RESPONSE BIAS AND ATTENTION IN DISCRIMINATIVE ECHOLOCATION BY TURSIOPS TRUNCATUS

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In the Einstellung experiment, stimulus correlated response set or bias can be induced which renders an animal in a maze "functionally blind" to a subsequent simple solution. Until the bias is extinguished, the animal remains insensitive to cues leading to the goal object. Observations on echolocating dolphins suggest that they too may become subject to an Einstellung phenomenon. The present experiment, which grew out of a series of biosonar studies on underwater material discrimination, tested the notion that a response bias acquired in an insolvable discriminative echolocation task will strongly influence the attention of a dolphin on a solvable discriminative echolocation task.

Method. In a two-alternative forced-choice procedure with targets presented on successive trials at a distance of 6 m (see Fig. 3 in Schusterman, this volume), the task of an adult male T. truncatus (Sven) was to differentiate echoes from 17.8 long hollow aluminum and hollow glass targets--each having two different sized outer diamters (OD) and wall thicknesses (see Fig. 1). Targets were submerged in a vertical orientation about 114 cm below the water surface in approximately the same location. Both large and small aluminum cylinders were to be reported on the A or left manipulandum and the large and small glass cylinders were to be reported on the B or right manipulandum. Results from synthesized dolphin-like clicks reflected from these targets in water are shown in Fig. 1. Target reflection characteristics are virtually identical for large aluminum and glass targets (7.62 cm OD), but the differences between small aluminum and glass(3.81 cm OD) are different in terms of the relative strength of the second component of the envelopes of the matched filter output and also with regard to frequency spectra--particularly between 100 and 130 kHz.

In Phase 1, each test session consisted of all four targets being presented 16 times in a quasi-random sequence. In Phase 2 (the Einstellung phase), a test session consisted of either a solvable discrimination problem (small aluminum and glass targets) or an insolvable problem (large aluminum and glass targets). Test sessions in Phase 2 were sequenced in a quasi-random fashion so that the dolphin would have difficulty "predicting" on which test session a solvable or insolvable problem would be given. In Phase 3, the dolphin was given the solvable task on each test session,

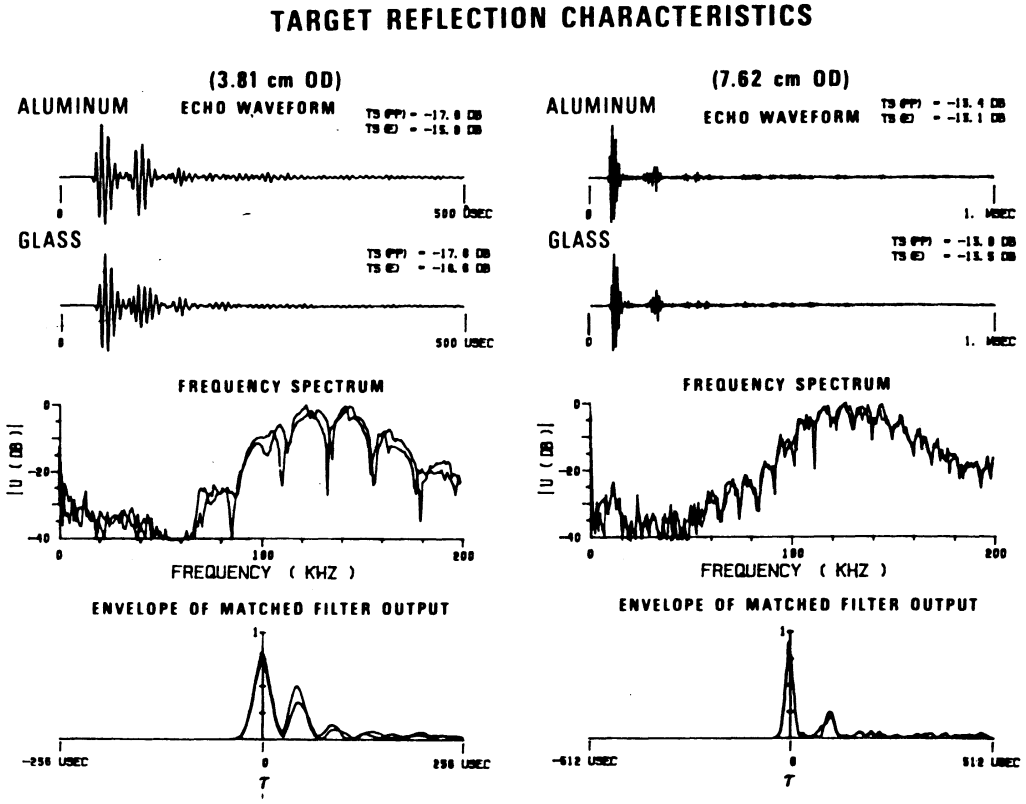

Fig. 1. Results of backscatter measurements for hollow aluminum cylinders and hollow glass cylinders. Wall thickness of the smaller OD's was 0.32 cm and that of larger OD's was 0.40 cm. Comparison of echoes from the same sized OD's can be made on the basis of the time-domain waveforms, the frequency spectra (superimposition of echoes from aluminum and glass) and the envelopes of the matched filter output (superimposition of the echoes from aluminum and glass).

i.e., the differentiation between small glass and small aluminum. Following the original experiment, the three phases were replicated in the same sequence.

Results and Discussion. After 30 test sessions of Phase 1 of the original experiment, the dolphin perfected the differentiation between the small aluminum and small glass targets. However, as predicted from the target reflection characteristics shown in Fig. 1, the animal did not distinguish between the large aluminum and glass targets. Instead, the dolphin developed a response bias and consistently reported both large glass and large aluminum on the B response manipulandum. In Phase 2, response bias not only increased

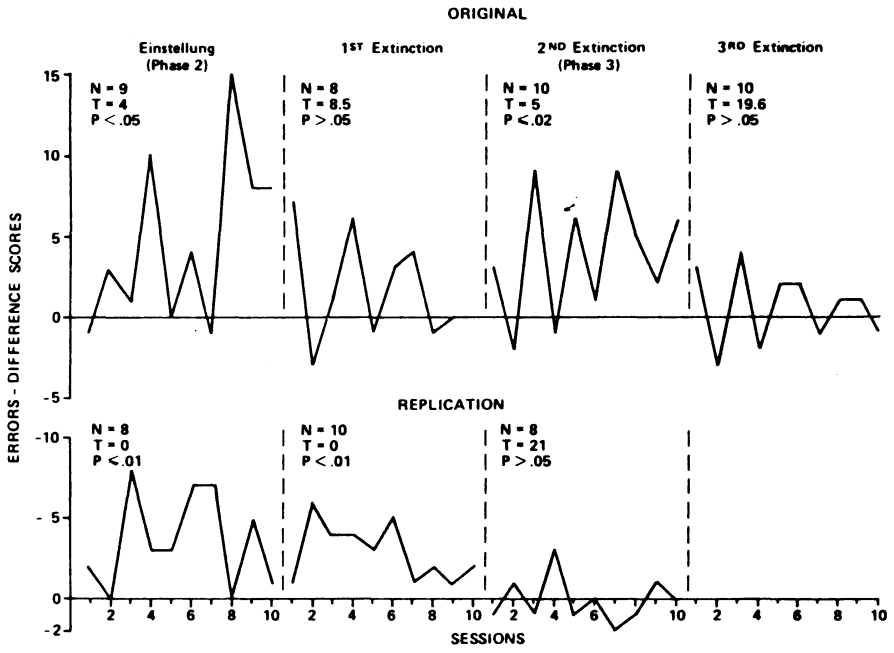

Fig. 2. Comparison of the dolphin's errors (reflecting response bias) during 1st and 2nd halves of each test session during Phases 2 and 3 of the original experiment and the replication. Values on the ordinate were obtained by subtracting errors made during the 2nd half of the test session from errors made during the 1st half of the test session. Positive values indicate response bias during the early part of a test session and 0 values indicate no difference in bias between the 1st and 2nd halves of a test session.

during insolvable large-target sessions, but bias also occurred in the first half of the solvable small-target sessions, decreasing significantly (Wilcoxin matched-pairs signed ranks test) during the second half of the sessions (see Fig. 2).

In Phase 3, when the solvable discrimination was repeatedly given, the initial bias or the Einstellung phenomenon was extinguished. When the entire experiment was replicated, the results were very similar to the first experiment except that the Einstellung phenomenon was extinguished more rapidly. Analysis of click trains from a single test session of Phase 2 showed that the dolphin emitted essentially the same echolocation signals during the solvable discrimination problem regardless of whether or not it had a response bias. The results are interpreted as indicating that persistant spatial responses during an insolvable echolocation task predisposed

the dolphin to diminish its attention for listening to previously established distinctive echoes. This interpretation is similar to one suggesting that bats relying on spatial memory pay less attention to echoes in an obstacle avoidance task. (This research was supported by the Naval Ocean Systems Center and ONR contract N00014-77-C-0185.)