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SPHERE-CYLINDER DISCRIMINATION VIA ECHOLOCATION BY TURSIOPS TRUNCATUS

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An experiment was conducted to investigate the ability of T. truncatus to discriminate between spherical and cylindrical targets by echolocation. The targets were constructed out of polyurethane foam to eliminate any internal reflections, and their dimensions were chosen so that the spheres and cylinders had overlapping target strengths. All targets were acoustically examined with dolphin-like echolocation signals. The results of the acoustic measurements performed under free-field conditions are shown in Table 1, along with the correlation coefficients between the echoes.

Two spheres and two cylinders were used in each 64 trial session except during the first portion of the initial acquisition phase (see first panel of Fig. 1). The targets were placed on an assembly which allowed them to be submerged (1.12 m depth) at approximately the same location; 6 meters in front of the animal's pen. The two-alternative forced-choice technique was used with the targets presented successively in a random sequence. During the initial acquisition phase, the dolphin was allowed to swim freely while echolocating. Eventually, the animal was required to station

Table 1. Results of the Acoustic Examination of the Targets

	Target Strength Measurements				Correlation Coefficients Between Target Echoes		
	Target	Diameter	Length	TS	S_1	S_2	S_3
Spheres	S_1	10.2 cm	–	-32.1 dB	1.00	0.98	0.99
	S_2	12.7 cm	–	-31.2 dB	0.98	1.00	0.99
	S_3	15.2 cm	–	-28.7 dB	0.99	0.99	1.00
Cylinders	C_1	1.9 cm	4.9 cm	-31.4 dB	0.94	0.97	0.96
	C_2	2.5 cm	3.8 cm	-32.3 dB	0.98	0.97	0.98
	C_3	2.5 cm	5.1 cm	-28.7 dB	0.91	0.93	0.92
	C_4	3.8 cm	3.8 cm	-30.1 dB	0.95	0.97	0.98
	C_5	3.8 cm	5.1 cm	-27.6 dB	0.98	0.98	0.99

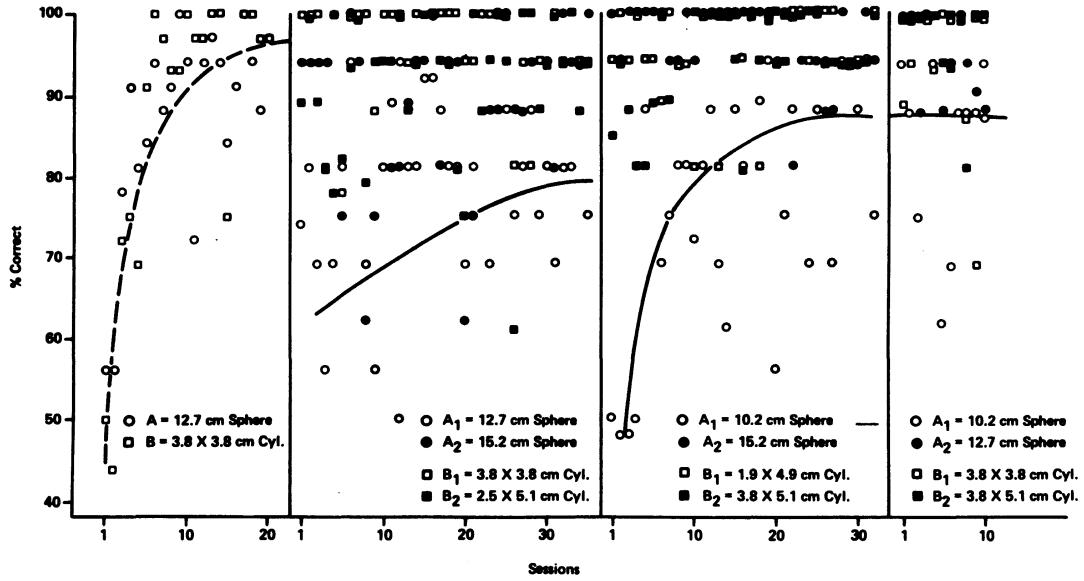

Fig. 1. Initial acquisition results with free-swimming animal.

in a hoop and only echolocate upon the introduction of an audio cue (see Schusterman, Kersting and Au, this volume). The hoop station was introduced to prevent the animal from receiving spatial cues by echolocating at different depths and thus respond on the basis of the aspect dependence of target strength for the cylindrical targets.

Results: The results of the four parts of the initial acquisition phase are shown in Fig. 1. The lines in the figure are curves fitted

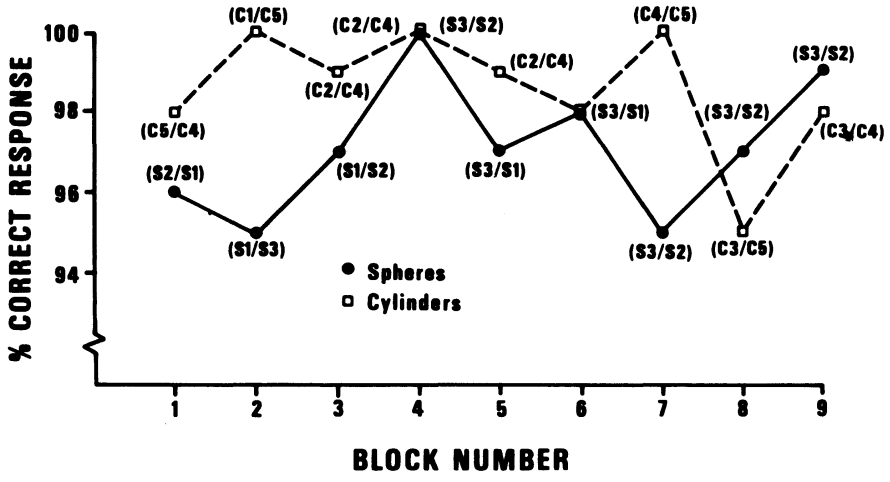

Fig. 2. Summary of the dolphin's in-hoop performance.

to the results of the smallest sphere. The curves show early acquisition with decrements in performance and reacquisition as a function of introducing different cylinders and spheres. Asymptotic performance was considered to have been achieved as shown in the last panel of Fig. 1. The results of the dolphin's performance with the use of the hoop station are illustrated in Fig. 2. Each block consisted of at least 5 sessions and at most 36 sessions. A comparison between Fig. 1 and 2 indicates that the dolphin's ability to differentiate between spheres and cylinders was superior for the in-hoop situation than for the free-swimming situation.

Discussion: The acoustic examination of the targets showed that the echoes were very similar, as can be seen in the high correlation coefficient values of Table 1. It appears unlikely that the dolphin made the discrimination based on differences in the measured reflective characteristics of the targets made in the free field. Further acoustic measurements were made in which the planar transducer was swept in azimuth to simulate the animal scanning across the targets. These measurements did not provide any information as to how the animal was making its discrimination. Finally, the transducer-target

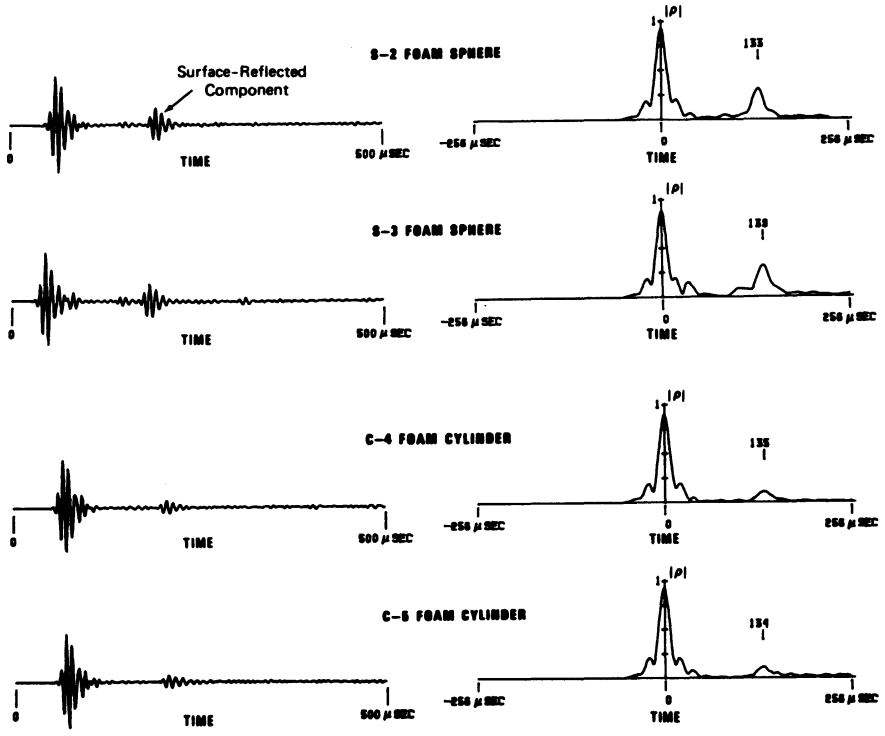

Fig. 3. Approximation of echoes received by the dolphin.

geometry was set up to approximate the animal's experimental condition. Examples of the results of this acoustic measurement are shown in Fig. 3. Also shown in the figure are the envelopes of the matched-filter responses, with the filter matched to the outgoing signal. It was found that the spheres introduced a larger surface reflected component to the echoes than did the cylinders. Furthermore, the surface reflected component of the cylinder echoes fluctuated in amplitude as wind and wave motion caused movements in the targets. The surface reflected component of the echoes seemed to have provided the eventual cue for the dolphin's differentiation between the targets. Superior performance in the hoop station over the free-swimming situation is consistent with the notion that the dolphin used the surface reflected component of the echoes as the primary cue.