

Visual acuity in two species of delphinid (*Tursiops truncatus* and *Orcinus orca*)



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Introduction

It is clear that much cetacean behavior is visually guided. Yet, little is known about visual processes in these animals. In a series of experiments that utilized a two choice discrimination paradigm, two delphinid species were assessed for their ability to respond to visual stimuli that varied in location, size and distance.

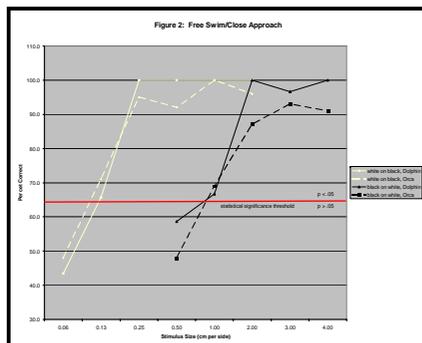
Experiment One: Free Swim/Close Approach

Methods: One bottlenose dolphin (male, 40yo) and one killer whale (female, 7yo) served as subjects. Over successive trials, they swam freely to closely approach two stimulus panels. Their task was to detect and touch single small squares that varied in size. They were alternatively tested with black figures on white backgrounds and with white figures on black backgrounds. See Figure 1.

Figure 1: Side by Side Stimulus Panels, set for testing white on black



Results: When approaching the panels, both subjects characteristically turned to bring their left eyes within 10-15 cm of the stimuli. For white figures on black backgrounds, reliable discrimination occurred with stimuli 1/8 cm² and larger. For black figures on white backgrounds, reliable discrimination occurred with stimuli 1 cm² and larger. See Figure 2.



Experiment Two: Fixed Distance

Methods: Two bottlenose dolphins (females, 8 & 11yo) and one killer whale (female, 8yo) served as subjects. Over successive trials, they swam from a fixed position to touch either of two panels placed at fixed distances (0.5, 1.0, 1.5, or 2.0 meters) at either side of their heads. The target stimuli were set on alternate days either below or above the water surface. See Figures 3a & b.

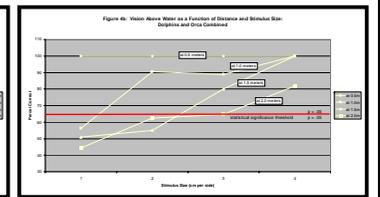
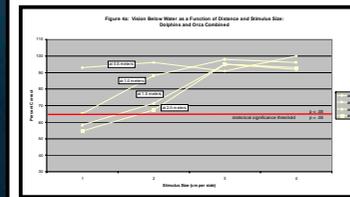


Figure 3a: Dolphin above-water trial at 1 meter



Figure 3b: Orca below-water trial at 2 meters

Results: The dolphins and orca did not differ significantly from each other. Their combined results for white target stimuli presented on black backgrounds are depicted in Figures 4a & b. Underwater, the animals were able to reliably respond to stimuli that subtended a visual angle of approximately 0.6 degrees or greater. This corresponds to the detection of a 2 cm² stimulus at a distance of 2 m. Above the water, reliable discrimination of the same targets occurred only when the stimuli subtended an angle of at least 0.9 degrees (equivalent to about 3.0 cm² at 2 m distance). When similarly tested with black targets presented on white backgrounds, the corresponding angles were 1.3 deg underwater and 2.8 deg above. Performance on these visual discriminations tests was NOT affected when ambient light level was varied between 0.05 and 8.0 mW/cm².



Discussion

Not surprisingly, the vision of these animals was better underwater (than above), and much better when detecting white stimuli on black backgrounds (than black stimuli on white backgrounds). The fact that performance on these visual tests did not vary with ambient light seems to rule out "glare" as a factor, and it suggests that they have a rather constant visual experience throughout a wide range of illumination. We offer these results as providing the lower limits of what these animals are able to see with respect to stationary stimuli, and as a contribution to a better understanding of their perceptual world.