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# Imprinting and other aspects of pinniped–human interactions

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### Editors' Introduction

Schusterman, Gisiner, and Hanggi offer evidence that early social interactions between California sea lions and human researchers result in major changes in the animals' behavior. These changes may be measured directly and used to considerable advantage, whether in routine handling or in specific experimental work, to explore the cognitive and perceptual abilities of the animals.

Rocky is a female California sea lion (*Zalophus californianus*) in Santa Cruz, California, who "understands" a human gestural sign language (Schusterman & Gisiner, 1988; Schusterman & Krieger, 1984, 1986). Hoover is a male harbor seal (*Phoca vitulina*) who was reared by people and used to "speak" English when he was at the New England Aquarium (Ralls, Fiorelli, & Gish, 1985). Mendicant feral California sea lions at Pier 39 in San Francisco have learned to do a variety of tricks for fish handouts from tourists (Nolte, 1990). Sea lions and seals are getting shot, shot at, or acoustically harassed following their disturbance of partyboat fishermen (Miller, Herder, & Scholl, 1983). All of these stories are examples of contemporary human–pinniped interactions and depend on skills acquired by individual animals during the course of their development. During development, the acquisition of learned skills may be facilitated by the bonding that occurs between individuals. Among the behaviors that reflect attachment and bonding are "following" and vocalization.

In this chapter we first discuss bonding between newborn *Zalophus* pups and human surrogate mothers and document the long-lasting effects that such "imprinting" has on the attachment behaviors of more mature

California sea lions. Next, we draw on our understanding of the natural history and behavioral ecology of feral pinnipeds to attempt to comprehend more fully the motivations of our animals and to improve control over the outcomes of pinniped–human interactions. We emphasize our work with human-raised or imprinted sea lions, since such animals tend to treat humans as social peers more than do wild-born sea lions or captive pups reared by their own mothers.

Young animals may become imprinted on certain characteristics of the environment at specific periods of development and thus learn about selective features of their parents, siblings, or habitat (McFarland, 1985). According to the originator of the concept, Konrad Lorenz, imprinting, as an irreversible learning process, is part of a "phylogenetic program determining precisely when a young organism is to learn what" (Lorenz, 1981). In filial imprinting, young animals, under natural conditions, may respond to their mother in a variety of ways, such as following, vocalizing, and nuzzling. Such behavioral patterns are genetically coded or innate. However, acquiring knowledge of the mother figure is not genetically coded but has to be acquired; that is, youngsters learn about certain features of the attachment figure. As Lorenz has delineated the phenomenon, the tendency to form a bond is innate, and the learning process or imprinting determines which stimulus configuration is selected, thus establishing the basis for the formation of filial attachments with one particular individual or class of individuals.

Imprinting, at least filial imprinting, studied intensively in birds, is probably widespread in mammals like otariid pinnipeds. These animals breed colonially in crowded groups where there is a high potential cost if social attachment by pup to mother is misdirected. There have been relatively few experimental studies of social attachment in pinniped pups (see Trillmich, 1981). The objective of our studies was to determine whether newborn captive sea lion pups formed behavioral attachments to human surrogate mothers in a manner similar to that described for pups bonding with their biological mother in the wild (e.g., see Schusterman, 1981). In the first section of this chapter, we describe several experiments that we believe do indeed demonstrate that California sea lion pups, within a narrow window of time after birth, form a relatively exclusive and long-term attachment to their original human caretakers. (Schusterman [1985, 1986] originally presented this material on videotapes. Copies of these tapes are available on request.)

## Imprinting experiments

### *Methods*

In all of these experiments, California sea lions were fed immediately before test observations in order to minimize the effects of food motivation, and observations were videotaped for later analysis. In these tests we were interested primarily in the amount of time a sea lion spent with a "passive person," that is, one who did not initiate contact with the animal. Animals were considered to be in "proximity" to the caretakers when they remained within 0.5 m of a person for at least 3 seconds. "Interactions" with people consisted of following and emitting the mother call and such contact behavior as climbing on the person as she or he was in a sitting or squatting position, nuzzling, resting or sleeping on or next to the person, and nonnutritive sucking of the chin or an article of the person's clothing. Sea lions made threats toward people only occasionally during these test observations. Interactions with other sea lions consisted principally of play-chase or play-fight. An animal was scored as "solitary" when it swam or locomoted without interacting with others or sat or rested alone. In the playback experiment (Experiment 3), "orientation and searching" consisted of looking at the speaker or locomoting directly toward the speaker. "Proximity" was scored when the sea lion was within about 1 to 3 m of the speaker for at least 3 seconds, depending on the location of the speaker for each test animal.

Experiment 1 was conducted at three different oceanariums: Marine World/Africa USA, Redwood City, California; Marineland of the Pacific, Palos Verdes, California; and Sea Life Park, Hawaii. All enclosures where testing occurred contained a single pool and ranged in size from about 20 × 14 to 6 × 4 m. Altogether, 20 California sea lions were observed in their home pools in the presence of two or three people, who repeatedly switched positions on haul-out or deck areas around the pools; included in three of the four tests were the current caretaker and the original surrogate "mother" or caretaker. In the small holding pool at Marineland, one person was the current caretaker and the other was a stranger. The comparison was between seven hand-reared or "experimental" sea lions who were cared for and bottle-fed by a person (their surrogate "mother") within 96 hours of birth and 13 "controls," who were cared for and nursed by their biological mothers for at least 21 days after birth, but usually for between 6 and 9 months after birth. Table 21.1 lists the rearing history of experimental and control sea lions; it can be seen that all animals were more than 9 months old when the first test observations were made and that all animals but one (Patty from Marineland's small holding pool) were

weaned before testing. Additional observations were made on three of the sea lions that were considered by the oceanarium personnel to be bonded to people and that were likely to remain at the park for another year. These sea lions were Buckwheat, who was initially nursed by Jenny Montague; Auntley, who was initially nursed by Marlee Breese; and Scooter, who was nursed by Brad Andrews. All three of these sea lions (see Table 21.1) had little or no contact with their original surrogate mothers for at least 1 month before testing.

In Experiment 2, a sea lion pup named Rio, born at Marine World, Redwood City, California, was taken from her nonlactating mother about 10 hours after birth. She was then hand-raised at our laboratory in order to follow her interactions with human trainers in greater detail. Furthermore, we wanted to test the strength of a pup–surrogate mother attachment by determining the extent to which the latter might affect the pup's exploration of a fear-provoking environment (swimming in a large, deep pool it had never been in before in order to gain access to the imprinted figure). The experimental evidence for what has been called the "secure base effect" (Rajecki, Lamb, & Obmascher, 1978) suggests that the presence of the attachment figure and communicative behaviors by an attachment figure will facilitate exploration of even relatively dangerous environments by the young of a variety of animal species. All attachment tests on Rio were conducted at the Long Marine Lab, University of California, Santa Cruz. (See Schusterman & Gisiner [1988] for a description of the pool and enclosure.)

In Experiment 3, olfaction and vision were eliminated as signals from the attachment figure by using audio tape playback voices (for Auntley and Scooter) or a hidden caller (for Rio) in order to test whether the pups' "representation" of the imprinted figure could be retrieved or activated by vocal signaling alone. All three sea lions tested in this experiment had no acoustical contact with their original surrogate mother for at least 1 month before testing. Contingent on its head being above water, each sea lion was given about 2 minutes of its original caretaker's voice, followed by about 4 minutes of a control voice (either the current caretaker or a novel voice) and finally 2 minutes of its original caretaker's voice. The times between the different voices were each about 10 seconds. In each case the words used by the people calling were essentially the same and included the name given to the sea lion. Each of the three sea lions was tested this way only once. Tape recordings were used for Auntley and Scooter. Recordings and playback were done with a Sony tape deck model TC-D5M and an Aiwa SC-A5 speaker. Although we initially tried playbacks with Rio, her indifference to the recordings forced us to abandon them and use live calling. Olfactory and visual cues were controlled by positioning both calling and

Table 21.1. *History and characteristics of California sea lions tested for attachment to people*

| Name | Sex | Age tested (months) | Separated from mother | Bottle feeding (months) | Tube-fed | Weaned | Captive-born | Attached to people |
|---|---|---|---|---|---|---|---|---|
| | | | *Tested at Marine World's large holding pool* | | | | | |
| Buckwheat[a] | M | 10 | 5 hr | 6 | No | Yes | Yes | Yes |
| Alfalfa | M | 10 | 9 mo | No | No | Yes | Yes | No |
| Froggy | M | 10 | 9 mo | No | No | Yes | Yes | No |
| Theodore | M | 22 | 9 mo | No | No | Yes | Yes | No |
| Elliot | M | 22 | 21 days | No | Yes | Yes | Yes | No |
| | | | *Tested at Marineland's large holding pool* | | | | | |
| Scooter[a] | F | 33 | 4 days | 9 | Yes | Yes | Yes | Yes |
| Cecil | M | 57 | 2 days | 4 | Yes | Yes | Yes | Yes |
| 900 | F | 33 | 12 mo | No | No | Yes | Yes | No |
| 741 | F | 57 | 3 mo | No | No | Yes | Yes | No |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 589 | M | 69 | 12 mo | No | No | Yes | Yes | No |
| 1087 | F | 33 | 12 mo | No | No | Yes | Yes | No |
| 1138 | F | 57 | 12 mo | No | No | Yes | Yes | No |
| 724 | M | 69 | 12 mo | No | No | Yes | Yes | No |
| | | | *Tested at Marineland's small holding pool* | | | | | |
| Xavier | M | 21 | 4 days | 11 | Yes | Yes | No | Yes |
| Patty | F | 9 | 3 days | 9 | Yes | No | Yes | Yes |
| Lolita | F | 21 | 2 days | 11 | Yes | Yes | No | Yes |
| 1146 | X | 9 | 6 mo | No | No | Yes | Yes | No |
| | | | *Tested at Sea Life Park's small holding pool* | | | | | |
| Auntley[a] | F | 12 | 1 day | 11 | Yes | Yes | Yes | Yes |
| Gregg | M | 12 | 25 days | 9 | Yes | Yes | Yes | No |
| Huapala | F | 12 | 10 mo | No | Yes | Yes | Yes | No |

[a] *These sea lions were given a choice between the original caretaker and their current caretaker.*

noncalling surrogate mother and current caretaker in the same general location behind a visually opaque barrier. Thus, any change in Rio's behavior should have been a function of the voice she heard, since visual cues were eliminated and olfactory cues were held constant. In Auntley's playback, the speaker was placed about 2 m above the ground in a palm tree, and in Scooter's, the speaker was placed on the corner of a 1.5-m-high rectangular wall surrounding Marineland's large holding pool. For Scooter's test, there were approximately eight other California sea lions in the enclosure; for Auntley's, there were four other California sea lions and several harbor seals in the enclosure; and for Rio's test, there were two other California sea lions in the enclosure.

### *Results and discussion*

*Experiment 1.* Figure 21.1 shows the results of our first set of observations. All 7 experimental sea lions showed stronger and more persistent attempts to make contact with people than did the 13 controls. The effect was strongest for those sea lions (Buckwheat, Scooter, Cecil, and Auntley) that had access to their original surrogate mother. However, even those sea lions that did not have access to any of their original caretakers (Xavier, Patty, and Lolita in the small holding pool at Marineland) showed the effect to some extent. Thus, when food motivation and exploratory motivation appear well controlled and length of time in captivity is also controlled for, hand-reared California sea lions interact more extensively with people, particularly their original caretaker, than those raised by their biological mothers.

Additional observations of the three "imprinted" sea lions, ranging in age from about 1 to 3 years, are summarized in Figure 21.2. All three individuals virtually ignored other sea lions, even animals that were their own age and sex (see Table 21.1), when they were in the presence of their original caretaker. All of Scooter's interactions with other sea lions were accounted for by a single individual, Cecil, a 5-year-old male, who had also been raised by Original Caretaker 1 (OC-1). Cecil often chased Scooter away from OC-1 and Scooter then spent time interacting with OC-2.

The three focal animals typically paid no attention to their regular or current caretaker and interacted preferentially with their original surrogate mother. The very few interactions they did have with their current caretaker were usually negative, consisting of mild, open-mouth threats. Illustrative of the preference test, Figure 21.3 shows that when yearling male sea lion Buckwheat was given a choice, he preferred his original mother surrogate (A) Jenny (light hair) to his current caretaker Cindy (dark hair). After Jenny and Cindy switched positions, Buckwheat would

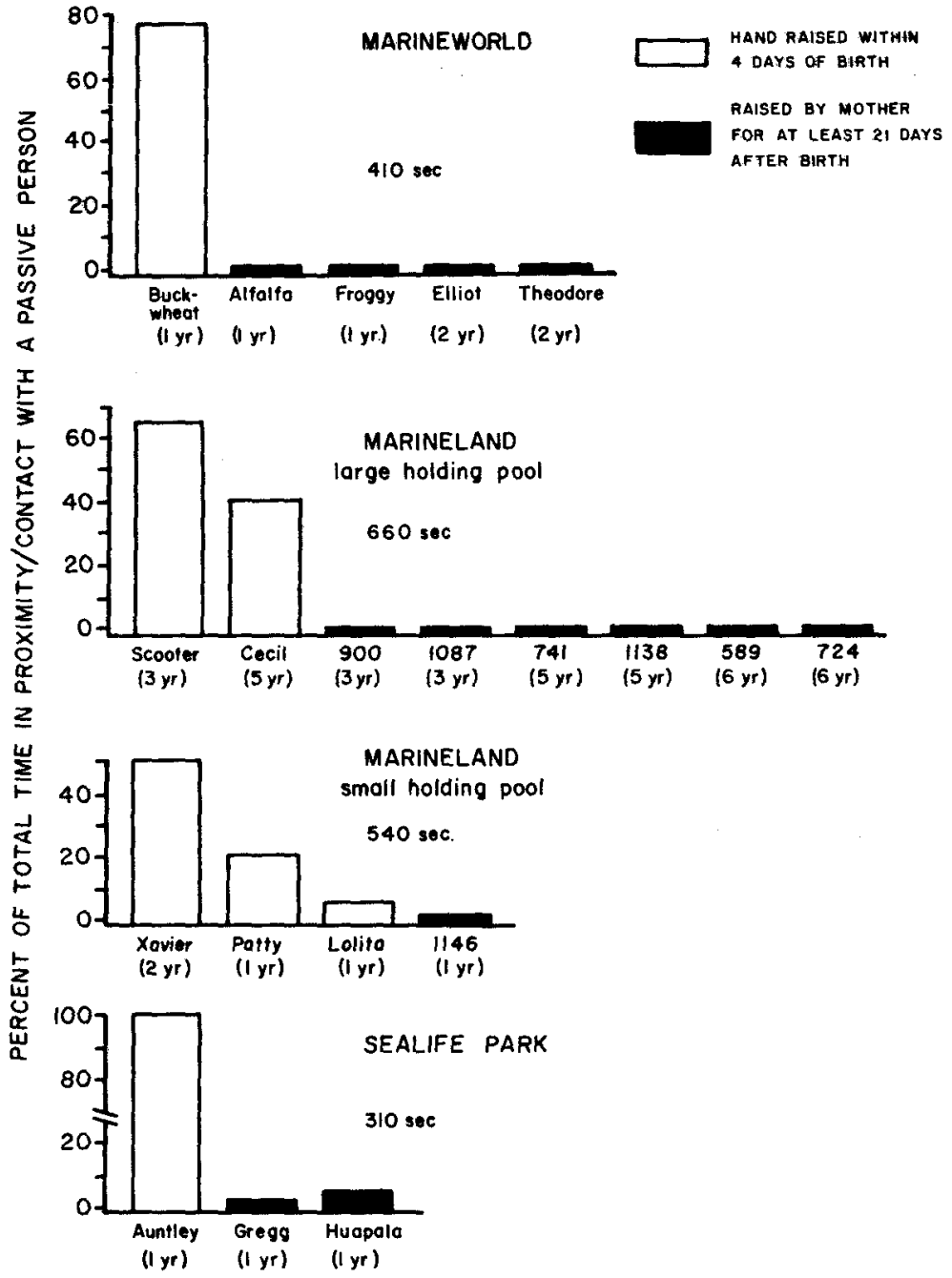


Figure 21.1. Bar graphs for each group of sea lions show the total time they were first tested with people in the enclosures. Proximity or contact time is shown as a function of whether the sea lion was raised by people within 4 days of birth or whether it was raised by its mother for at least 21 days after birth.

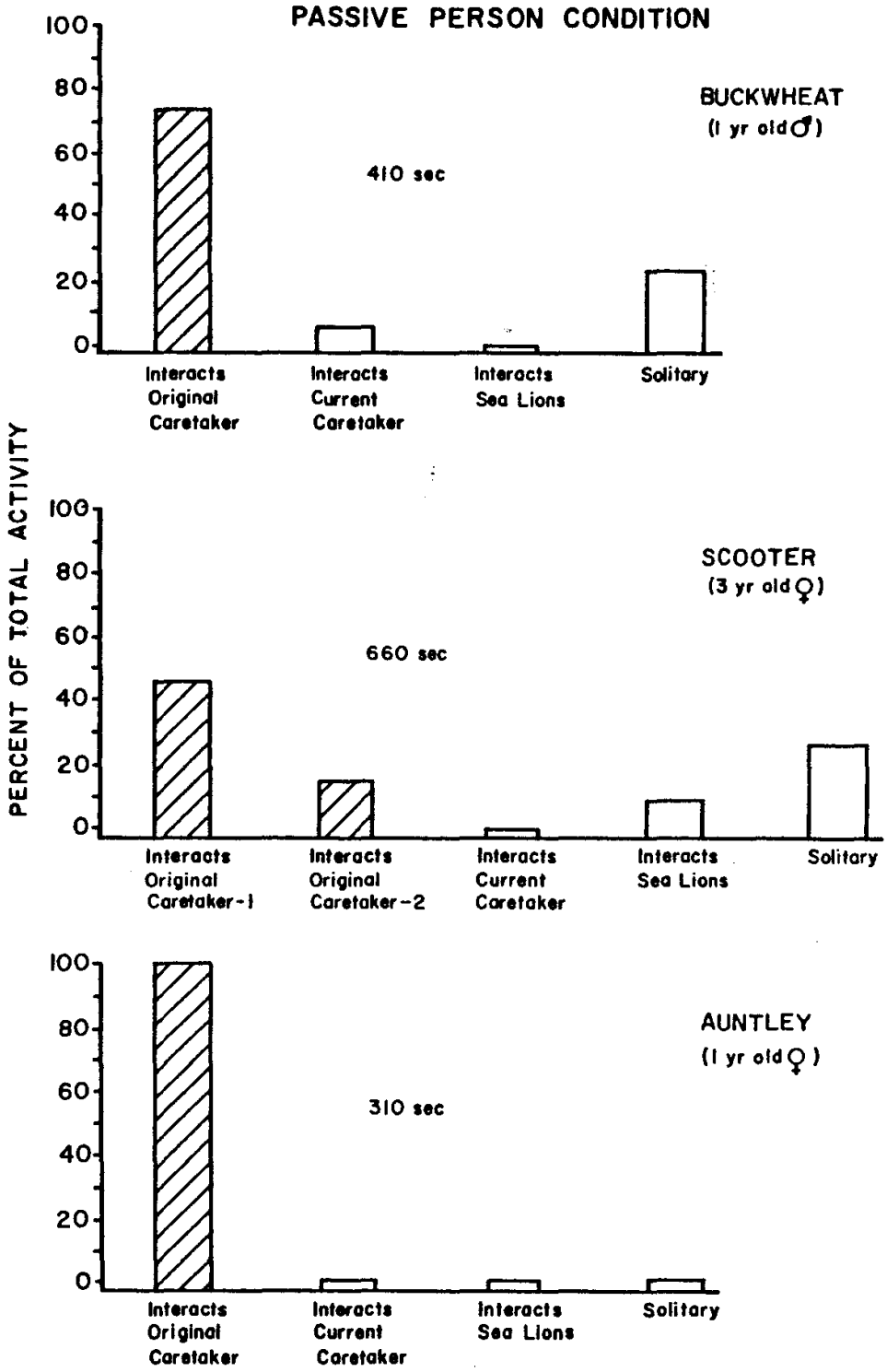


Figure 21.2. On the basis of data shown in Figure 21.1, additional time was spent observing and scoring other behavioral categories from the videotapes. Time periods shown here were matched to those previously used on Buckwheat, Auntley, and Scooter. The percentage of time spent in four mutually exclusive and exhaustive behavioral categories is given. "Passive person condition" refers to the fact that the caretakers did not initiate contact during the test.

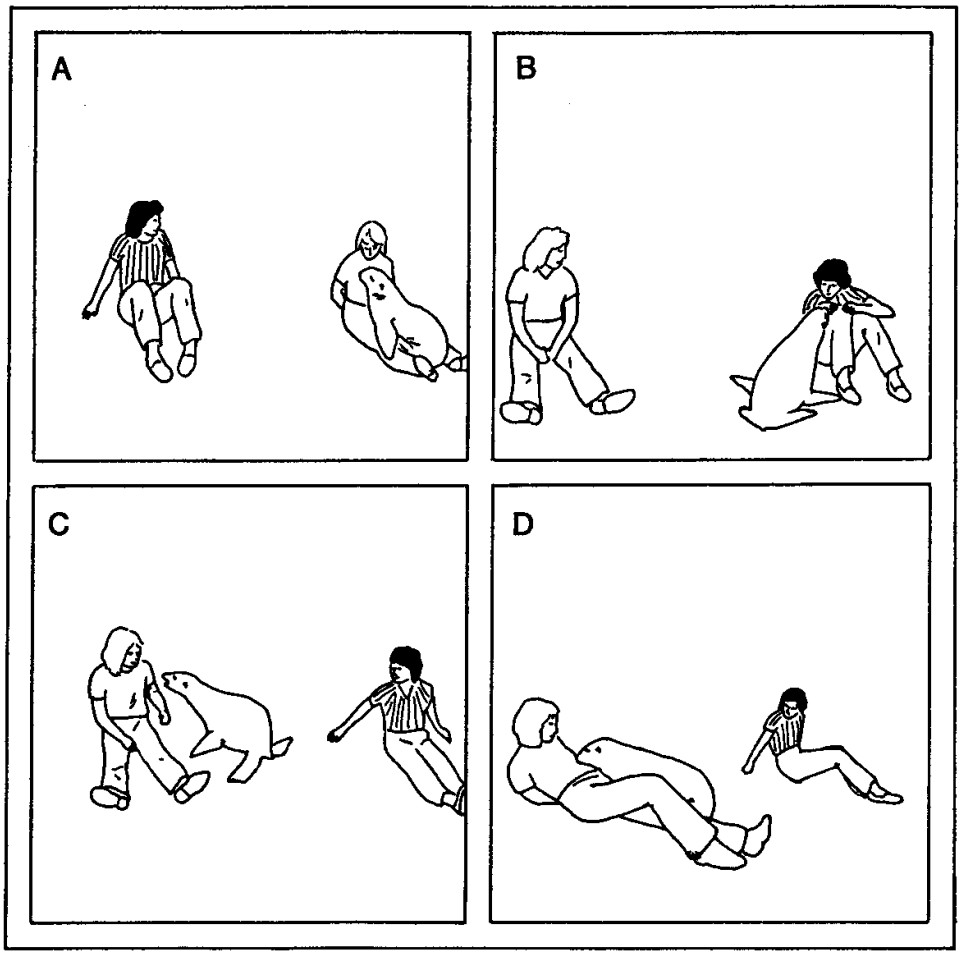


Figure 21.3. Yearling sea lion Buckwheat showing he prefers his original caretaker Jenny (the blond) to his current caretaker Cindy. After Jenny and Cindy switched positions, Buckwheat sniffed Cindy, oriented, and gave a "mother call" to Jenny, climbed on her, and nuzzled her. (This figure was drawn from slides.)

sometimes sniff Cindy (B), occasionally rebuffing her with a mild threat, then search, and give a "mother call" to Jenny (C), rapidly locomote to her while vocalizing, climb back on Jenny and nuzzle her (D). All three subjects responded to calls by their original caretakers, and frequently appeared to use olfaction to confirm identification by voice. Attachment behavior included frequent calling by the two yearlings, and all three showed nuzzling and some nonnutritive sucking of the surrogate's neck and chin or an article of clothing. Following, another attachment behavior, occurred most often when the surrogate changed positions or tried to leave the enclosure. Contact behaviors such as climbing on and resting on the legs or body of the surrogate were seen in all three focal animals. During these tests, it was unclear as to how exclusive the attachments were to the original caretakers. Additional choice tests in 1984 with Buckwheat (similar

to the one just described), for example, showed that he always preferred Jenny to all other trainers at Marine World, even those who began caring for him following Jenny's initial caretaking, that is, about a week after Buckwheat's birth. However, when these early caretakers were pitted against later ones, Buckwheat's attachment behaviors toward the earlier caretakers were similar, although not as intense nor as frequent as those displayed toward Jenny (the original caretaker). Also, note in Figure 21.2 that Scooter interacted by sitting in contact with OC-2 during her testing.

Additional tests on the strength of attachment were conducted on Buckwheat and Auntley. For example, in one test their original caretakers walked at a fairly brisk pace around the enclosure for 1 minute, and the extent to which these yearlings followed was noted. Buckwheat and Auntley started following their surrogate mothers immediately and continued to do so throughout the entire test with one exception; Buckwheat interrupted his following by diving into the pool half-way through the test (presumably to themoregulate) and then immediately resumed following. Both yearlings directed mother calls at the original caretakers almost continuously while they pursued them. Follow-up studies one and two years later with all three of these sea lions indicated that the attachments these animals had formed toward their original human caretakers as pups were quite durable. This occurred despite the fact that after these sea lions were weaned at about 6 or 7 months of age, the original caretakers (Jenny and Marley) had little to do with their feeding and their food-reinforced behavior.

*Experiment 2.* Rio's initial surrogate mother was Michelle Jeffries (Figure 21.4), who was the first person to bottle-feed the pup 10 hours after birth and who had almost continual contact with Rio for 48 hours. At that point, Evelyn Hanggi and Michelle alternated 24-hour shifts. After the first week, other caretakers also cared for and nurtured Rio several times a week, and their frequency of caretaking increased as Michelle's and Evelyn's decreased over the following months.

Within the first week, it became obvious that Rio was exclusively attached to Michelle. All attachment behaviors noted previously with Buckwheat, Auntley, and, to some extent, Scooter were directed by Rio more frequently and more intensively to Michelle than to Evelyn or any of the other caretakers. When Rio was in contact with Michelle, the pup often threatened all other caretakers, including Evelyn. Such aggressive behavior in the presence of the original mother surrogate, Michelle, toward social targets is similar to findings in precocial chicks where the presence of the chick's mother increases the likelihood that the chicks will emit aggressive pecks (Hogan & Abel, 1971).

Figure 21.4. Rio at 6 months of age nursing on formula from a bottle held by her original caretaker Michelle.

Rio learned to nurse from a bottle during the first 2 days with Michelle. At the time of the transition between surrogate mothers, Michelle gave Rio the bottle and fed her for a couple of minutes and then Evelyn came in and began feeding her for the first time. This was the first contact Evelyn had with Rio. The transition went smoothly, and the pup accepted food from both of the caretakers equally well. During those first days, Rio ate well, nuzzled, followed, and vocalized to both Michelle and Evelyn. Then Michelle took over caretaking duties again, and Rio was moved from Marine World/Africa USA in Redwood City to Long Marine Lab in Santa Cruz, California. Evelyn was with her the following day and noticed that her behavior had changed. Rio avoided contact and did not come to her when Evelyn entered the pen. When Evelyn tried handling her, she nipped at her hands. Rio's calling diminished, and from then on she ate less from Evelyn. This pattern was typical over the first 5 months, and only 22% of the time did she eat as much from Evelyn as she did from Michelle. In contrast, Rio ate consistently and well from Michelle. Only 2.7% of the days when Michelle cared for her did she eat less compared with what Evelyn had fed her on the previous day.

Her reactions toward both Michelle and Evelyn had changed. Rio initiated more approaches to Michelle than she did to Evelyn and showed excited greeting behaviors when Michelle went to her but not when Evelyn or anyone else did. Such behaviors included running to and climbing on

Michelle and sucking on her face and arms. Rio greeted Michelle with loud vocalization, sniffed her face, and did a characteristic rapid head shake at the same time. Rio had shown these same behaviors toward Evelyn, but they diminished to almost nothing after the first 2 weeks. Indeed, she stopped calling to and sucking on Evelyn's neck or chin altogether within 1 month.

During her first 5 months on formula, Rio took 70% as much from Evelyn as she did from Michelle and only about 20% as much from three additional caretakers as she did from Michelle. If Rio refused to eat from any of the caretakers other than Michelle, the mere presence of Michelle would facilitate her formula intake, either directly from Michelle or from the caretaker as soon as Michelle entered the area.

Once Rio arrived in Santa Cruz, she was housed at the lab in a fenced enclosure containing a small pool (4.8 x 2.3 m and 1.2 m deep). When Rio was 2 months old, we took her into a much larger pool (7.6 m in diameter and 1.8 m deep) for the first time. We designed a test in which Evelyn interacted affiliatively with her on land for 2 minutes, then got into the water for 2 minutes, called to Rio and tried to get her to go in, and finally sat with her on land for an additional 2 minutes. Then Evelyn left the area and Michelle went through the same procedure.

For the whole 2 minutes Evelyn was in the pool, Rio refused to go in. However, Rio showed an interest by leaning her head down to the water several times. In contrast, when Michelle went into the water, Rio immediately followed her by diving in, swam in a relaxed manner with her, and stayed in the pool for 2 minutes. We had been a little apprehensive about Rio's ability to get out of the pool on her own, so as a safety measure, we built her a ramp. However, when Michelle climbed out, Rio, not needing the ramp, jumped right out after her. Next, Evelyn went back in. Rio did not follow her until 75 seconds had elapsed. She appeared very panicky and did not stop thrashing about until she found the ramp. Evelyn called to her the whole time she was in the water, but Rio essentially ignored her. After finding the ramp, Rio did go to Evelyn and swam with her much as she did with Michelle. Her previous swim probably made this possible. Once she gained some experience with Michelle, she was more inclined to go into the water.

Rio was swimming in a fear-provoking context that was facilitated by the presence of the attachment person, and later she was able to generalize it to other people. This is a case where we were able to use the attachment person to overcome an aversive situation and promote an adaptive response.

We were able to use this bond to elicit exploratory behaviors as well. For instance, Rio followed Michelle wherever she went, including areas she

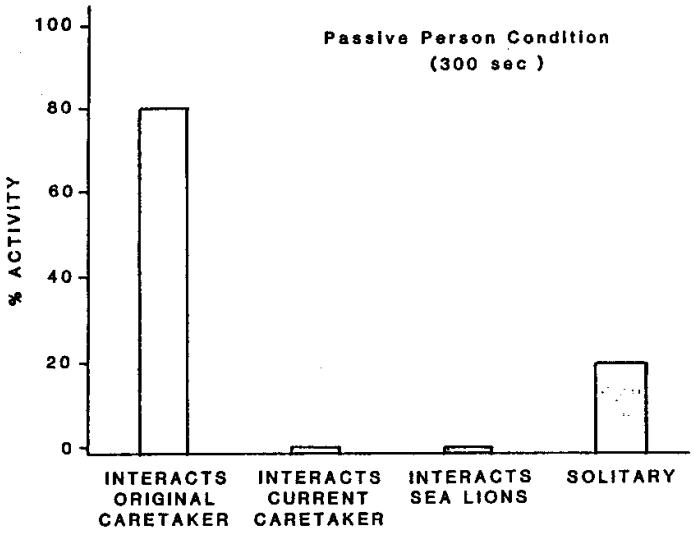


Figure 21.5. The percentage of time Rio spent in four mutually exclusive and exhaustive behavioral categories.

had never been to before. This was very useful for such tasks as moving her about and weighing her.

Following weaning at 12 months, Rio was no longer fed by Michelle. At 14 months of age, Rio was given a preference test and, like the other three hand-reared sea lion pups and as Figure 21.5 shows, she ignored her current caretaker and two other sea lions and interacted in a positive way almost exclusively with Michelle, with whom she had had no sensory contact of any kind for 2 months.

*Experiment 3.* As Figure 21.6 shows, voice playbacks for Auntley and Scooter and calls by individuals hidden behind a blind for Rio demonstrated that these imprinted sea lions were able to distinguish the voices of their attachment figures from those of other individuals. Both Rio and Auntley vocalized quite frequently to their mother surrogate's voice and hardly at all to the control or current caretaker's voice. Auntley's vocalizations occurred just before the onset of the current caretaker's voice, as the sea lion was beneath the tree holding the speaker that had just emitted its mother surrogate's voice. Auntley continued these vocalizations within that context for about 30 seconds before she ceased orienting to the speaker, stopped vocalizing, and left the proximity of the speaker. Scooter, at 5 years of age, showed no vocal reply to playbacks of her mother surrogate's voice. However, Scooter was quite responsive to voice playbacks of her surrogate mother as reflected by her orientation responses to the speaker. It should be noted that except for a blind adult male California sea lion in the enclosure with Auntley, no other California sea lions were

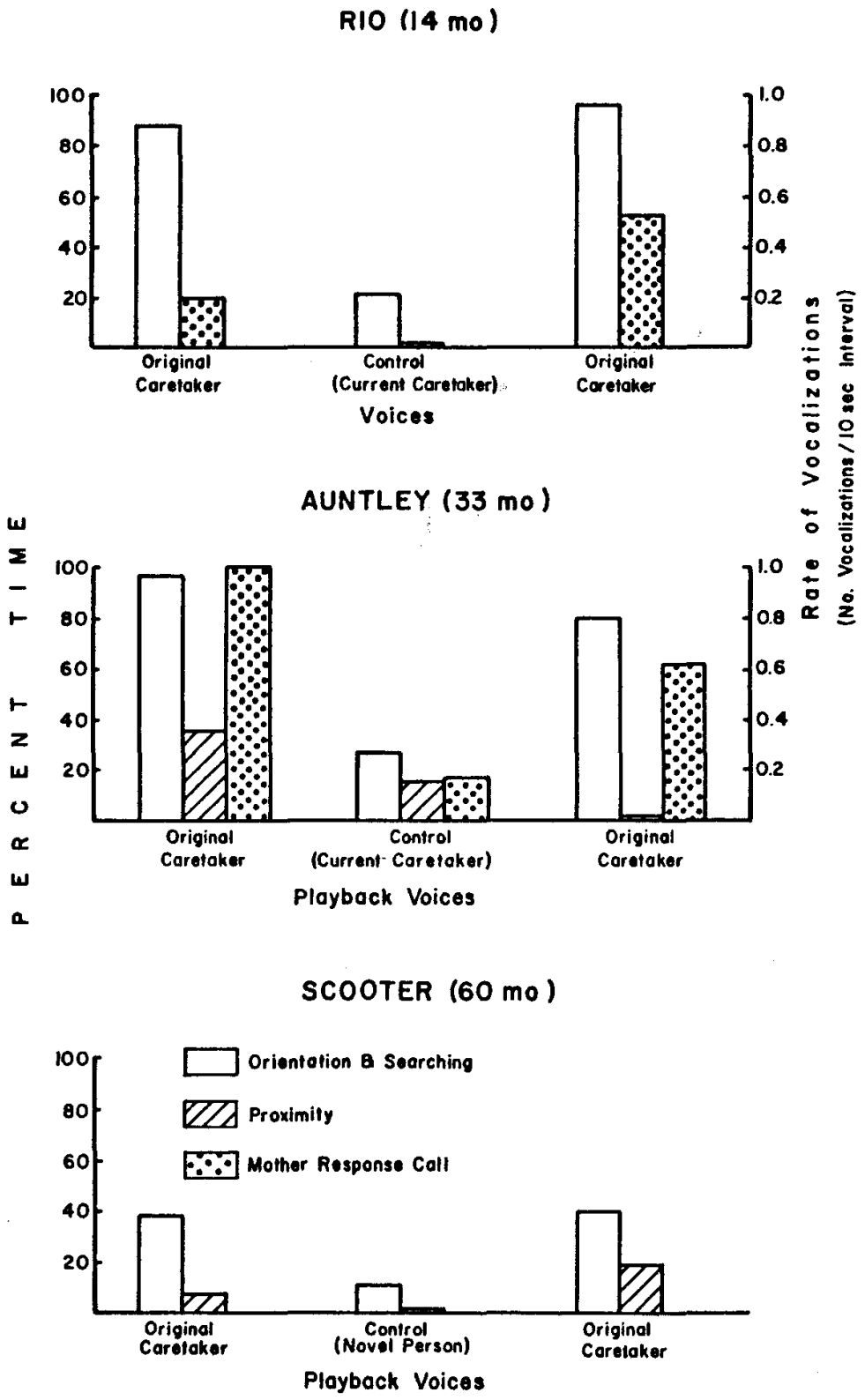


Figure 21.6. The left ordinate refers to the percentage of time sea lions spent orienting to and searching for the source of the calling voice (either live for Rio or tape playback for Auntley and Scooter) as a function of who was calling. Time spent in proximity to the speakers as a function of playback voices is also given. The right ordinate refers to rate of vocalizations (mother response call) for Rio and Auntley as a function of who was calling.

responsive to calls by any of the voices in any of the three different enclosures used in this experiment. Thus, the experiment confirms our initial impression that California sea lions become imprinted on the voice of their original human caretakers. Since auditory cues seem critical for individual recognition in sea lions, and because a human voice contains most of the frequencies found in a sea lion pup attraction call, perhaps it is not so surprising that a sea lion pup imprints on a human voice.

## *Summary and discussion*

Many of the behavioral interactions that California sea lion pups had with their attachment figures in these studies were quite similar to the kinds of interactions observed in the field between pups and their biological mothers (Gisiner & Schusterman, 1991; Peterson & Bartholomew, 1967; Trillmich, 1981). Moreover, when yearling, or even older, sea lions and fur seals are seen with their mothers, their interactions are also similar to those observed in our sea lion–human surrogate mother interactions. Both inter- and intraspecies types of bonding appear to proceed in much the same way. A pup suckles from its biological mother soon after birth and begins recognizing her voice within a few days. This bonding between offspring and biological mother is usually exclusive among otariid pinnipeds and can, at least in captivity, last a lifetime (Hanggi & Schusterman, 1990). In California sea lions, when pups are bottle-fed by a human caretaker soon after birth and cared for by that person intensively for at least 2 or 3 days, there is a good probability that the pup will form an exclusive attachment to that surrogate mother and that the bond will be long lasting. The pup will recognize its surrogate mother's voice and will approach her vocal signaling under a wide variety of circumstances. Like pups with their biological mothers, human-raised pups benefit from the presence of their attachment figures. Their presence promotes exploration, swimming, and many other adaptive responses, including feeding.

Thus, a sea lion is similar to a lamb that follows the person who feeds it with a bottle, even when it is not hungry. Though it has been weaned and plays with other sheep, the lamb will still approach and follow its former keeper (McFarland, 1985). In a similar manner, a weaned yearling will stop playing with other sea lions, and will approach and attempt to interact positively with its former keeper. Continuing with the similarity between a lamb and a sea lion that have imprinted on a person, in both cases juveniles follow the person and call to her or him as if the person were its mother, and as adults both retain some attachment to the person, showing that imprinting for sheep and sea lions can have both long- and short-term aspects.

Our results suggest that sea lion pups imprint first on the voice of their caretaker (and probably on her or his smell as well). The sensitive period for this type of filial imprinting by a sea lion on a human voice, containing most of the frequencies found in sea lions pup attraction calls, appears to range from a few hours to several days after birth. In a later section of this chapter, we discuss the costs and benefits of working with a mature sea lion that has earlier formed an attachment to a person.

## Using behavioral cues during interactions with pinnipeds

A student of captive pinnipeds can benefit from an understanding of the motivations and outcomes typical of certain behaviors in wild pinnipeds. We have had the good fortune to have spent time watching wild pinnipeds and also to have interacted with captive pinnipeds. The following are some of the techniques we use with captive pinnipeds that draw on an understanding of the natural history and behavioral ecology of wild pinnipeds.

### *Species and sex differences in aggression*

Despite the apparent docility or tameness of many wild pinnipeds and those pinnipeds common in captivity such as the California sea lion, there is one obvious point that no student of wild pinnipeds is likely to forget: Pinnipeds are large carnivores. That is to say that pinnipeds survive by hunting and killing things, and they are as large or larger than the average human. Pinniped social interactions involve hard physical contact and biting. Trainers of pinnipeds, like trainers of many large animals, maintain control of the animal only by maintaining the illusion of social dominance and/or superior ability in physical confrontation. Once that illusion is lost, the animal is in control. Maintaining the illusion requires an understanding of the social cues used to indicate dominance and aggression.

To use examples from species we know best, we have chosen the northern elephant seal (*Mirounga angustirostrus*) and the California sea lion. Male northern elephant seals may exceed 5 m in length and 2,000 kg in weight. Nevertheless, they can usually be moved easily by a human holding up a stick that makes her or him "taller" than the elephant seal. (Fighting males balance themselves as high as possible to gain leverage advantages during contests, and an obviously "shorter" male usually backs down before a taller adversary.) It is also possible to move elephant seals by clapping hands or banging on metal drums, by making other banging noises that simulate the clapthreat vocalization of an aggressive male elephant seal, or by thumping on the ground to simulate the ground-shaking attack of a large male. California sea lions, although large, do not exceed 2.5 m in

length, and large adult males weigh 300 to 350 kg. They also try to gain height during contests, but since they stand a little more than a meter high, a human nearly 2 meters tall can actually overdo things by crowding or leaning over a sea lion, since the sea lion may panic and lash out in "self-defense."

Sea lions, especially males and females with pups, select a site that they will defend aggressively, usually against individuals of the same approximate age and sex. In captive sea lions this site-specific aggression, or territorial behavior, often manifests as barring a doorway or an entrance to a pool from other sea lions or the trainer (Schusterman & Dawson, 1968). Even a subadult sea lion weighing 50 kg or less can be nearly impossible to dislodge from a site, almost as if it had glued itself to the spot. Usually one can dislodge or aggressive territorial sea lion only by approaching from behind (which often requires two people and enough space for the escaping sea lion) or by behaving like a social dominant, approaching without hesitation, making a lot of noise, and perhaps expanding one's profile by carrying a large piece of cloth or plywood. During drives of fur seals on the Pribilof Islands, rapidly opened umbrellas are used to move recalcitrant or straying individuals.

We know of one especially clear example of the value of knowing species differences in behavior. Trainers familiar with California sea lions know that part of their aggressive, territorial display behavior is a rapid lateral shaking of the head, like a person emphatically indicating a "no, no, no" response. Working with the much larger and less familiar Steller sea lion (*Eumatopias jubatus*), trainers were gratified to see this sea lion emphatically nodding its head and reinforced the behavior with food, thinking it might be useful in a show or as a step to some other behavior. In fact, the nodding of the Steller sea lion was the aggressive equivalent of the lateral head shaking of the California sea lion. Trainers were, in fact, positively reinforcing aggressive signals directed at them (S. Allen, personal communication).

Pinnipeds as a group tend to show great dimorphism in size, form, and behavior between the sexes. Despite the fact that male sea lions are much larger and more aggressive than females, both sexes are common in captivity and one can find trainers with preferences for working with either sex. In our experience, mature males, despite their large size and aggressive posturing and signaling, are easier to control because their social communicative behaviors tend to contain more ritualized, stereotyped behaviors. Not only are their intentions easy to read, but they respond very consistently to the trainer's use of the same signals (or an approximation). Given the behavioral ecology of polygynous pinnipeds, this is not surprising. Mistakes in interpreting social aggressive signals from other males or

in the social aggressive signals a male gives can have serious effects on survival and reproductive success.

Since female sea lions are smaller and less aggressive than males, many trainers find them less intimidating than males (and cheaper to feed). However, we have found females to be more dangerous because (1) they do not provide obvious signals of aggressive intent to the same degree as males, and (2) they are less likely to inhibit direct physical aggression, like biting, because the typical social consequences of such actions are not as severe for females as males. A female sea lion that bites a male inflicts relatively little damage compared with a male rival. Furthermore, females can use submissive social behaviors to inhibit male retaliation. Contests between females are between individuals of approximately equal size (relative to the males) who also lack some of the specialized armament (large canines, heavy jaw and neck muscles) found in males. On the rookeries, contests between females are less injurious than male contests but are also much more frequent and escalate rapidly. We hear of people being bitten by females much more often than by males. Bites from males are often not as severe as female bites, because males tend to inhibit biting against an "adversary" when the adversary is high ranking, or, perhaps more appropriately, when the sea lion is unsure of the retaliatory capability of the individual it bites.

### *Imprinting sea lions*

As techniques have improved over the years there have been more successful births of captive sea lions and, as a consequence, more successful attempts at hand rearing those pups that, for one reason or another, must be raised to weaning by bottle feeding by human "surrogate mothers." As reported earlier in this chapter, sea lion pups tend to form an exclusive social bond early in life with their primary human caretakers. Although it is unclear what effect this early social bond with a human has on subsequent social and sexual interactions with other sea lions, we have found that all hand-reared pups are later able to interact "normally" with other sea lions, mate, and give birth.

Nevertheless, all trainers and animal caretakers that we have spoken to about hand-reared sea lions report differences in the way these sea lions interact with people relative to sea lions born in the wild or raised in captivity by a female sea lion. This may also be true of harbor seals. For example, although captive, mature male harbor seals are highly vocal during the breeding season, they do not appear to incorporate human spoken words spontaneously into their repertoire. The mimicry of human speech by Hoover when he was mature may have been related to his early social ties with humans (Ralls et al., 1985).

Our direct experience comes from our interactions with Rio, now almost 6 years old, who we hand-reared as part of our imprinting study (see the preceding section) and have since incorporated into our experimental studies of complex learning and cognition. In practical terms this means that Rio has had extensive and continuous experience interacting with sea lions and a large number of people. Although Rio is more attentive to, and more interactive with, trainers than are sea lions reared by their biological mothers she has also been more difficult to handle. Her interactants are currently limited to a small number of persons with extensive field and/or captive experience of sea lion behavior. In all other circumstances, save one, she has been trained to "keep her distance."

The one exception is during play in the water. We regularly join Rio in her pool for play and social interaction, and she interacts nonaggressively even with complete strangers. Her play may get a little rough at times (inhibited biting or mouthing of hands and feet, clinging to swimmers), but she interacts without the aggressive vocalizations and open-mouth displays we see on land. The same social effect is observed in populations of wild sea lions. Groups of sea lions float together in close proximity, and the primary interactions are relaxed play nipping and chasing, nose-to-nose olfactory inspection, and gentle physical contact; there is little or no vocalization. The same group on land would be characterized by aggressive barking, pushing, biting, and jockeying for comfortable sleeping positions. The transition from land to water brings about a very rapid change in behavior from intense social competition to nonaggression and play. In some populations of California sea lions these groups, referred to as 'milling groups," become focal sites of sexual play (mock mounting, chasing) and copulation with territorial males (Health, 1985). In Steller sea lions these milling groups form at the edge of the rookery in the evening, and groups of about 3 to 10 females later split off and head to sea, apparently to feed (R. Gisiner, personal observations).

Out of the water, Rio has been harder to control and more aggressive than animals raised by their biological mothers. We attribute this difference to her social bond with humans, and not to any behavioral pathology brought about by the "abnormal" circumstances of her rearing. When frustrated by a difficult training task or made uncomfortable by the close proximity of a person or another sea lion, Rio is more likely to direct her aggression at a person than at other sea lions or inanimate objects. Under the same circumstances other sea lions might direct their aggression at another sea lion or an object near the person (a bucket, a training target, the edge of a door).

Another factor has added to Rio's tendency to engage humans in aggressive social interactions. When she has challenged or "attacked" some

individuals they have flinched, fled, cried out, or given off other submissive/subordinate signals. These types of interactions constitute the large majority of play and nonbreeding social interactions in juvenile and adult sea lions; two individuals posture or tussle, one breaks away, and the other immediately presses its advantage and chases the other. We noted earlier that sea lions in general are carnivores and have physically aggressive social interactions. Given these predispositions, it is perhaps not surprising that Rio has learned to take immediate advantage of these signs in her handlers to assert her social dominance over them. Rio, more than our other pinnipeds, tends to discriminate among individual humans and interacts with them differently. Once she has developed an ability to induce signs of fearfulness in a person, she tends to behave aggressively and dominantly and is therefore hard to control by normal food-reinforcement procedures. (In other words, social dominance sometimes outweighs food as a reinforcer.) From those individuals whom she has never successfully challenged, a word or a glance is usually sufficient to cut off aggressive vocalizations and posturing; from individuals that Rio has successfully displaced in the past, she requires prolonged and concerted efforts at control before she will "give in" to their commands. This can vary somewhat with her food motivation and the difficulty or aversiveness of the task she is being asked to perform.

Pups develop some social strategies while still under the "protection" of their mothers. It is possible, therefore, that offspring of dominant mothers take a more aggressive approach to social interactions than pups whose mothers could not protect them from the consequences of their early social interactions (in most of which they would be the smaller and therefore subordinate interactant). In Rio's case, her surrogate mothers were trainers with high social dominance who could and did protect her from the large sea lions. To some extent she is therefore a "spoiled brat," and she typically takes a very aggressive stance during her initial interactions with unfamiliar sea lions (and humans).

## Conclusion

We have found that a hand-reared sea lion is capable of forming a strong, durable bond with its human caretaker. Such bonding depends on many of the same variables controlling bonding between a sea lion pup and its biological mother. We believe that an imprinted or hand-reared sea lion is more attentive to the signals of humans and more likely to respond to a human as a social "equal" than a sea lion reared by its mother either in captivity or in the wild. It is also possible that rearing by humans, who are

usually at the top of the dominance "hierarchy," tends to make hand-reared pups more socially aggressive than most pups raised by females of moderate to low dominance rank. This makes it extremely important that the human interacting with the imprinted sea lion understand sea lion social behavior and know the significance of sometimes subtle social cues. Since the penalties for misreading social cues in sea lions include dangerous physical contact with a large animal and injurious biting, sea lions socialized to humans should be handled carefully by experienced professionals. Under these circumstances one can enjoy the close social bonds that sea lions, normally reserve for one another (nose-to-nose contact, lying or sitting in physical contact, and play) without being aggressively confronted by a physical, and therefore social, dominant.

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## References

Gisiner, R., & Schusterman, R. J. (1991). California sea lion pups play an active role in reunions with their mothers. *Animal Behaviour, 41*, 364–6.

Hanggi, E. B., & Schusterman, R. J. (1990). Kin recognition in captive California sea lions (*Zalophus californianus*). *Journal of Comparative Psychology, 104*, 368–72.

Heath, C. B. (1985). The effects of environment on the breeding system of the California sea lion (*Zalophus californianus*). Presented at the 6th Biennial Conference on the Biology of Marine Mammals, Vancouver.

Hogan, J. A., & Abel, E. L. (1971). Effects of social factors in response to unfamiliar environments in *Gallus gallus spadiceus*. *Animal Behaviour, 19*, 687–94.

Lorenz, K. A. (1981). *The Foundations of Ethology*. Springer, Verlag, New York.

McFarland, X. (1985). *Animal Behaviour*. Benjamin/Cummings, Menlo Park, CA.

Miller, D. J., Herder, M. J., & Scholl., J. P. (1983). *California Marine Mammal–Fishery Interaction Study*, 1979–1981. Southwest Fisheries Center, Administrative Report LJ-83-13C. National Marine Fisheries Service, La Jolla, CA.

Nolte, C. (1990). Bold, sexy sea lions delighting visitors. *San Francisco Chronicle*, Jan. 26.

Peterson, R. S., & Bartholomew, G. A. (1967). *The Natural History and Behavior of the California Sea Lion*. American Society of Mammalogists Special Publication No. 7, 1–9.

Rajecki, D. W., Lamb, M. E., & Obmascher, P. (1978). Toward a general theory of infantile attachment: A comparative review of aspects of the social bond. *Behavioral and Brain Sciences, 3,* 414–64.

Ralls, K., Fiorelli, X. & Gish, S. (1985). Vocalizations and vocal mimicry in captive harbor seals, *Phoca vitulina. Canadian Journal of Zoology, 63,* 1050–6.

Schusterman, R. J. (1981). Steller sea lion, *Eumetopias jubatus.* In *Handbook of Marine Mammals,* S. H. Ridgway & R. J. Harrison (Eds.). Academic Press, New York.

(1985). Imprinting in California sea lions. Presented at the 6th Biennial Conference on the Biology of Marine Mammals, Vancouver.

(1986). California sea lions imprint on human voices. Presented at the annual meeting of the International Marine Animals Trainers Association (IMATA), Vancouver,

Schusterman, R. J., & Dawson, R. G. (1968). Barking, dominance, and territoriality in male sea lions. *Science, 160,* 434–6.

Schusterman, R. J., & Gisiner, R. (1988). Artificial language comprehension in dolphins and sea lions: The essential cognitive skills. *Psychological Record, 38,* 311–48.

Schusterman, R. J., & Krieger, K. (1984). California sea lions are capable of semantic comprehension. *Psychological Record, 34,* 3–23.

(1986). Artificial language comprehension and size transposition by a California sea lion (*Zalophus californianus*). *Journal of Comparative Psychology, 100,* 348–55.

Trillmich, F. (1981). Mutual mother–pup recognition in Galagapos fur seals and sea lions: Cues used and functional significance. *Behaviour, 78,* 21–42.