STIMULUS CONTROL OF ECHOLOCATION PULSES IN TURSIOPS TRUNCATUS

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Until recently, it was extremely difficult to determine what cue or set of cues a dolphin used in detecting or differentiating between targets by means of its sonar system. One of the major problems was the ambiguous nature of the echo return in relation to the position of the dolphin during pulse emission and prior to the animal's choice response. In this experiment, we solved the problem by acquiring unambiguous control over a dolphin's position and pulse emission while it was actively engaged in a discriminative echolocation task.

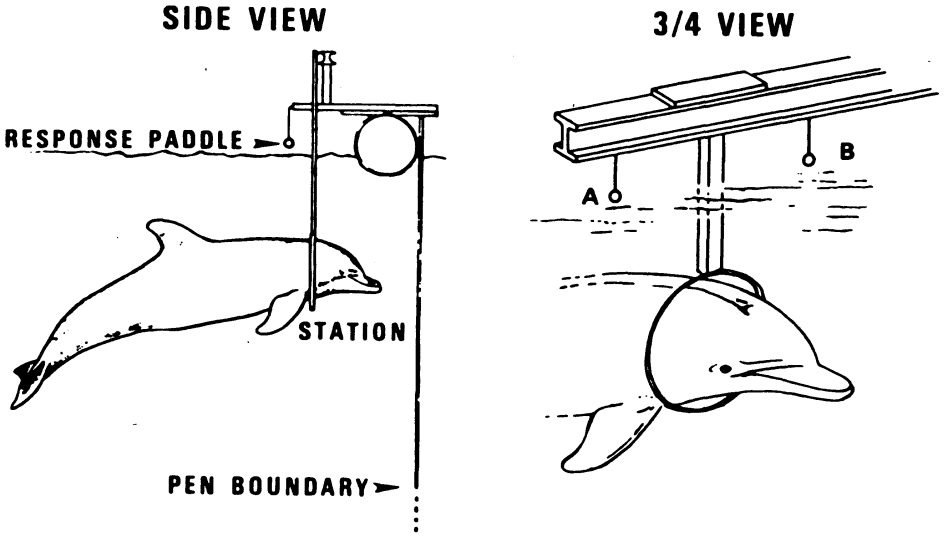

Fig. 1. Diagram of an Atlantic bottlenose dolphin (T. truncatus) maintaining a fixed position in a water-filled plastic hoop. The dolphin remained in the hoop up to its flippers and when given an audio signal, it emitted a burst of echolocating clicks at a target 6 m directly in front of its melon. Following the termination of the last pulse within a burst of pulses, the dolphin backed out of the hoop and reported the presence of a sphere or cylinder by hitting the "A" or "B" response paddle or manipulandum with its rostrum.

An adult male Atlantic bottlenose dolphin (Ekahi), originally signalled by a tone to echolocate and discriminate spheres from cylinders while swimming across his pen, was trained to continue the same task from a fixed position. The animal was first trained to place its head(including blowhole) in a sixteen inch diameter hoop. The hoop was submerged to a depth that placed the dolphin's rostrum directly in line with the center of the target located six meters away (see Fig. 1). When the dolphin maintained the appropriate position in the hoop and emitted no echolocation pulses, the tone cue was activated. The tone signalled the dolphin to echolocate from its position in the hoop. If the animal left the stationary hoop to continue echolocation, the tone was terminated before a choice response was made. If it left the hoop only to surface and make a choice response, the tone remained activated until a response was made. With continued training, control over both the position of the dolphin and the time that it emitted echolocation pulses was exerted in a precise fashion. Control over echolocation pulses was so refined that termination of the tone invariably resulted in the termination of echolocation pulses even though the animal was stationed correctly and the target was present in front of him.

In order to determine if the dolphin was echolocating before the tone was given, a simultaneous measurement of the animal's signals and the tone cue was performed. A B and K 8103 hydrophone was placed one meter behind the target to measure the animal's echolocation signals. The hydrophone signal was amplified by 20 dB and recorded on one channel of an Ampex FR-1300 instrumentation tape recorder. The audio cue was recorded on another channel. Both channels were examined simultaneously using a dual-trace storage oscilloscope in the chop-mode. Analysis of tape recordings made during testing showed that the porpoise did not emit any echolocation signals while stationary in the hoop before the onset of the tone cue.

A second dolphin (Sven) was trained in essentially the same way as we trained Ekahi. The training took approximately the same amount of time (two weeks) and again resulted in controlling not only the postural orientation, but also the signal emissions of an echolocating dolphin in a materials discrimination task.

Supported by the Naval Ocean Systems Center and ONR contract N0014-77-C-0185.