

Underwater Vocalization by Sea Lions: Social and Mirror Stimuli

Abstract. Underwater vocal response of three sea lions (*Zalophus californianus*) increased under conditions of social interaction. When confronted by their mirror images, two animals increased their number of vocalizations, which included "whinny" sounds, barks, buzzing, and varying patterns of click trains. Click vocalizations showed habituation and recovery when the animals were in the presence of the mirror stimulus.

Vocalization by an animal often appears related to alertness or increased activity; presumably during activated states, physiologic arousal is great (1). Among seals and sea lions, vocalizations in air (sounds often having a pulsed structure) are valuable in communication and are frequently associated with stress, social play, fighting or sparring, increased sexual activity, and disturbance from a resting state (2). It has been suggested (3) that underwater click vocalizations by the sea lion *Zalophus californianus* may be related to a general arousal phenomenon (1) as well as to a specific or focused arousal such as the "questioning reaction" or "orienting reflex" (4). Since click vocalizations are likely to convey information concerning the moods of the animal, these sounds may function as part of its underwater-communication system.

Social and novel stimuli strongly induce behavioral and physiologic arousal, and the concept of arousal is useful in the interpretation of investigative behavior (5) and of patterns of social behavior (6). If clicking vocalizations underwater are related to the emotional character of *Zalophus*, they may be expected to play a prominent role in its behavior in situations considered arousal-producing. To test this hypothesis, three sea lions in a tank were presented with a social stimulus (another sea lion) and novel stimulus (a mirror) (7).

The amounts and types of underwater vocalization (8) were compared in the presence and absence of the stimuli. Underwater vocal behavior and investigative behavior were quantified by means of a time-ruled check list; frequency was recorded by 30-second intervals. Two experimenters observed the animals from the testing platform: one monitored and scored the occurrence of underwater vocali-

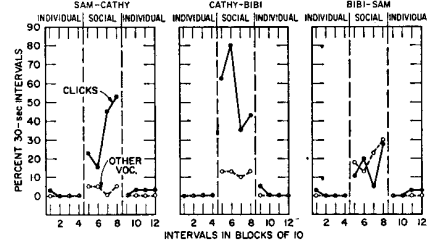


Fig. 1. Amount of clicking and other underwater vocalizations by sea lions tested individually and in pairs.

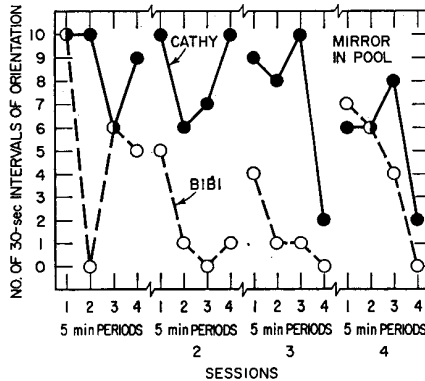


Fig. 2. The course of intra- and inter-session visual orientation toward back-to-back mirrors.

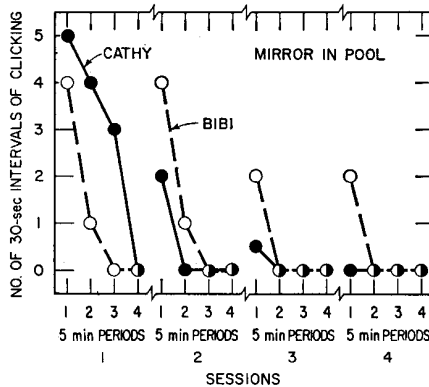


Fig. 3. The course of intra- and inter-session clicking vocalization in the presence of back-to-back mirrors.

zations; the other observed the animals, activating a stop-watch only when an animal's head was submerged, scoring behavioral categories, and making qualitative notes on the behavior of each animal. Vocalizations were scored only during "running time," that is, when at least one animal had its head underwater.

We used a male (Sam) and two females (Bibi and Cathy), 3 to 4 years old; all had been captive for at least 1 to 2 years. Previously, in different types of visual-discrimination tasks,

Bibi (3) and Sam had spontaneously produced clicking sounds under water, and Cathy had been conditioned to emit these sounds (9).

Each animal was paired with each of the other two on separate occasions. One pair was tested each day and all three pairs initially received a total of four test sessions, with one animal of each pair alternately introduced into the tank individually or as a "partner." The procedure was as follows: (i) an animal was introduced into the tank and swam freely for 1 hour, observations being made during the first 10 minutes of this period; (ii) the underwater vocalization of the single free-swimming animal was recorded for 20 minutes; (iii) a second animal, the "partner," was introduced into the tank and underwater vocalizations by both animals were recorded for 20 minutes; and (iv) the partner was removed from the tank and recording of underwater vocalizations by the first animal was resumed. One session was run daily for 12 days.

Underwater vocalizations during this experiment included "whinny" sounds, barks, and a buzzing sound, as well as varying patterns of click trains (10). Since there was little change in the amount or type of vocalization for each pair over the four test sessions, the results from each of the sessions were combined (Fig. 1). Clicks and other vocalizations were far more prevalent for each pair during social testing than for individuals before and after the social tests.

Clicking was the predominant vocalization by all animals, but Bibi frequently whinnied, especially when interacting with Sam; Sam and Cathy never emitted this sound. Play-fighting (characterized by chasing, gentle biting and pushing, and "porpoising" together and over one another) was the most frequent social activity. Although clicking was frequent during a social encounter, especially during an extensive chase, it was equally frequent when the animals were not swimming close to each other. Barking and Bibi's whinny were specific to social encounters, usually occurring when play appeared to shift to aggression (consisting of hard biting and lunging).

The effects of a mirror on underwater vocal and investigative behavior were determined; a mirror may be thought of as a novel stimulus having to some extent the properties of a social stimulus. Reflected self-images

elicit intense interest and investigation in chimpanzees (11), and Tinbergen (12) reports that a sexually active male stickleback assumes a threatening posture when it sees itself in a mirror.

Two mirrors, each 41 by 51 cm, were hung vertically back-to-back over the center of the tank and 71 cm below the surface. Vocalizations and visual orientation to the mirror were scored. Orientation was recorded when an animal looked at either mirror for at least 3 seconds from within 0.9 to 1.2 m. The experimental design and procedure resembled those of the previous study except that the mirror replaced the partner during the test phase.

No animal vocalized underwater before or after the test periods, but all immediately oriented and produced underwater clicks upon initial exposure to the mirrors. After the initial burst of clicks while approaching the mirror, Sam remained silent and showed no further interest. The results for the other two sea lions (Figs. 2 and 3) indicate that both orientation and clicking: (i) decreased within each test session, (ii) recovered between sessions, and (iii) generally declined over sessions. In addition to clicking, Bibi emitted sharp cracks and whinnies. Both animals frequently swam 3 to 4 m from the mirror before swinging about to make a rapid "run" at it while vocalizing; they either paused a few centimeters in front of it or made a sharp turn away. In many of these excursions the animals moved their heads back and forth spasmodically in front of the mirror as if threatening; they pushed it with their noses, bit it, and occasionally slapped and clasped it with the front flippers.

Our results generally confirm the notion that clicking and other underwater vocalizations by *Zalophus* are associated with its social and investigative response and are therefore related to increased behavioral and presumably physiologic arousal. Furthermore, social facilitation of clicking and other vocalizations, and their frequent association with aggressive behavior patterns, indicate that vocalization does play a role in the underwater-communication system. Since the most vocal animal in the experiments (Cathy) had been the least vocal of the three before it was conditioned to vocalize, the threshold for elicitation of underwater vocalization may decrease as a function of previous learning.

Welker (5) lists prominent features that tend to characterize play and investigative behavior: response to novelty, habituation, and recovery; all have been demonstrated in connection with *Zalophus's* investigative behavior as reflected by measures of visual orientation, and the underwater click vocalizations also conform to these principles. In fact, the curves for underwater clicks (Fig. 3) resemble those of object-contact curves obtained with chimpanzees (13). Moreover, the frequency and type of investigative behavior displayed by *Zalophus* appear to resemble those of other modern Carnivora (14).

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References and Notes

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7. The interior of the oval redwood tank (4.6 by 9.1 by 1.8 m deep) was painted white; it was filled with 82 kl of fresh water, and six windows in the walls permitted observation and photography.
8. Underwater vocalizations were continuously monitored by a Channel Industries-275 hydrophone (20 cy/sec to 150 kc/sec) and an Ampex-2044 amplifier-speaker system (65 cy/sec to 13 kc/sec). Vocal signals were periodically recorded with a Uher-4000S tape recorder at 20 cm/sec (40 cy/sec to 20 kc/sec) and were analyzed with a Kay-661 spectrum analyzer.
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10. Copies of sonograms of these sounds are available from R.J.S.
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