The Social Cetaceans

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Whales, dolphins, and porpoises have become a fixture of contemporary popular culture. In addition to their star turns at aquarium shows around the world, cetaceans have been immortalized as stars of film and television, and celebrated in documentaries.[1] Cetacean-themed tourism has also flourished, with whale- and dolphin-watching tours estimated to be generating more than $2 billion a year in revenue.[2] Although perhaps long overdue, the present fascination with these creatures is still relatively new. The International Whaling Commission's worldwide moratorium on commercial whaling took effect only in 1986.[3] Since then, cetaceans have undergone a remarkable transfiguration in the popular imagination. Once hunted to near extinction, these creatures are now thought a natural wonder.

Research has revealed a range of social and prosocial behaviors among cetaceans, including caregiving, tool use, and the teaching and passing on of behaviors across generations.[4] Cetaceans rank near the top of any list measuring neuroanatomical sophistication, next to great apes, humans, and elephants.[5] The highly social nature of these mammals has led researchers to investigate a potential link between sociality and brain complexity.[6] First proposed in the late 1980s,[7] the social brain hypothesis posits that the demands of complex, information-rich social interactions will tend to create evolutionary pressure for the development of larger, more complex brains.[8] Originally advanced as a model for primate brain evolution, the social brain hypothesis has since been expanded to include many other orders, with cetaceans the most recent addition.[9] Though separated from humans by tens of millions of years of independent evolution, whales and dolphins represent, in some ways, our closest living parallel.

The ancient Greeks were astute observers of cetacean behavior. Aristotle reported that dolphins spontaneously imitated the sounds of human speech and would work cooperatively with fishermen.[10] Both of these behaviors have been confirmed by recent research.[11] Aristotle also noted that cetacean young fed on breast milk and should therefore be classified as mammals.[12]

The prescience of Aristotle's observations were in sharp contrast to the prevailing views of the early nineteenth century, when cetaceans were seen primarily as a valuable source of oil.[13] In New York in 1818, a major court battle took place in which opposing sides debated whether cetaceans were mammals or fish.[14] A whale-oil merchant, Samuel Judd, had contested the right of the authorities to collect fish-oil taxes on his product, since, he argued, whales were not fish. Despite the ample scientific evidence presented to the contrary, the jury ultimately decided whales *were* fish.[15] Admittedly, Judd was likely more interested in preserving his profits than pursuing scientific truth, but that does not change the fact that he was right.

Cetaceans spend nearly all of their time underwater, often in the open ocean, which makes intimate, long-term studies extraordinarily expensive, difficult, and time-consuming. It was not until the 1960s that serious scientific studies first began appearing, sparked by the early work of John Cunningham Lilly.[16] Trained as a medical doctor at the University of Pennsylvania, Lilly went on to conduct psychiatric research into psychedelics and sensory deprivation at the National Institute of Mental Health before becoming fascinated by cetaceans.[17] Lilly used a combination of personal and government funds, most of the latter granted by NASA, to set up a dolphin research facility in the Virgin Islands. Lilly believed, and apparently convinced NASA, that a project to communicate with dolphins would provide an ideal proving ground to prepare humans for imminent contact with extraterrestrial intelligence.[18] In the course of his work, Lilly had become convinced that dolphins possessed a discernible and comprehensible language.[19] He published a series of papers in *Science*, all of which were focused on the vocalization and communication abilities of the bottlenose dolphin. Lilly's was the first modern research to note a tendency among dolphins to communicate with each other using complex vocalizations and to identify their distress calls. Lilly also confirmed Aristotle's observation that dolphins could mimic the sounds of human speech.[20]

Despite the promise of Lilly's early publications, deep communication with the dolphins proved elusive, and his grandiose claims concerning "humans of the sea" began

to look foolish. Some of Lilly's dolphins died of infectious disease and other complications—a major setback to research, a financial loss, and a public embarrassment.[21] It did not help matters when it became known that Lilly was dosing the dolphins, and himself, with LSD in an effort to establish psychic communication where traditional means had failed.[22]

Researchers have since felt the need to distance themselves from these unorthodox methods.[23] Lilly may not have turned out to be the kind of pioneering figure that later scientists and activists would prefer to be associated with, but he was perhaps precisely the kind who was needed at that time. Irreverent, erudite, and independently wealthy, Lilly took a species that was thought of, if at all, as a source of oil and helped recast them in the public eye as icons of animal intelligence.

Although Lilly's work on the communicative, linguistic, and social abilities of cetaceans anticipated some aspects of the social brain hypothesis, its ideas are typically traced back to the Machiavellian intelligence hypothesis, proposed by Richard Byrne and Andrew Whiten in 1988.[24] Traditional ecological accounts of primate and human brain evolution emphasized foraging and hunting techniques, size and complexity of home range, and tool use.[25] The work of Byrne and Whiten emphasized that the most complex and challenging part of a primate's environment was, in fact, other primates. In densely social species, social standing could easily mean the difference between life and death, or, at least, between sex and celibacy, which in evolutionary terms amounts to the same thing. Presumably, the imperative to assist allies and outwit opponents produces a psychological and neurological arms race. An expansion of cognitive architecture would be required to undertake increasingly complex social behavior and keep track of increasingly elaborate social hierarchies and alliances. Robin Dunbar presented evidence for just such a relationship in 1992, claiming a correlation between the size of the neocortex and group size in 38 genera of primates.[26] Dunbar also found no relationship between neocortex size and ecological factors, such as the size of the home range that a genus needed to explore and map or the degree to which complex extraction strategies were employed to exploit food resources. Dunbar's paper provided the first credible quantitative evidence in favor of social over ecological theories of primate brain evolution.[27]

It did not take long for scientists to notice similar trends among whales and dolphins. In a 1996 study of odontocetes, Lori Marino published evidence of a correlation between maximum group, or pod, size and brain size relative to body size.[28] She observed this trend across 16 species—by no means a majority of the nearly 100 living cetacean species. The correlation was admittedly speculative. In 2001, Luke Rendell and Hal Whitehead provided the first truly comprehensive literature review showing that, in addition to their ecological and genetic conditioning, cetaceans also learn socially. Subgroups within a species display distinct repertoires of behavior that are passed between individuals and generations. Among orcas, different subgroups demonstrate highly distinctive patterns of behavior, diet, and vocalizations, which remain stable over long periods, even when habitats are shared with other subgroups.[29] Humpback whales have been studied long enough for scientists to observe novel hunting and feeding strategies emerge in just one or a few individuals and then spread like wildfire through the larger population, through mimicry or perhaps direct teaching.[30] Rendell and Whitehead surveyed a wide range of cetacean behavior that was unlikely to be genetic or ecological, and thus more likely sociocultural.[31] The article prompted dozens of replies, ranging from the supportive, to the critical, to the openly hostile and dismissive.

Not everyone has agreed with a social brain hypothesis for cetaceans. The most notable dissent has come from the neuroscientist Paul Manger. In 2006, he published a 24,000-word manifesto arguing against the notion that high intelligence and brain size were linked in cetaceans.[32] Manger suggested instead that water temperature was the primary driver of cetacean encephalization. He argued that about 35 million years ago cooling ocean temperatures induced anatomical changes in cetaceans, including larger brains rich in myelin. The exceptionally high amount of myelin evolved to counteract heat loss, keeping cetaceans warm as ocean temperatures dropped.[33] Manger's theory had obvious difficulties. Not least was that it overlooked the brain's role in perceiving, thinking, and planning and controlling actions, as well as myelin's role in facilitating those activities.[34] Two years after Manger's paper was published, 17 cetacean specialists came together and examined the thermogenesis hypothesis.[35] Manger had provided incorrect data about the temperature range of waters inhabited by several cetacean species and had ignored readily available data for several others.[36] Rerunning Manger's regression analyses using accurate data showed no significant relationship between inhabited temperature range and relative brain size, undermining the central pillar of the thermogenesis hypothesis.[37]

Even as Manger was debunked, little had been done to explore the social brain hypothesis in cetaceans in a rigorous, quantitative manner. A simple correlation between relative brain size and group size was not sufficient. After sifting through the whole of the documentation on social behavior engaged in by each cetacean species, Michael Muthukrishna, Susanne Shultz, and I found compelling correlations.[38] The dolphin family tends to have the largest relative brain size, the broadest social repertoires, and the tightest-knit social bonds. Filter-feeding baleen whales showed the opposite pattern, with little by way of social behavior and small brains relative to their large bodies.[39]

The most significant finding was that both social repertoire and brain size are largest in the species that associate in midsized groups, and smaller in solitary species and those that associate in large but relatively anonymous mega-pods. Contrary to the earlier and simpler version of the social brain hypothesis, which predicted the largest brains in the largest groups,[40] our dataset suggested that it is not simply large groups that are the key factor in brain size; rather, the depth and diversity of social interactions counts most.[41]

Even as the slaughter of cetaceans in whaling has subsided, new moral dilemmas have arisen, somewhat paradoxically, as the direct result of a newfound appreciation for the complex behavior of dolphins and whales. It is estimated that more than 2,000 cetaceans are in captivity, and that more than 5,000 have died in captivity since the confinement of cetaceans began in the 1950s.[42] Captive cetaceans demonstrate a wide range of sociopathic and psychopathic behavior rarely if ever witnessed in the wild.[43] These include abnormal repetitive behavior, self-mutilation, attempted suicide, and murder—killing trainers and aquarium visitors who have entered their tanks. Such outcomes are similar to the sociopathic behavior induced by overcrowded prisons and solitary confinement among our own species. To mitigate these pathological behaviors, captive cetaceans are administered a range of antidepressants, antianxiety drugs, antibiotics for stress-induced stomach ulcers, and hormone therapy to control sexual urges.[44] It should come as no surprise that the average lifespan of cetaceans in captivity is considerably lower than in the wild.[45]

Most research observations have been made in captivity and from the water's surface, but in the wild cetaceans spend upwards of 95% of their time underwater. What goes on below the surface has remained largely mysterious. It was only a few years ago that a wildlife photographer was able to capture the first footage of a sperm whale giving birth in the wild. In the video, several other sperm whales can be seen attending to the mother and then ushering the newborn calf to the surface for its first breath.[46] Death is also accompanied by distinctive sociocultural behaviors. Cetaceans display a wide range of grieving behavior following the death of offspring, relatives, and even unrelated members of the same species. Giovanni Bearzi et al. recently found that the odontocetes, and especially dolphins, were far more likely to grieve than baleen whales.[47] Bottlenose dolphins have been known to carry around dead newborns and attend to dead calves.[48] As to be expected, dolphins are also the cetaceans with the largest relative brain mass, the largest social repertoire, the tightest-knit social groups,[49] and the most sonically complex communication.[50]

More about cetaceans' behavior beneath the waves remains to be discovered. What is certain now is that the study of cetaceans in captivity has confirmed that these animals display cognitive skills surpassing any other animal.[51] In one study, two dolphins were able to correctly follow symbolic instructions in a screen display.[52] The dolphins were able to perform the instructions almost perfectly after one exposure, and even as the instructions became more and more abstract: ultimately, the trainers disappeared from the video and were replaced with two white circles representing the key movements of the gestural commands. Such a feat had never been accomplished by another animal, not even the chimpanzee.[53] Dolphins, despite having no hands or fingers of their own, also easily understand the symbolic significance of a human's pointing gesture without any explicit training, another feat unknown in primates and demonstrated elsewhere only in dogs, which have a long history of domestication.[54] Careful study of cetaceans in their natural habitats could reveal a host of other social and cognitive abilities so far unsuspected.

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