MECHANISMS OF SIGNAL DISCRIMINATION AND IDENTIFICATION IN
THE AUDITORY SYSTEM OF TURSIOPS TRUNCATUS

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INTRODUCTION

Discrimination and identification of acoustic signals in
the human and animal auditory system are performed by means of
feature extraction and analysis (Chistovich et al., 1976;
Bibikov, 1978). Our first observations showed that dolphins
also use features for signal discrimination (Dubrovsky and
Titov, 1978; Dubrovsky and Zorikov, 1983).

In this study, we describe the results of an experimental
study intended to reveal the main set of discrimination and
identification features used by the auditory system of Tursiops
for single and paired clicks. These simple stimuli simulate
echoes from targets caused by echolocation clicks of the dol-
phin.

Our goal also is to investigate the hierarchy of discrimi-
nation features and principles of decision-making in the dol-
phin.

EXPERIMENTAL PROCEDURE

Single and paired clicks were produced by shock excitation
of a spherical transducer in water by short unipolar electric
pulses. The stimuli which had to be compared, were presented to
the dolphin at random. Four paired stimuli patterns have been
used: "the positive", "the negative", "the first test" and "the
second test" (Fig. 1). The positive and negative stimuli con-
tained at least two different physical characteristics (a1, a2)
and (b1, b2), correspondingly.

The two test stimuli also contained two different physical
characteristics, one taken from a positive stimuli (a1 or a2)
and one taken from a negative stimuli (b1 or b2). The charac-
teristics a1 and b1 were related to the time profiles of each
pulse in the positive and the negative pulse pair. Characteris-
tics a2 and b2 were related to the time intervals between
The 'positive' signal

The 'negative' signal

The first test

The second test

Fig. 1. Time profiles (a, b, c, d) and power spectra (e, f, g, h) of stimuli at the initial series of experiments. $T_+$ and $T_-$ are interpulse intervals values for the "positive" and the "negative" stimuli; $T_1$ and $T_2$ are intervals for the first and the second test pairs of pulses.

pulses in a pair. For example, a test stimulus (a1, b2) corresponds to a pair with the time profile of each single pulse identical to that in a positive stimulus and with a time interval equal to that in a negative stimulus ($T_1 = T_2$).

At the initial stage of each experimental run of trials, the dolphin discriminated between the "positive" and the "negative" stimuli. Its task was to come to the transducer if the positive stimulus was presented and to remain at the starting position in case of a negative stimulus presentation. Correct reaction of the animal was rewarded by fish.

RESULTS

After a learning period, when the animal's reaction to the positive and the negative stimuli became stable, two test stimuli (a1, b2) and (a2, b1) were presented. It is easy to imagine three different strategies of the dolphin in response to test stimuli. The first strategy was to ignore both test stimuli and to remain at the starting position. It might imply that the animal is unable to extract features related to the characteristics a1 or a2 from the test stimuli. The second possible strategy is to come to the transducer after the presentation of any test stimulus. This could indicate that the features related to a1 and a2 can be extracted by the animal and that they are equivalent. The third possible strategy is to react only to the feature which dominates the other one.