

BRIEF REPORT
Temporal Patterning in Sea Lion Barking
(*Zalophus californianus*)¹

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Quantitative data were obtained to determine whether the temporal patterning of barks by male California sea lions (*Zalophus californianus*) could be used in their acoustical communication. The most important findings were: (a) The mean number of barks per series was significantly greater while a bull was locomoting than while he was stationary. (b) Nondirected barks were significantly slower than the mean repetition rate of a series of directed barks. (c) The repetition rate was significantly more rapid when bulls were at close range and displaying at their mutual boundary than when they were in the center of their territories. (d) If a bull was actively herding females, his rate of barking was significantly more rapid than when he barked from a stationary position. Thus, adult male *Zalophus* vary both the number of barks in a series as well as the rhythm of their barks, depending on the social context. In this way the barking animal appears to control the movements and other behavior patterns of its neighbors.

Temporal patterning of percussive or pulse-type sounds has been shown to play an important role in the acoustical communication of both terrestrial and aquatic animal forms including insects, fish, amphibians, birds, and mammals (Myrberg *et al.*, in press). For example, among elephant seals the pulse repetition rate of one type of threat vocalization by males is very stereotyped within a colony but varies from one colony to the next suggesting local dialects (Le Boeuf and Petrinovich, 1974).

In contrast to reproductively active territorial fur seal bulls, which use four or more readily distinguishable vocalizations in different situations (Bartholomew, 1953; Peterson and Bartholomew, 1969; Stirling, 1971), breeding territorial male California sea lions (*Zalophus californianus*) use only a single percussive kind of sound, the bark. The question arises as to whether a *Zalophus* male uses temporal patterning of this vocalization to

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transmit enough information regarding its motivational state to maintain a breeding territory similar to northern and southern fur seals. On the basis of field observations, it has been suggested that territorial *Zalophus* bulls grade their vocalizations by varying the loudness and the temporal patterning of their barks (Peterson and Bartholomew, 1969).

In order to acquire quantitative data as to whether temporal patterning occurs in the percussive barking sounds emitted by *Zalophus* bulls, both airborne and underwater barks were recorded on magnetic tape from two captive 6 to 8-year-old males (Growler and Marty) during two breeding seasons. In the first season, the group included four juvenile males as well as the two adults, and there was only a single pool available (Schusterman and Dawson, 1968). In the following season, the two adult males were housed with two juvenile males together with four females and two pools were available.

The primary analysis was accomplished with a Raytheon Rayspan spectrum analyzer, which allows one to feed magnetic tape-recorded barks into a scanning tube and produce a continuous spectrograph at some fraction of the actual recording speed (Poulter, 1968). The main parameters were the number of barks in a series and the repetition rate (barks per second). A barking series was defined as a succession of barks followed by an interval twice as long as all preceding interbark intervals. The repetition rate was measured from the beginning of the first bark to the end of the last bark. While recording vocalizations on one track of the tape, the observer noted on the other track whether the barking sea lion was stationary, locomoting slowly, or galloping, whether the barking was directed at another individual, and whether a boundary ceremony was involved (Schusterman and Dawson, 1968).

During the first breeding season, a total of 50 barking series was sampled from Growler and 116 from Marty. All of Growler's barks were directed at another individual sea lion while 21 of Marty's barks were nondirected.

The numbers of barks in a series was significantly greater (Growler, $t(48) = 2.9, P < 0.01$; Marty, $t(114) = 2.3, P < 0.01$) when a male directed its barks while locomoting (Growler, $\bar{X} = 8.8 \pm 3.7$; Marty, $\bar{X} = 10.5 \pm 5.1$) than while remaining stationary (Growler, $\bar{X} = 5.9 \pm 1.9$; Marty, $\bar{X} = 7.4 \pm 3.4$), regardless of whether a series of barks was directed or nondirected. In this series of observations, mean repetition rate was unaffected by whether the animal was stationary or moving. The mean repetition rate of Marty's directed barks was 2.7 ± 0.3 , which was significantly faster ($t(114) = 9.7, P < 0.01$) than the mean repetition rate of his nondirected barks (2.0 ± 0.3). For both males the repetition rate was significantly more rapid (Growler, $t(33) = 2.9, P < 0.01$; Marty, $t(88) = 8.9, P < 0.01$) when they were at close range displaying at their mutual boundary (Growler, $\bar{X} = 2.8 \pm 0.1$; Marty, $\bar{X} = 3.2 \pm 0.4$) than when they

were in the center of their territories (Growler, $\bar{X} = 2.5 \pm 0.3$; Marty, $\bar{X} = 2.4 \pm 0.1$).

During the next breeding season, only Growler barked a great deal while Marty showed submission by remaining silent (Schusterman and Dawson, 1968). Marty stayed in one pool accompanied by a juvenile male and Growler stayed in the other pool with four females and another juvenile male.

While Marty, always remaining silent, swam in a clockwise stereotyped fashion, raising his head periodically to check the activities of Growler in the second pool, Growler's most prominent activity was the attempted herding of the four females. Generally, Growler tried to keep the females in the same pool with him. If any or all of the females escaped the general vicinity of "Growler's pool" and went into "Marty's pool," Growler invariably would enter Marty's pool, barking both in air and under water, and would chase the females back to his pool. During these encounters, Marty would leave the pool and slink away with his head lowered and with an open relaxed mouth similar to the appeasement displays given by Stellar sea lions (Gentry, 1975; Sandegren, 1975).

The herding behavior of all otariid species appears similar in many ways (Miller, 1974). In the captive situation, the male *Zalophus* (Growler) barked almost continuously, usually placing himself at a position in the pool which most readily blocked the females' escape route into the other pool. However, as is true with other otariid species, Growler's herding behavior was frequently ineffective in keeping females in his pool. However, once he "lost" the females, he never had difficulty chasing them back to his pool. In addition to blocking the females with his body (he was never observed biting a female), Growler's most effective technique was to chase after and bark at the females. Frequently, when a female appeared to be leaving Growler's pool, she stopped and returned to his pool as Growler approached while barking continuously in her direction.

The repetition rate was analyzed in relation to three categories: stationary, patrolling, and chasing. A total of 20 barking series was analyzed for each behavioral category. If Growler was resting in a sitting position and barking in a routinely self-advertising way (series of nondirectional barks), the mean repetition rate was 2.1 barks/sec. If he chased or confronted others, the mean rate was 2.5 barks/sec. Since the rates of barking in a series within each of these social contexts were relatively stereotyped (standard deviations ranged from 0.1 to 0.3), each of these rates was significantly different from each other ($P_s < 0.01$). Furthermore, when chasing or confronting, Growler might increase his rate of barks during a single emitted series without a noticeable pause, the mean rate of these rapid barks being 3.0.

The repetition rate of underwater barking was almost exactly half that for a series of airborne barks (Schusterman and Balliet, 1969). For exam-

ple, if Growler was either stationary or swimming slowly underwater, the mean rate of barking was 1.0, but if he was swimming rapidly while chasing another sea lion, his mean barking rate would go as high as 1.4 barks/sec. Since there are few or no bubbles produced when *Zalophus* barks under water, presumably the animal recycles the air in order to emit its underwater barks and this causes the barks of a series to diminish to half their "normal" rate.

Thus, it would appear that a great deal of information content may be contained in the temporal patterning of *Zalophus* barks. Adult male *Zalophus* vary both the number and rhythm of their barks depending on the social context. The recipient of these calls probably can discriminate the motivational state of the sender. In this fashion, a barking territorial male can control the movements and behavior patterns of neighboring territorial males, nonterritorial male intruders, and, to some extent, females. Moreover, barking in *Zalophus* is primarily a male vocalization and shows seasonal variation in relation to territorial behavior similar to the singing of passerine birds (Schusterman and Dawson, 1968; Schusterman and Gentry, 1971). Therefore, the fact that territorial males bark almost continuously, not only when actively chasing male intruders, patrolling their territorial borders, or herding females but also when they are in the center of their territories, seemingly "self-advertising," suggests that barking, like male bird singing, may play a significant role in attracting mates (Kok, 1972).

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