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Filial Imprinting in a Steller Sea Lion (*Eumetopias jubatus*)

Brian L. Lynn,[1] Colleen Reichmuth,[1] Ronald J. Schusterman,[1] and Frances M. D. Gulland[2]

[1]*Long Marine Laboratory, 100 Shaffer Road, University of California, Santa Cruz, CA 95060, USA; E-mail: brian.l.lynn@gmail.com*
[2]*The Marine Mammal Center, 2000 Bunker Road, Sausalito, CA 95965, USA*

Abstract

The Marine Mammal Center hand reared a male Steller sea lion (*Eumetopias jubatus*) after it was found abandoned as a neonate in June 2006. Following release in April 2007, the animal repeatedly approached humans on the shore, necessitating long-term captive placement. To evaluate the extent of this preference for human contact, we conducted three behavioral assessments: (1) a stationary preference test, (2) a following test, and (3) a vocal playback test. This sea lion demonstrated an overall penchant for human interaction and a strong preference for the voice of one of his early caretakers. Filial imprinting, a developmental phenomenon extensively studied in birds but less so in mammals, is suggested as the cause of this aberrant social behavior. The long-term effects of imprinting in mammals, including impacts on reproductive success, remain poorly understood. This observation with a Steller sea lion is the first documented case of probable imprinting in this species.

Key Words: Steller sea lion, *Eumetopias jubatus*, imprinting, social recognition, development, pinniped

Introduction

Filial imprinting can be defined generally as a rapid learning process during early development that leads to a persistent preference by an individual for a defined group of social partners. Extensively studied in birds, imprinting remains poorly documented in mammals; however, group-living species, including sheep, goats, and sea lions, may be particularly sensitive to this bonding phenomenon (Klopfer et al., 1964; McFarland, 1985; Schusterman et al., 1992). Otariid pinnipeds (sea lions and fur seals) are especially interesting subjects for studies of attachment behavior because they breed in high-density rookeries, their pups have relatively long periods of maternal dependency, and mother-pup pairs are subject to lengthy separations within days of parturition when females resume foraging (Reidman, 1990). These breeding circumstances have resulted in rapid and accurate individual recognition between otariid mothers and their dependent offspring (Insley et al., 2003). Typically, before a female leaves to forage at sea for the first time after giving birth, her pup has already learned to recognize her call (e.g., Charrier et al., 2001). Otariid mother-pup pairs identify and locate each other on the rookery through the exchange of unique stereotyped vocalizations as well as with visual and olfactory cues at close range (Trillmich, 1981; Schusterman et al., 1992). Furthermore, mature females of at least one species, the northern fur seal (*Callorhinus ursinus*), have been shown to remember and preferentially respond to playbacks of the calls of their mothers even when tending offspring of their own (Insley, 2000).

The learning process that underlies imprinting relies on this capacity for individual recognition yet differs from other forms of learning in a few special ways (see Shettleworth, 1998). Imprinting occurs during a sensitive period which varies in duration from a few hours to a few days depending on the species. Once an individual has imprinted, the process is nearly impossible to reverse, even in the prolonged absence of reinforcement delivered through positive social interactions. Filial imprinting has been studied in captive settings in which California sea lion (*Zalophus californianus*) pups have been hand-raised by human caretakers. Schusterman and his colleagues (1992) evaluated 20 juvenile sea lions housed at three different public display facilities. Of these, seven individuals had been separated from their biological mothers within 4 d of birth. The study, which included voice playbacks, demonstrated both generalized human attachment behavior and specific bonding between sea lion pups and the individuals who had served as their original surrogate "mothers." These preferences of captive animals raised to weaning by human caretakers were similar to those of wild otariids raised in natural contexts, including the finding that these

preferences could be demonstrated by behavioral responses to voice cues alone.

Filial imprinting in sea lions undergoing rehabilitation for eventual release has not been studied as most pups strand following weaning as opposed to in the days immediately following parturition. In this brief report, we describe a probable case of interspecific filial imprinting in a Steller sea lion (*Eumetopias jubatus*), including the circumstances surrounding his rehabilitation and captive rearing, the outcome of his post-weaning release, and the findings of behavioral observations made in interactive contexts aimed at identifying the possible role of imprinting in the behavior of this individual.

Materials and Methods

A male neonate Steller sea lion identified as "Astro" (NOA0006398) was admitted 23 June 2006 to The Marine Mammal Center (TMMC) in Sausalito, California, within 24 h of birth following presumed maternal abandonment. The pup had a moist umbilicus, weighed 18.8 kg, and had not been observed with a mother. TMMC staff tube-fed the pup for 1 wk and bottlefed him by hand for an additional 2 wks. While staff encouraged the sea lion to nurse from a bottle during this time, they frequently touched and spoke to him. To reduce his attraction toward the caretakers at TMMC, Astro was shifted to a remote bottle attached to a fence once he suckled freely at 3 wks of age, and from this point, all direct human contact was prohibited except when Astro had to be restrained for medical procedures. For the duration of his rehabilitation, Astro was housed with similar-sized California sea lions and, for a few weeks, a juvenile female Steller sea lion.

Following 10 mo of rehabilitation, once weaned and free feeding on herring and live bait fish, Astro was released on 25 April 2007 at the mainland beach of Año Nuevo State Reserve, immediately across from the Año Nuevo Island rookery where he was born. He remained on the beach for the next 2 d, approaching human bystanders and sometimes associating with nearby northern elephant seals (*Mirounga angustirostris*). Following recapture and subsequent re-release in the Farallones Marine Sanctuary on 28 April 2007, Astro appeared days later approaching fishermen along the coast. Following a final release attempt in the Farallones on 9 May 2007, Astro traveled beneath the Golden Gate Bridge and restranded 2 d later on the athletic field of Marin Country Day School, likely attracted by the intense level of human activity. To the delight of parents, students, and national news outlets, he completed a lap of the school's annual jog-a-thon before being picked up for a third and final time by the Center. Despite attempts to minimize positive human contact during his rehabilitation, Astro showed persistent attachment behavior directed toward humans.

To determine whether this Steller sea lion was imprinted on people, we conducted a basic behavioral evaluation modeled after earlier captive studies with California sea lions (Schusterman et al., 1992). The evaluation consisted of three components: (1) a stationary preference test, (2) a following test, and (3) an acoustic playback test. Each test was recorded onto videotape for later scoring. The sea lion was 12 mo old at the time of testing, and he was fed prior to these observations to control for the confounding effects of food motivation. Our assessment involved four TMMC caretakers: two surrogate mothers who bottlefed Astro by hand during his first 3 wks in rehabilitation (identified as caretakers A and B) and two other individuals (identified as caretakers C and D) who provided general animal husbandry but who did not participate in bottlefeeding by hand. All tests were conducted in a 10 m × 10 m fenced enclosure with a small above-ground pool at its center.

Stationary Preference Test

The stationary preference test consisted of three trials lasting 4 min each during which two caretakers sat approximately 3 m apart along one side of the enclosure, allowing Astro to initiate contact while they remained unresponsive, only moving to exchange positions midway through the trial. On the first test, caretakers A and D were paired; on the second test, caretakers B and C were paired; and on the third test, both of the individuals who had served as surrogate mothers (caretakers A and B) were paired. Preference was measured as a function of percent of time spent in direct physical contact with a given caretaker.

Following Test

In the following test, the same four workers, one at a time, continuously walked around inside the enclosure for separate 2-min intervals. The order of presentation of the caretakers was D, A, B, then C. Responsivity was measured as the percentage of the time during which Astro maintained close physical proximity with each person. The criterion for close physical proximity was designated to be any location within 1 m of the moving person.

Acoustic Playback Test

For the final assessment, the voices of the four workers were presented in a series of acoustic playbacks. Prior to testing, the voices of the workers were recorded using a Neumann 82i condenser shotgun microphone with a Stewart Electronics BPS-1 power supply, which connected to a Sony TCD-D8 digital audiotape recorder with a

sampling rate of 44.1 kHz. The workers were instructed to vocalize for 30 s in a way that was imitative of their previous interactions with the subject. Three of the workers emulated sea lion maternal calls (caretakers A, B, and C), while one spoke as though communicating to other humans (caretaker D). Based on a subsequent study of aerial hearing in Steller sea lions, these calls would have been clearly audible to this individual (Mulsow & Reichmuth, in press).

The playback test was conducted late in the day while Astro was in a generally restive state. Two similar-sized California sea lions were present in the enclosure during testing. During the playback, an Advent AV 570 speaker was positioned adjacent to the fence surrounding the enclosure. The 30-s recordings of each of the four workers' vocalizations were presented from the speaker, with each recording separated by 60 s of silence. The 30 s immediately prior to the playback of each recording acted as a matched "control" period. This four-trial test was repeated four times over a period of 2 h, totaling 16 trials, with the presentation order of the playbacks assigned using a Latin Square design. Astro's responsivity was measured by the number of vocalizations emitted during each playback and corresponding control interval, and his movements and orientation toward the speaker were noted.

Results

Stationary Preference Test

During the stationary preference test, Astro exhibited strongly affiliative behavior toward all four of the caretakers, which consisted of rubbing, nuzzling, sniffing, gentle biting, and suckling on skin and clothing. He remained in physical contact with a caretaker for 81% of the total testing time and did not show a preference for any one individual. The percentage of time spent in direct contact for each pairing is as follows: caretaker A (42%) vs caretaker D (41%), caretaker B (45%) vs caretaker C (52%), and caretaker A (2%) vs caretaker B (61%). Astro usually stayed with the person he initially approached and would sometimes switch between people when they reversed positions and crossed paths. His strong preference for association with people in general did not abate with repeated exposure in the absence of food or attention.

Following Test

Although the caretakers were not in a fixed position in the following test, Astro still attempted to stay in close contact with them as they moved about the enclosure. He continuously oriented to the movements of all of the caretakers and frequently attempted to engage them by lunging over the side of the pool or throwing himself beneath their feet. The percentage of time spent following each caretaker, in the order of their presentation, was 50% for caretaker D, 67% for caretaker A, 58% for caretaker B, and 87% for caretaker C. His affiliative behavior toward each caretaker did not differ noticeably nor did it diminish over the testing intervals.

Acoustic Playback Test

Similar to a pup trying to locate its mother on a crowded beach, Astro oriented, approached, and vocalized toward the speaker during each of the four recordings presented in the initial playback set. However, only the recording of one of the original caretakers who bottlefed him by hand (caretaker A) reliably elicited a strong response in a paired call and response pattern. Over the remaining three testing series, Astro responded almost exclusively to the recorded vocalizations of caretaker A, regardless of presentation order. These responses were accompanied by conspicuous affiliative behaviors, including facial rubbing, sniffing, and suckling, which were similar to those exhibited in the stationary preference test. The numbers of calls emitted during each of the four testing series are summarized in Table 1.

Discussion

Similar to the imprinted California sea lions studied by Schusterman and his colleagues (1992), Astro showed a heightened and persistent interest

Table 1. Number of vocal responses to the recorded vocalizations of four caretakers during the testing and control periods of the acoustic playback test

		Caretaker A		Caretaker B		Caretaker C		Caretaker D	
Test #	Test order	Control	Test	Control	Test	Control	Test	Control	Test
1	B D A C	5	13	0	6	2	5	3	6
2	A C D B	0	11	0	0	0	0	0	1
3	D B C A	0	0	0	0	0	0	0	0
4	C A B D	0	6	0	0	0	0	0	2
Total		5	30	0	6	2	5	3	9

in humans during these assessments, which took place approximately 2 mo after weaning. His intensely affiliative responses, which occurred in the absence of food, were characterized by behaviors typically reserved for interaction with a maternal figure. These behaviors, including suckling, strong sniffing, facial rubbing, and vibrissal rubbing, were present throughout the assessments. During the stationary preference and following tests, these behaviors appeared to generalize to all caretakers. When the modality of interaction was restricted to auditory stimulation, Astro exhibited a strong vocal response to playback in a paired call and response pattern toward the vocalizations of one caretaker in particular, with whom he had the opportunity to form a bond in early development. He frequently positioned himself in front of the playback speaker and accompanied his vocalizations with suckling, sniffing, and vigorous facial rubbing against the fence. While this case study simply reports our observations of one individual made over the course of a single day, the intensity and specific nature of the responses of this Steller sea lion suggest that, during his early development, Astro likely imprinted upon one or more of his caretakers and consequently prefers humans as his social partners. As a result of his probable imprinting and repeated failed release attempts, Astro was deemed unsuitable for further release attempts by the National Marine Fisheries Service (NMFS) and placed into permanent captive care in August 2007.

Very young pinnipeds in rehabilitation settings are not only critical cases in terms of medical care, but additionally, and just as much so, in regards to behavioral development. Habituation to the sight, sound, and overall presence of humans is a constant concern for rehabilitation managers as is the unintentional formation of a positive reinforcement history through the direct and repeated pairing of human caretakers and food. While the behavior of this individual was not systematically compared to that of other sea lions, the veterinary and husbandry staff noted that the quality of attachment differed from that of sea lions that were merely habituated or positively conditioned to human presence (D. Wickham, pers. comm., 1 June 2007). While both of these forms of learning undoubtedly played a role in Astro's social development, it is not likely that they would result in the suckling behavior or prolonged vocal responses observed in this individual. Furthermore, Astro's behavior also differed from conspecifics raised in a similar environment but admitted at a slightly older age. Three other Steller sea lion pups, rehabilitated using similar methods at TMMC from 2 wks of age, were monitored by Lander & Gulland (2003), and their post-release diving behaviors were shown to be similar to those of free-ranging Steller sea lions, indicating successful rehabilitation and release. In contrast to Astro, these individuals were afforded the appropriate temporal conditions to bond with their mothers and form irreversible social preferences during a brief sensitive period prior to rehabilitation, in a process similar to the bonding and individual recognition described in other otariid species (Insley et al., 2003).

Sea lions and fur seals brought into captive rehabilitation settings before successfully bonding to their mothers will likely imprint onto the most salient stimulus in their environment, which in most cases is a human caretaker. As a result, their age and behavioral development must be primary considerations in determining how to manage their care. Their level of extreme sensitivity in early development appears to be quite different from that of phocids (true seals), which are notoriously resistant to attachment in rehabilitation settings. This difference could result from the brief period of maternal dependency in phocids, which is characterized by nearly continuous contact and does not necessitate a pup's recognition of its mother or her voice (Insley et al., 2003).

The long-term effects of interspecific filial imprinting in otariids remain poorly studied but may include both aggressive and affiliative species-typical behavior directed toward people (Schusterman et al., 1992). The few documented cases of imprinting in captive-reared individuals, including the case described here, provide a rare opportunity to observe the behavior of these animals from early development through sexual maturity, which may improve our understanding of the significance of this process in nature.

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