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Introduction

Animals in captivity have always brought up questions on whether this is ethically correct. Although many argue that sea mammals live longer and better lives in captivity, there is research that claims otherwise. The main sea mammals being talked about in this research are bottlenose dolphins. Although bottlenose dolphins display certain social behaviors in captivity, it is shown that bottlenose dolphins have better social behaviors in the wilderness compared to being kept in captivity. In the wildness, flipper rubbing between different age and sex of dolphins is usually seen between mother and calf affection or kinship between same sex dolphins. Whistling activity is demonstrated quite often for a long amount of time. Dolphins usually kept in aquariums can get aggressive by the lack of motherly and kinship affection received by flipper rubbing. Not only that, bottlenose dolphins' vocally whistle between each other less often, with or without staff present.

Methodology

Mai Sakai

Sakai et al. (2006) observed and recorded how often bottlenose dolphins would rub their flippers on other dolphins as well as the age group and sex the dolphins that interact would be in. The research was done to discover characteristics of flipper rubbing and the function for the contact. Researchers at Mikura Island in Japan took non-invasive methods to study by

video-recording the dolphins that would approach the researchers. No dolphins were fed or touched, and scuba tanks were not used. When a dolphin would approach, their sex was determined by examining the genital slit, and then classified into four age classes: adult, subadult, juvenile and neonate. If an adult female and a calf was seen together for more than 50% of observation, the pair were considered as mother-and-calf and the calf was categorized as a juvenile or neonate.

“Flipper-rubbing” was the behavior seen between two dolphins where one dolphin has contact with another dolphin with its pectoral fin (also known as flipper) and one or both dolphins actively move touching body parts back and forth. The ‘Rubber’ was considered as the dolphin whose flipper made contact while the ‘Rubbee’ was categorized as the dolphin whose body made contact with the flipper. An ‘episode’ was defined from the beginning to the end of flipper contact while a ‘bout’ was the continuation of rubbing after a certain time pause.

For the types of flipper behavior seen between the dolphins, two categories were made for ‘flipper-to-flipper rubbing’ (F-F rubbing) and ‘flipper-to-body rubbing’ (F-B rubbing). In F-F rubbing, both dolphins rubbed the ends/edge of their flippers back and forth. In F-B rubbing, the Rubber rubbed some part of the other dolphins body excluding the flipper. Approximately 561 episodes of flipper rubbing was analyzed, which included 108 multiple episode bouts and 200 single episode rubs. 26 episodes of F-F rubbing was video-recorded and 535 episodes of F-B rubbing was video-recorded, all of the episode in total were performed by 145 identified dolphins. The duration of F-F rubbing episodes range was from 2 to 5 seconds while F-B rubbing episode range was from 2 to 53 seconds. Each bout contained 2 to 6 rubbing episodes and F-F rubbing often occurred with F-B rubbing in the same bout. After an interruption, the roles of Rubber and Rubbee switched.

Nanami Tamaki

Tamaki et al. (2006) observed the association between flipper-rubbing and aggression, or the display of aggressive behavior, by recording interactions between three bottlenose dolphins kept in Suma Aqualife Park in Kobe, Japan. The three dolphins consist of one immature male dolphin named 'Smile', and two adult females named 'A1' and 'F1'. A1 and F1 were never seen nursing Smile after his mother died and there is no kinship between the three dolphins. The dolphins lived in an oval performance pool (20m major axis, 13m minor axis, 3.5m deep) and were displayed to the public by a transparent wall around the rim of the pool during business hours. The dolphins were observed for 3 to 6 days per month, in total for 23 days between May and October 2003 with the expectation of June. The dolphins were observed through an underwater window (1m x 1.5m, 0.95m from the water surface to the upper edge) as continuously as possible. Observations were made during 9:00am to 8:00pm and on days of performances, which occurred four times for 30 mins in the day, or during feeding times, observations were adjourned.

Aggressive behavior was categorized as chasing, biting, hitting, body-slammings, or head butting when the 'recipient' resisted or avoided the 'initiator' of the behavior by escaping or its body. This was to exclude playful behavior for the data. An aggressive event (or a bout) ended after more than 1 minute of no more aggressive behavior between the dolphins was seen. Flipper-rubbing was considered as the act of one dolphin moving its pectoral fin back and forth on the body of another dolphin. A rubbing event was considered over after the flipper was removed from the recipient's body and a longer than one minute pause was seen.

It was tested to see how long it would take after an aggressive event between 2 or more dolphins to have a flipper-rubbing session as a form of reconciliation. It was also noted if after an aggressive bout ended, instead of flipper-rubbing, another aggressive bout occurred.

Denise L. Herzing

Herzing (1996) discovered a community of Atlantic spotted dolphins and Bottlenose dolphins in the Bahamas inhabiting a shallow sandbank that were accessible for underwater observation. They were able to identify 155 individual Atlantic spotted dolphins as well as their gender by observation of their genital areas. The dolphins were categorized into age groups and observed over a 10 year period. The same was done for the 30 Bottlenose dolphins that Herzing was able to identify. The gender of the dolphins and approximate age range were also determined and studied for that same duration. Using underwater video cameras with audio channels flat to 22 kHz, underwater behavioral and sound data were collected with "direct Labcore 76 hydrophone (frequency to 20 kHz, -192 dB re 1 u Pa) into the underwater housing to assure simultaneous recordings of underwater behavior and vocalizations. Vocalizations were processed using a Spectral Innovations 32-bit floating point digital signal processor with a 125kHz 16 bit analog to digital card (maximum sample rate of 62.50 kHz) and stored on a Macintosh 11ci computer" (Herzing, 1996). Using Canary 1.1 acoustic measurement software, the measurements of the digitalized vocalizations were calculated. They were able to identify a vocalizing dolphin when there was an appearance of visible bubble emissions that were synchronized with a certain vocalization when the dolphin was either alone or proximate to the recording equipment. During this study, ad lib and focal sampling were utilized. General categories of behavior were made for associations of vocalizations. This included, (1) Foraging/Feeding: when the dolphins searched for or ingested prey, (2) Agnostic/Aggressive: when there was threatening or dominating behavior being exhibited towards another dolphin(s), (4) Sexual Play, (5) Courtship: dolphins would engage in activities which would lead up to mating or an attempt at mating, (6) Parental: mother and calf interaction such as nursing, (7) Alloparental: a supervising dolphin besides the mother would interact or tend to younger dolphin, (8) Disciplinary: dolphins would interact with and reprimand other dolphins. This would include punishment or reasserting order, (9) Distress/Excitement: dolphins would swim erratically and vocalize. These behavioral contexts are not to be a reference to a specific

behavioral unit of action such as an ethogram, which is very objective, but instead indicate behavioral setting, social situation or action.

Rachel Probert

Probert (2021) observed the correlation between vocal expression and arousal that show up in bottlenose dolphins. For this experiment to be carried out, a permit issued by the South African Department of Environmental Affairs (DEA) authorizes the dolphins to be kept in this facility under human supervision. As passive, non-invasive technology was utilized and there was no direct contact with the animals, no ethics clearance or permit was needed for the acoustic monitoring of these animals. The uShaka dolphinarium is composed of an 11 000 m³ network of enclosed and open-air pools with several interconnected pools of varied sizes. Ten bottlenose dolphins were living at the facility at the time of data collection in 2018: one female Indo-Pacific bottlenose dolphin (*T. aduncus*), one common bottlenose dolphin (*T. truncatus*), and six hybrids (four female and two male) of the two species. The subjects were grouped into three social groups and were held back by gates that prevented free movement between them but permitted partial visual and complete auditory contact. Throughout the length of the study, the dolphins used all seven pools, with the number and arrangement of pools in which social groups were housed changing throughout the day and at night. We observed morning activities at the dolphinarium, such as the arrival of husbandry personnel (hereinafter referred to as "staff") and food preparation at 05h00, as well as feeding and vitamin administration at 06h00, as potential anticipatory- or arousal-eliciting behaviors. Outside of the research period and starting after the morning feed, each animal received formal training for 50–60 minutes each day. All pools had enrichment equipment available between these training sessions, and trainers had lots of chances to interact with the animals informally. Since their office is located poolside, trainers might frequently be seen by the animals throughout the day. The last trainer departs between 17:00 and 18:00, while the final public presentation takes place between 15:00 and 15:30.

Data/Results

Mai Sakai

In Sakai et al. 's (2006) experiment, both dolphins being subadult males had the highest count of flipper-rubbing of 109, and the second highest count between adult female and juvenile (their calf) of 77. The rubber and rubbee were categorized between: adult male, subadult male, adult female, subadult female, juvenile, and neonate. With the Rubber and Rubbee being of the same sex and age class, the F-B rubbing count was; adult male 9, adult female 31, subadult female 32, juvenile and neonate 0. With the rubber as an adult male, the count of rubbing with: subadult male 4, adult female 6, subadult female 1, and juvenile and neonate 0. With the rubber as a subadult male, the count of rubbing with: adult female 10, subadult female 14, juvenile 1, and neonate and adult male 0. With the rubber as an adult female, the count of rubbing with: subadult female 3, neonate 25, and adult male, adult female, and subadult female 0. Between Juvenile/neonate and adult male, subadult male, adult female, subadult female, and neonate is 0.

	Adult male	Subadult male	Adult female	Subadult female	Juvenile	Neonate
Adult male (9)	<u>9</u>	4	6♦	1♦	0	0
Subadult male (46)	0	<u>109</u>	10♦	14♦	1	0
Adult female (36)	0	0	<u>31</u>	3	77*	25*
Subadult female (19)	0	0	0	<u>32</u>	0	0
Juvenile (26)	0	0	0	0	<u>0</u>	0

Neonate (9)	0	0	0	0	0	<u>0</u>
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Table 1: Difference in F-B rubbing partner with sex and age class with the top row being the rubbee and the first column being the rubber

*** all of adult female and calf pairs in F-B rubbing were between mother and her calf**

♦ F-B rubbing consists of bottlenose dolphins of the opposite sex

Underlined: dolphin pairs with same sex and age class

() parenthetic figures (in left column) are number of individuals that performed F-B rubbing

Nanami Tamaki

Tamaki et al.'s (2006) research shows that more aggression is seen between Smile (immature male) and F1 but not a lot of flipper-rubbing between the two. In diagram 1, the number of aggressive bouts between: Smile to F1 (146), F1 to Smile (97), Smile to A1 (69), A1 to Smile (72), A1 to F1 (15), and F1 and A1 (17) with a total of 416 aggressive bouts. The number of flipper-rubbing between: Smile to F1 (18), F1 to Smile (23), Smile to A1 (64), A1 to Smile (42), A1 to F1 (7), and F1 and A1 (5) with a total of 159 flipper-rubbing events. In table 2, the number of periods with flipper-rubbing and no intrusion with the third dolphin between: Smile – A1 (8), A1 – F1 (0), and F1 – Smile (11). The number of periods without flipper-rubbing and no intrusion with third dolphin between: Smile – A1 (30), A1 – F1 (17), and F1 – Smile (44).

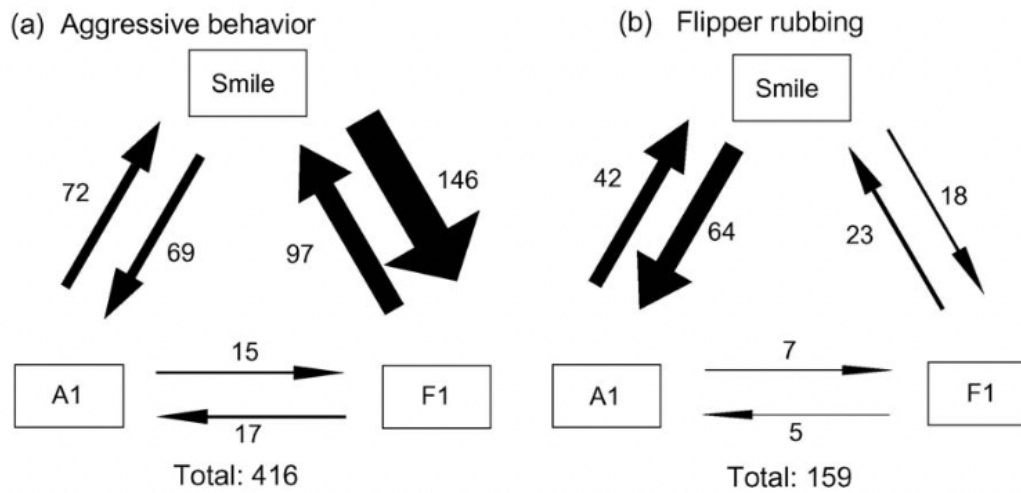


Diagram 1: Number and direction of (a) aggressive interactions and (b) rubbing behavior.

The width of the arrow expands as the number increases.

	With rubbing	No rubbing
Smile – A1	8	30
A1 – F1	0	17
F1 – Smile	11	44

Table 2: Number of periods with and without rubbing without intrusion of third dolphin

Denise L. Herzing

A variation of behavioral contexts were observed over a 10 year period and were displayed in Table 3. Table 4 summarizes the occurrence of specific vocalization types.

Table 3. Incidences of behavioral contexts observed

	Mother/calf Alloparental	Courtship	Discipline	Intraspecific Aggression	Interspecific Aggression	Sexual play	Intraspecific Foraging/ Feeding	Interspecific Foraging/ Feeding
1985	4	-	-	-	-	-	2	-

1986	3	-	-	-	2	-	5	-
1987	4	3	1	2	2	2	11	-
1988	4	4	2	-	2	1	4	-
1989	4	6	1	1	2	1	9	-
1990	8	2	1	-	1	2	11	-
1991	8	10	2	1	4	4	8	-
1992	12	6	1	5	5	1	4	2
1993	21	13	10	2	8	7	8	-
1994	13	18	14	4	6	7	3	1
Totals	81	62	32	15	32	25	65	3

Table 3: Note that intraspecific behavior refers to behaviors within the spotted dolphins species and interspecific refers to behaviors involving both spotted and bottlenose dolphins.

Table 4. Incidences of vocalization type observed

	Signature whistle	Excitement vocalization	Genital Buzz	Squawk	Synchronized squawk	Scream	Bark	Razor Buzz
1985	2	-	-	1	-	-	-	1
1986	1	-	1	1	-	-	-	1
1987	1	16	1	6	-	-	-	4
1988	-	4	-	3	-	-	-	1
1989	1	21	2	2	-	-	-	2
1990	20	21	4	6	-	-	-	3
1991	30	15	7	8	-	-	-	7
1992	26	13	17	2	1	4	2	6
1993	62	19	13	9	1	1	-	7
1994	34	12	5	8	-	2	2	9
Totals	177	121	50	46	2	7	4	41

Table 5. Vocalizations and associated underwater behavior

Vocalization Type	Spectral Description	Behavioral Context	Species, age, class and sex
Signature Whistle	<ul style="list-style-type: none"> ● Frequency modulated ● (FM) whistle ● 4–18 kHz ● 0.5–8 s ● Bubbles emitted from blowhole occasionally 	<ul style="list-style-type: none"> ● Mother/calf reunions ● Alloparental care ● Courtship 	<p>Spotted dolphins All age classes Female/male offspring</p> <p>Spotted dolphins Juvenile, young and old adults Females/Males</p> <p>Spotted dolphins Females/Males</p>
Excitement vocalization	<ul style="list-style-type: none"> ● Burst-pulsed vocalization with overlapping signature whistle ● 4–18 kHz ● 2–30 s duration ● Bubbles emitted from blowhole 	<ul style="list-style-type: none"> ● Distress/Excitement 	<p>Spotted dolphins All age classes Most frequently calves Females/Males</p>
Genital Buzz	<ul style="list-style-type: none"> ● High repetition-rate clicks ● 1.2 kHz–2.5 kHz ● 8–2000 clicks/s ● 6–20 s duration 	<ul style="list-style-type: none"> ● Courtship ● Discipline 	<p>Spotted dolphins Juvenile, young, and old adults Males</p> <p>Spotted dolphins and Bottlenose dolphins Adult, juveniles Females/males</p>
Squawk	<ul style="list-style-type: none"> ● Broad-band burst-pulsed vocalization ● 0.2–12 kHz ● 0.2–1.0 s duration ● 200–1200 clicks/s 	<ul style="list-style-type: none"> ● Agnostic/Aggressive ● Sexual Play 	<p>Spotted dolphins and Bottlenose dolphins All age classes Females/Males</p> <p>Spotted dolphins and Bottlenose dolphins</p>

			All age classes Females/males
Scream	<ul style="list-style-type: none"> • Overlapping FM whistles • 5.8–9.4 kHz • 2.5–4.0 s duration 	<ul style="list-style-type: none"> • Agnostic/Aggressive 	Spotted dolphins and Bottlenose dolphins Juvenile, young and old adults Males
Bark	<ul style="list-style-type: none"> • Burst-pulsed vocalization • 0.2–2.0 kHz • 0.5–1.0 s duration 	<ul style="list-style-type: none"> • Agnostic/Aggressive 	Spotted dolphins and Bottlenose dolphins Juvenile, young and old adults Males
Synchronized squawk	<ul style="list-style-type: none"> • Burst-pulsed vocalization • 0.1–15 kHz • Main energy 0.1–2.2 kHz • 0.9–1.0 s duration 	<ul style="list-style-type: none"> • Agnostic/Aggressive 	Spotted dolphins and Bottlenose dolphins Juvenile, young and old adults Males

Rachel Probert

Probert (2021) finds correlations between the duration of dolphin whistles and staff presence/absence. Signature whistle F2 is slightly lower when staff is absent resting at about 1.3s while during staff presence it is at 1.4s. M1 is significantly higher at during staff absence than lack of 1.8s rather than 1.5s. M2 rests at about 1.3s with staff absence and 1.2s with the staff. M3 rests at .8s without the staff and 0.6 with staff. P1 sits at 1.3s with no staff and .9 with staff. P2 rests at 1.0s with no staff and .6s with staff.

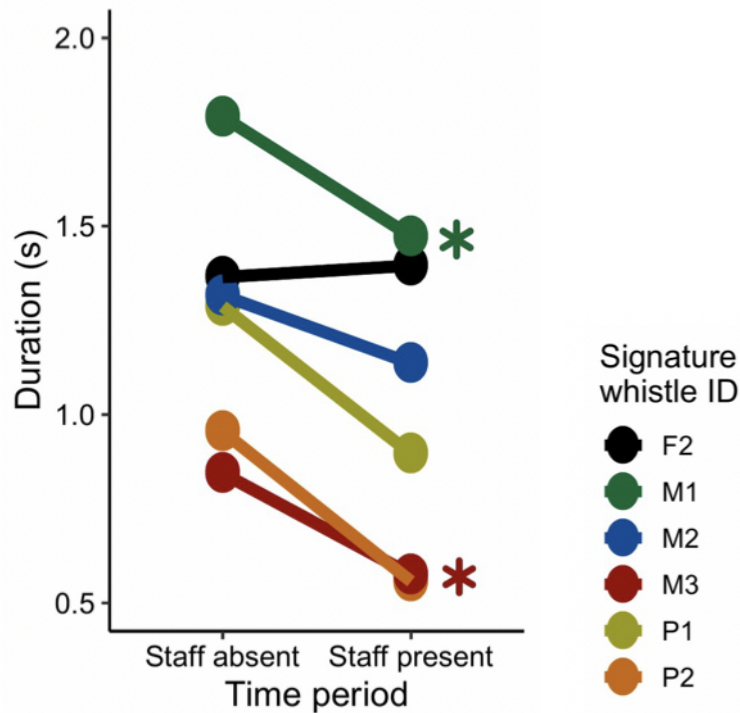


Diagram 2: Intervals of Dolphin Whistles in Correspondence to Staff presence vs. Staff absence

Discussion

Bottlenose dolphins are better kept in the wilderness because of the lack of aggression and increase in communication. In captivity, bottlenose dolphins tend to become more aggressive due to the lack of flipper rubbing affection. In addition, dolphins in captivity don't socialize as much as wild bottlenose dolphins. This may also as a result lead to the increase in aggression within dolphins as they begin to mature in captivity. There is also a correlation between captivity and the amount of time spent whistling.

Dolphins show better social behaviors in the wilderness as they are more friendly and have better companionship between each other. This is because of the excess flipper-rubbing affection that is received in the wild, however, due to the lack of flipper-rubbing as there are fewer dolphins in aquariums, it can lead to aggression as immature dolphins get older. Smile in Diagram 1a (Tamaki 2006) were recorded displaying aggressive behavior towards F1 dolphins

146 times, which was the highest number of aggressive behavior between all of the dolphins. Yet, Smile only had 18 flipper-rubbing incidents to make up for his aggression, which is not a lot compared to the amount of times he abused F1. Even though Smile has aggressive bouts towards A1 69 times, and A1 has aggressive bouts with Smile 72 times and they 'make it up' 64 to 42 times respectively, F1 has 97 bouts with Smile yet only makes it up 23 times. Not only that, as seen in Table 2, the number of times no flipper rubbing was seen between aggressive bouts are a lot higher compared to with rubbing. The number of aggressive bouts is very high, especially from the immature male (Smile) towards the other adult female dolphins. It demonstrates how in captivity, due to lack of motherly flipper-rubbing and other dolphins their age as they grew older, the dolphins do not understand how to express their emotions without being aggressive. On the other hand, a lot of flipper-rubbing was seen between the same sex and age groups of subadult, subadult female, and adult female, as well as adult female and juvenile dolphins with just 145 dolphins (Sakai 2006). However, bottlenose dolphins would synchronize barking to stop aggressive behavior seen by another dolphin as a way to stop the behavior (Herzing 1996), which is considered as an aggressive behavior to stop another aggressive behavior. The dolphins would work together to stop others that would act out in a manner that was not acceptable. Not only that, adult/subadult males would be show aggression to other male dolphins if they were seen giving their sexual partners flipper rubs as a way to drive them away (Sakai 2006). Even though there were aggressive bouts seen, most of them were seen as a way to keep social standing within the group. It can be interpreted that social behavior in the wilderness is better than the bottlenose dolphins in captivity/aquariums.

Bottlenose dolphins are better kept in the wild since captivity has a negative affect on their communication skills. Dolphins in general are very socially and emotionally complex creatures that use vocalizations to communicate with one another and display certain behaviors. In the wilderness, it was shown that whistling and vocalizations recorded were for a longer duration in time compared to those in captivity. The excitement vocalization was recorded with a

duration of 2-30 seconds, rarely ever surpassing 30 seconds because normally the focal dolphin would be calmed down by another (Herzing, 1996). In captivity, the duration of a whistle would vary from 0.5-2 seconds, regardless of if staff were present in the aquarium. However, according to diagram 2 by Probert (2021), when staff were in fact present, the interval of whistles was significantly lower. A lower interval of whistles can reflect how dolphins in their captive environment accompanied by the presence of humans can hinder their natural vocalizations. This can relate to Herzing's study where it is mentioned that the presence of human observers in the water would affect the behavior of the dolphins. The presence of humans would trigger distress behavior (Herzing, 1996). Further, dolphins would engage in choruses of barks during chases in captivity. Barks are associated with highly escalated agonistic/aggressive behavior (Herzing, 1996). Thus, indicating that human presence and captivity can trigger and contribute to negative behavior.

Limitations

For the research done by Tamaki et al. (2006), since the data was conducted between only three dolphins, the results do not stand for a general population of bottlenose dolphins, and a bigger scaled experiment must be done for a better understanding of whether flipper-rubbing is used as a way to mend a relationship between dolphins after an aggressive bout.

For the research conducted by Herzing (1996), since the dolphins were being accessed in the wild, it was proven difficult to associate vocalizations with their underwater behavior due to lack of access underwater. Additionally, there was lack of life history, sex and relationship information prior to studies.

For the research conducted by Probert (2021), there were only ten dolphins used in the experiment and there was no direct contact between the researchers and the subjects. There were no ethics or permits needed for this research to be conducted due to the lack of direct contact.

Conclusion:

Overall, bottlenose dolphins become more aggressive in captivity. Therefore their social behaviors and interactions are better when they are in the wild. Captive bottlenose dolphins become more aggressive while in captivity due to the inability to socialize with other dolphins causing them to grow up more hostile. Meanwhile in the wilderness dolphins are able to make more friends due to the amount of bottlenose dolphins near them. Bottlenose dolphins are also able to whistle in the wilderness while this decreases in captivity.

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