Humpback whales have brain cells also found in humans

Cetaceans, the group of marine mammals that includes whales and dolphins, have demonstrated remarkable auditory and communicative abilities, as well as complex social behaviors. A new study published online November 27, 2006 in *The Anatomical Record*, the official journal of the American Association of Anatomists, compared a humpback whale brain with brains from several other cetacean species and found the presence of a certain type of neuron cell that is also found in humans. This suggests that certain cetaceans and hominids may have evolved side by side.

Although the biology of the humpback whale is well understood, there have been virtually no studies published on its brain composition, leaving an open question as to how brain structure may relate to the extensive behavioral and social abilities of this mammal. Although brain to body mass ratio, a rough measure of intelligence, is lower for baleen whales such as the humpback compared to toothed whales such as dolphins, the structure and large brain size of baleen whales suggests that they too have a complex and elaborate evolutionary history.

Patrick R. Hof and Estel Van der Gucht of the Department of Neuroscience at Mount Sinai School of Medicine in New York, NY, examined the brain of an adult humpback whale and compared it with the brain of a fin whale (another baleen species) and brains from several toothed whales, including three bottlenose dolphins, an Amazon river dolphin, a sperm whale, two beluga whales, a killer whale and several other whale and dolphin species. They found that the humpback cerebral cortex, the part of the brain where thought processes take place, was similar in complexity to smaller sized cetaceans such as dolphins. The large area of cortex found in these mammals is thought to be related to acoustic capabilities and the current study shows that it is organized into a system of core and belt regions. However, substantial variability was found between the cell structure of the cortex in humpbacks compared to toothed whales. The authors suggest that these differences may indicate differences in brain function and behavior in aquatic species that are not yet understood.

One feature that stood out in the humpback whale brain was the modular organization of certain cells into "islands" in the cerebral cortex that is also seen in the fin whale and other types of mammals. The authors speculate that this structural feature may have evolved in order to promote fast and efficient communication between neurons. The other notable feature was the presence of spindle cells in the humpback cortex in areas comparable to hominids and in other areas of the whale brain as well. Although the function of spindle neurons is not well understood, they are thought to be involved in cognitive processes and are affected by Alzheimer's disease and other debilitating brain disorders such as autism and schizophrenia. Spindle neurons were also found in the same location in toothed whales with the largest brains, which suggests that they may be related to brain size.

The authors note that spindle neurons probably first appeared in the common ancestor of hominids about 15 million years ago, since they are observed in great apes and humans, but not in lesser apes and other primates; in cetaceans they evolved earlier, possibly as early as 30 million years ago. It is possible that they were present in the ancestors of all cetaceans, but were retained only in those with the largest brains during their evolution. It may also be that they evolved several times independently in the two cetacean suborders; part of this process may have taken place at the same time as they appeared in the ancestor of great apes, which would be a rare case of parallel evolution.

"In spite of the relative scarcity of information on many cetacean species, it is important to note in this

context that sperm whales, killer whales, and certainly humpback whales, exhibit complex social patterns that included intricate communication skills, coalition-formation, cooperation, cultural transmission and tool usage," the authors state. "It is thus likely that some of these abilities are related to comparable histologic complexity in brain organization in cetaceans and in hominids."

The authors conclude: "Cetacean and primate brains may be considered as evolutionary alternatives in neurobiological complexity and as such, it would be compelling to investigate how many convergent cognitive and behavioral features result from largely dissimilar neocortical organization between the two orders." They also suggest that the current study provides a framework for further investigations into the brain and behavior of cetaceans, which are naturally elusive, poorly documented and often endangered.

The study is available online via Wiley InterScience at http://www.interscience.wiley.com/journal/ar

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