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QUESTIONING THE INTERPRETATIONS OF BEHAVIORAL OBSERVATIONS OF CETACEANS: IS THERE REALLY SUPPORT FOR A SPECIAL INTELLECTUAL STATUS FOR THIS MAMMALIAN ORDER?

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Abstract—This review evaluates and contextualizes the behavioral studies undertaken on cetaceans in terms of the relationship of these behaviors to special levels of intelligence associated with these marine mammals and the evolution of their relatively and absolutely large brain size. Many believe that the large size of the cetacean brain and reported behaviors indicate the need to create a special status for these animals in terms of their intellect, positing that they are second to humans in terms of general intelligence. Cetacean brains became relatively large approximately 32 million years ago, at the Archaeocete–Neocete faunal transition, and have since remained stable in relative size. The behaviors reported for modern cetaceans are thought to parallel those of great apes, to the exclusion of other mammals. By creating an autocatalytic model of cetacean brain evolution, the behaviors thought to be indicative of sophisticated cognitive processes can be assessed as to their potential involvement in the evolution of larger brains in cetaceans. By contextualizing these behaviors in a broader comparative framework, and not the limited cetacean – great ape comparisons mostly used, it is evident that the behaviors used to argue for high levels of intelligence in cetaceans are found commonly across mammals and other vertebrates, and are often observed in invertebrates. This contextualization indicates that cetacean intelligence is qualitatively no different to other vertebrates. In addition, the inability of cetaceans to surpass Piaget stage 4/5 on object permanence tests and to solve an ''if and only if, then'' abstract task indicates the possibility that their levels of general intelligence may be less than that seen in other vertebrates. Sophisticated cognitive abilities appear to play no role in the evolution of large brain size in cetaceans, indicating that alternative theories of large brain size evolution in cetaceans should be considered in more detail.

Key words: whales, dolphin, porpoise, brain evolution, intelligence, behavior.

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INTRODUCTION

Almost anywhere one looks regarding the ''public face'' of cognitive studies or behavioral observations relating to cetaceans (e.g. various internet sites, popular science books, ecotourism pamphlets, miracle cures for autism), they are virtually universally accepted as being indicative of high levels of intelligence. Cetaceans are commonly regarded as perhaps only second to *Homo sapiens* in general intellectual prowess, though some consider them far superior both intellectually and emotionally to humans (Fraser et al., 2006). This public leaning, while derived from mass media, ultimately originates from the scientific literature, in peer-reviewed journals, where assertions of undeniable intelligence

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Abbreviation: EQ, encephalization quotient.

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appear regularly (e.g. Marino et al., 2007, 2008; Grimm, 2010; Herman, 2012). Three examples of this typology are: Tyack (2000), who states: ''Dolphins are remarkably intelligent creatures...''; Reiss et al. (1997) who aver: ''Reports of the cognitive achievements of bottlenose dolphins leave little doubt that they are intelligent animals.''; and Marino (2004) who asserts: ''Like humans, dolphins are, without a doubt, brainiacs of the animal kingdom.'' The word ''brainiac'' is the name of a super-intelligent alien character from the Superman comics – a blending of the words ''brain'' and ''maniac''.

What these statements, published in well-respected peer-reviewed scientific journals, imply is that the species that comprise the order Cetacea hold a special place in the animal kingdom in terms of their intellectual capacity. But what is different? Is it the quantity or the quality of the intellect? Macphail (1996) has argued that it is yet to be proven that there are differences in the qualitative intellectual abilities of vertebrate species (except for human linguistic abilities), as when contextual ambiguities are removed from cognitive tests all species appear to perform equally well; but the statements made by those studying cetacean cognition clearly support the notion of a special status, both qualitatively and quantitatively, for the Cetacea (Reiss et al., 1997; Marino, 2002, 2004; Simmonds, 2006; Marino et al., 2007, 2008; Grimm, 2010; Herman, 2012). Perhaps the key central observation upon which the cognitive studies of cetaceans have been built is the absolute and relative size of the brain. Indeed, some cetaceans have a larger relative brain size than all other non-human animals, and some species, while having a low relative brain size, have the absolute largest brains on the planet (Pilleri and Gihr, 1970; Jerison, 1978; Marino, 1998; Manger, 2006). On the basis of Jerison's hypothesis, that relative brain size (the encephalization quotient) is a proxy measure of biological intelligence (Jerison, 1973), the absolute and relative brain sizes of cetaceans is the most often cited basis for undertaking studies directed at revealing the potential cognitive abilities of dolphins and whales (e.g. Marino, 2002; Simmonds, 2006; Marino et al., 2007, 2008). But is this justified, and are the subsequent behavioral studies really supportive of the claims made? Are there perhaps simpler or alternative answers?

Previously (Manger, 2006), I outlined the anatomy of the cetacean brain, how the structure may relate to function on the basis of comparison to other mammals, and proposed a scenario for the evolution of the size of the cetacean brain related to thermogenesis as the selection pressure driving changes in both absolute and relative size, or encephalization. This hypothesis is at odds with previous concepts as the shackles of the ''intelligence constraint'' of cetacean brain size evolution were broken, and in fact much of the data outlined casts serious doubts over the ''accepted wisdom'' that cetaceans are undeniably intelligent. Despite this alternative hypothesis, several researchers are of the opinion that the observed behavior of cetaceans supports the concept of high levels of cognitive functioning (e.g. Simmonds, 2006; Connor, 2007; Marino et al., 2007, 2008; Herman, 2012), irrespective of what the anatomical data (which is far more difficult to misinterpret) indicate – the structure of the brain and how it works in other mammals is of no consequence, what is important is what we can infer about intelligence from cetacean behavioral studies. The present paper critically analyses the behavioral evidence that has been forwarded in support of apparent higher level cognitive abilities in cetaceans.

WHAT DOES ENCEPHALIZATION MEAN?

Encephalization is simply a measure of the size of the brain relative to the body; thus to determine how ''encephalized'' a particular animal is, the mass of the brain and the mass of the body is compared to the mass of the brain and body of a number of other species. Thus, a standard baseline is predetermined and the particular species is compared against that baseline. When ''mammals'' are used as a baseline (in this sense, mammals consists of those mammalian species not belonging to either the primate or cetacean orders), and a variety of species compared against this baseline, humans have been shown to have the highest encephalization quotient of all mammalian species, in fact of all the Animalia (Jerison, 1973). Certain species of cetaceans are seen to have the next highest encephalization quotients, while some are seen to have the lowest encephalization quotients of the extant Mammalia (Manger, 2006). There is no dispute regarding these facts – some cetaceans have relatively large brains, whereas others have relatively small brains.

The hypothesis forwarded by Jerison (1973) indicated the encephalization quotient is a measure of biological intelligence, such that those species with higher encephalization quotients will be more intelligent than those species with lower encephalization quotients. Thus, humans are the most intelligent animal species, and the smaller bodied cetaceans come in second (Jerison, 1978). But what about those cetaceans that have low encephalization quotients? These are the large baleen whales and the sperm whale (Manger, 2006), and these creatures have brains that have a mass in the range of 3.6–7.8 kg (compared with the average human brain mass of 1.4 kg). With brains that large can they really be considered unintelligent? In the case of these larger bodied cetaceans, it has been the practice to simply ignore Jerison's ideology and forward other possibilities to account for this major discrepancy, with proposals such as aquatic weightlessness apparently dismissing these ''exceptions'' to the ''encephalization rule'' (Marino, 1998).

There are many other exceptions to the encephalization equates to intelligence concept proposed by Jerison (1973) (e.g. chimpanzees and other great apes have lower encephalization quotients than many other primates but are clearly more cognitively complex); but it is an extremely useful biological measure. Brains are metabolically costly, and thus to over-endow a particular body with an ''excess''