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ABILITY OF A DOLPHIN COMMUNITY TO RECOGNISE ITS OWN SONAR SIGNALS

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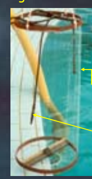
ABSTRACT: The study, carried out from Nov. '00 to Feb. '01, investigates on the ability of a community of captive tursiops to recognise its own clicks and to discriminate them from clicks emitted by a different community. Three adult wild-born tursiops and their three captive born calves resident in the Rimini pool, were the community subjected to the test. The four tursiops resident in the Palablu of Gardaland were the alternative community. In the first phase of study clicks of both communities were collected on a broad-band recorder (30Hz-300kHz) from free-swimming dolphins, without stimulating them. In laboratory one set of data (10 min. long), for each community was selected for the test. In the second phase the two sets of data were presented to the Rimini community in two successive sessions, delayed one week. Acoustic and swimming behaviour of the community was monitored during the test. The behavioural measurements showed striking differences between the two sessions. When the set of their own clicks was backpropagated, all the dolphins of the community were attracted by the projector and produced signals approaching it. When the set of Palablu community was presented, the dolphins retired into a part of the pool far from the projector and almost only the adult male emitted signals at an intensity about 40 times higher than that used in the previous session. No evident differences between wild-born and captive-born dolphins were observed. Results of this study suggest that: (1) clicks of a dolphin community contain features concerning the identity of the group; (2) dolphins use this acoustic information to recognise its own group and probably to enhance the group effectiveness/unity; (3) the dominant dolphin try to defend this unity (i.e. using clicks with high intensity); (4) captivity does not seem change these recognition and discrimination capacities.

MATERIAL & METHODS: Study environment Delphinarium of Rimini (RN) Italy. **Subject of study** the six bottle-nose dolphins (*Tursiops truncatus*) of Rimini community (TAB.1). **Stimulus object** a cylindrical net cage (20 cm diam.; 40 cm height) containing an hydrophone (B&K type 8105), to capture the signals emitted by the dolphins and a projector (Reson TC4034) to play back sequences of sonar signals (Fig.1) **Equipment** Digital oscilloscope (HP54520A), amplifier (B&K type 2626) and wide band (20-300000 Hz) analogue recorder for monitoring and storing sonar signals. Wide band recorder (0.03 Hz-300 kHz) power amplifier (1501) to play back the recorder signals. Camera to determine the dolphin that was emitting sounds. MATLAB toolbox for data processing. **Procedures** three different experiments took place in Feb.2001. In the exp.1 the object, completely new to dolphins, was passive.. The experiment lasted around 30 min. The exp.2 was divided in three consecutive phases, each 10 min.long. In the first phase the object remained passive, exacty as in the exp.1. In the second phase the pojector played back the sequence of sonar signals (235) produced by Rimini community 3 months before. In the third phase the projector ceased emitting . The exp.3 followed the same procedure than the exp. 2, except that in the second phase played back the sequence of sonar signals (90) recorded in Palablu delphinarium

TAB.1 RIMINI COMMUNITY

NAME	AGE	SEX	NOTE
SPEEDY	ADULT	M	FREE BORN
ALFA	ADULT	F	FREE BORN
BETA	ADULT	F	FREE BORN
SOLE	YOUNG	M	BORN IN CAPTIVITY
LUNA	YOUNG	F	BORN IN CAPTIVITY
BLUE	YOUNG	F	BORN IN CAPTIVITY

Fig.1 HYDROPHONES CAGE

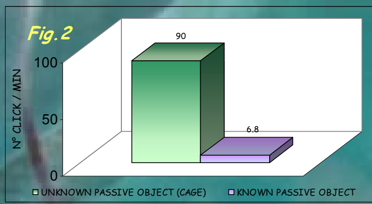


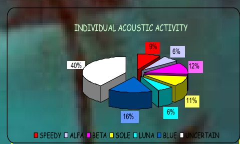
RESULTS: Experiment 1 Fig. 2 shows that the acoustic activity of the community (n° clicks/min.) became high (90 clicks/min) as soon as the object was lowered into the water. After some dozens of minutes dolphins accustomed themselves to the object, the acoustic activity decreased to a normal level (6-7 clicks/min.)

Experiment 2 Fig 3 Shows that as long as the object remained passive (phase 1) the acoustic activity of the community was normal and the swimming behaviour was regular. When the projector played back the sequence of 235 clicks recorded in Rimini delphinarium, the acoustic activity increased more than twice (15.8 clicks/min), but it remained about 6 times lower than in the exp.1. In the last phase, when the proiector ceased emitting , the acoustic activity decreased slightly (12.9 clicks/min.).During the second and third phase the dolphins swam faster(Tab.2) than in the first phase and aggregated in groups of two-three individuals. Therefore identifying the dolphins emitting signals was more difficult (46% and 40% of clicks remained unidentified respectively in the second and third phase, Fig.2)

Experiment 3 Fig. 4 shows that in the first phase the acoustic behaviour of the community was quite similar to that of exp.2. When the projector played back the sequence of 90 pulses (second phase),the acoustic activity increased up to 17.2 clicks/min (9% more than in the exp.2). However, when the projector ceased playing back the acoustic activity, differently from the exp.2, raised further (17.9 clicks/min.). During the phase 2 and 3, the dolphins remained aggregated in an unique group and kept far from the object.Therefore it was very difficult identifying the dolphin emitting signals and about 66% of the clicks remained unidentified (cake). There was a significant difference in the signal mean intensities produced by dolphins in the experiment two and three (phase 2). Fig.5,6,7 compare the sonar signals produced by Speedy (the adult male) and By Blue (the youngest of the two calves) in the two exp. The structure of the signals of both dolphins is less modulated in the exp.3 than in the exp.2. The Speedy's signals have an intensity 40 times higher and the Blue's signals 4 times lower in the exp.3 than in the exp.2.

Fig.2





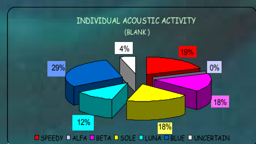


Fig.3

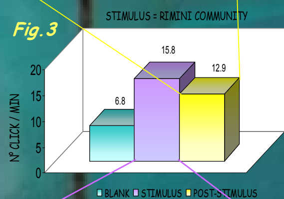
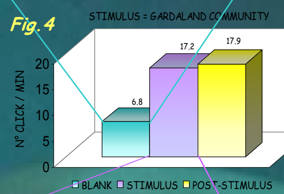
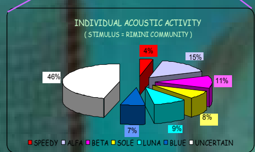
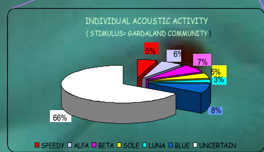


Fig.4



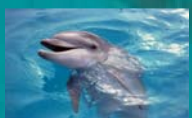
TAB. 2			ACOUSTIC STIMULUS FROM: RIMINI COMMUNITY	ACOUSTIC STIMULUS FROM: GARDALAND COMMUNITY
RIMINI COMMUNITY BEHAVIOR	NEUTRAL	CIRCLE SWIM	□	
		RANDOM SWIM	□	
		GLIDE		
		STAND		
	APPROACHING	SWIM AROUND THE STIMULUS	□	
		STAND BY IN FRONT OF THE STIMULUS		
	AVOIDING	FAST SWIM/EXTREME AGITATION	□	□
		AVOIDING		□





NAME: SPEEDY (a) SEX: ♂
ADULT FREE BORN (Adriatic Sea)

LEGGENDA:
acoustic stimulus=Rimini comm.
acoustic stimulus=Gardaland comm.



NAME: BLUE (b) SEX: ♀
YOUNG BORN IN CAPTIVITY

Fig.5a

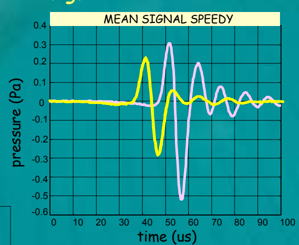


Fig.6a

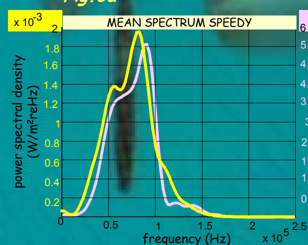


Fig.7a

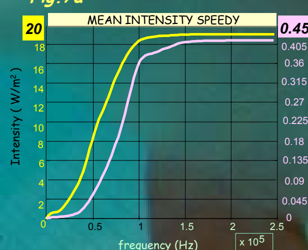


Fig.5b

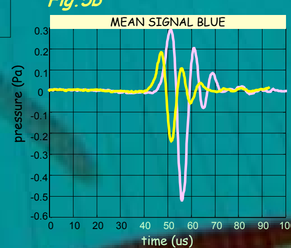


Fig.6b

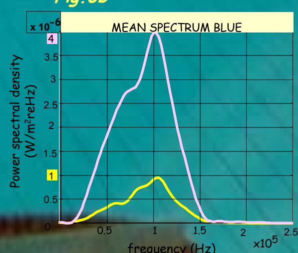


Fig.7b

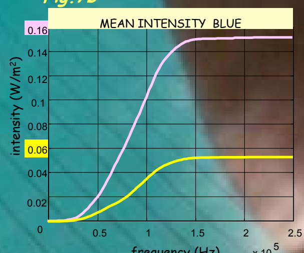
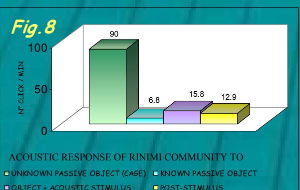


Fig.8



CONCLUSIONS:This paper tackled the problem: can dolphins recognise the sonar signals produced by members of their own community? Although the investigation presented here is far to be conclusive, some interesting results that seem to validate a positive answer were achieved.

The first experiment used a passive object and the dolphins responded to it with typical echolocating signals and behaviour. They produced a very high number of pulses when the new object was lowered into water and reduced of more than ten times their activity when they got accustomed to the object. The acoustic attitude of dolphins was different when they were confronted with the same object but playing back sequences of signals (Fig. 8). That is:

1) When the object played back the sequence of sonar pulses of their own community, groups of two-three dolphins approached the object with the attitude of "duetting" with them or of mimicking them.

2) When the object played back the sequence of pulses of an unknown community, the dolphins aggregated in an unique group that remained far from the object. The adults, and mostly the adult male Speedy, produced scarcely modulated sonar signals at unusually high intensity, that could be interpreted as alarm sounds. The calves, and mostly Blu the youngest between them, produced sonar signals at low intensity and modulation that could be interpreted as distress sonar signals.