criteria should be used to judge intelligence? Are these intellectual standards set by humans or are they dictated by the life style and natural history of dolphins (i.e., by the nature of their feeding ecology, predator defense and social organization)? How do we study the intelligence and cognition of dolphins and what precisely do these terms mean? Should we emphasize the notion that intelligent behavior reflects various aspects of cognition (e.g., memory, expectancies, conceptualization, intentionality, etc.) or are we primarily concerned with long-term fitness maximizing behaviors? In what ways are the cognitive components, i.e., the short term aspects of intelligent behavior, related to those behaviors which, in the long haul, tend to maximize an individual's inclusive biological fitness? What cognitive characteristics do dolphins have in common with smaller brained creatures such as pigeons and rats, and what skills are unique to dolphins, i.e., what are their cognitive specializations?

The papers in this section deal with these and other knotty issues of animal intelligence in a most forthright and illuminating manner. Louis Herman, Karen Pryor, and Harry Jerison deal with proximal factors affecting the perceptual and cognitive worlds of dolphins. Herman approaches the subject empirically, using rigorous experimental tech-

niques in a laboratory setting, while Pryor uses anecdotal observations from an oceanarium setting, and the piece by Jerison is intended to be essentially heuristic. Jerison focuses on the exotic notion that the "enhancement" of echolocation information from objects in the environment may result in group or consensual decision making before joint action is taken. This would be analogous, I suppose, to an electoral process in which an individual's wishes are deferred to the needs of the society. John Eisenberg discusses the selective forces resulting in higher levels of encephalization, and correlates these higher levels with greater cognitive skills. Theodore Bullock, Earl Hunt and Emil Menzel are concerned with the question of how to study and describe intelligence. The issues here are clearly delineated. Bullock and Menzel take a different position from that of Hunt. Menzel, in particular, articulates a nonreductionist, comparative, holistic, organismic, Darwinian approach to the study of intelligent behavior, while Hunt gives what I would characterize as a mechanistic, process-oriented, modeling or analogyzing account. I whole-heartedly agree with Menzel's warning about analogyzing between shaping pigeons to solve problems and the reasoning ability of chimpanzees, and about confusing problems of artificial intelligence with problems of biological intelligence. However, I do think that some experiments with simpler organisms, like pigeons and rats, enable us to focus our attention better on certain cognitive processes, like memory, with the aim of establishing continuity of species with regard to a particular cognitive ability. Moreover, Hunt suggests an exciting line of research in comparing the intelligence of man, animal and machine.

Although dolphins like some nonhuman primates may use semantic signaling under free-ranging conditions, we currently have no reason to believe, as apparently John Lilly did about a quarter of a century ago, that dolphins possess a sonic language which they use to communicate with one another about past and future events. Nor is there any evidence to date suggesting that dolphin sonic emissions reflect a language analogous to human spoken language which enables them to think in "words" as well as in "images". However, Herman does suggest that the brains of dolphins may be specialized for processing sights and sounds into temporal patterns, with the implication that dolphins have specialized cognitive skills. Do these skills play a role in language acquisition?

Questions about the linguistic behavior of animals and the extent to which man and other animals share mental abilities have been revived. There is little question that teaching artificial languages to anthropoid apes, which began in earnest in the late 1960s, played a major role in the revival of the Darwinian thesis for mental continuity and the recent burgeoning of research in comparative animal cognition. Herman's recent work on the ability of dolphins to comprehend the meaning and structural features of artificial acoustical and gestural languages is seen as a direct offshoot of the ape language research and should aid in assessing the cognitive abilities of dolphins relative to other highly encephalized species. One of the key questions here is the extent to which artificial

language comprehension depends on the acquisition of conditional discriminations.

Other rigorous research efforts are needed to gain a wider appreciation of the intelligence of dolphins as well as other marine mammals. The expense of these efforts is enormous and comparative psychologists and behavioral biologists will need all the help they can get from public and private granting agencies. In particular, oceanariums and aquariums throughout the world can help by making some of their dolphins, pinnipeds, sea otters and other biological resources as well as facilities available for the noninvasive behavioral procedures currently in use or being devised for studying cognition and intelligence of marine mammals. Benefits from cognitive research accruing to the institutions displaying dolphins to the public will be of a dual nature. First, cognitive research will increase the educational aspects of the marine mammal exhibits. Second, show performances will be able to incorporate newly devised behavioral preparations to demonstrate first hand dolphin or sea lion reasoning abilities to the public. Indeed, the stage is set and the time is right for more intensive comparative study of cognition in dolphins and other marine mammals.