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An Examination of the Social Functions of Mouth Behaviors in Bottlenose Dolphins (*Tursiops truncatus*)

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An examination of the social functions of mouthing behaviors in bottlenose dolphins (*Tursiops truncatus*)

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Abstract

This project examines the social functions of mouthing behaviors in bottlenose dolphins (*Tursiops truncatus*). The Roatan Institute for Marine Sciences (RIMS) houses dolphins which are captive but in a natural habitat. The twenty-six dolphins are used in human interactions, but for the rest of their time they are allowed to roam naturally. These dolphins make it possible to examine natural social behavior in a captive setting. The following study examines video data of these dolphins obtained by Dr. Stan Kuczaj in 2009. Behavior of the dolphins in these videos was recorded, the primary focus being mouthing behaviors.

There are three commonly observed mouthing behaviors: open mouth, mouthing, and biting/raking. This project aims to examine how often and in what context mouthing behavior occurs, which has not previously been widely studied. This will be examined in three main questions:

1. How often does each type of mouthing behavior occur?

2. What sex and age of dolphins are doing the mouthing behavior?

3. In what contexts does the mouthing behavior occur?

I expect to find that open mouth is the most often mouthing behavior performed in a wide variety of social situations. Due to strong bonds between males and male-male dominance displays, I expect males to mouth males more often than females. I expect that juveniles will generally perform mouthing behaviors most often and to other juveniles. I expect mouthing behaviors will also be observed commonly in general contexts such as orient. Dolphins use social signals in a complex social life and I predict mouthing behaviors are an integral part of many social situations of bottlenose dolphins.

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Introduction

Mouthing behavior is an area of dolphin behavior which has not been previously well documented. Understanding the social functions of mouthing behavior will increase our understanding of the social lives of dolphins. Determining mouthing behavior patterns and contexts will help to specify the nature of social interactions between adult males, adult females, juveniles and adults to juveniles. The examination of mouthing behaviors as a social signal will help us interpret how the complex social lives of dolphins are managed by their interactions.

Social behavior

Bottlenose dolphins have complex social structure characterized by their interactions and associations (Smolker et al., 1992). Dominance and social hierarchy function to synchronize members of a dolphin colony (Gubbins et al., 1999). Male dolphins associate with one another most closely and their social behaviors often function as dominance displays or to strengthen bonds (Dudzinksi, 1999; Smolker et al., 1992). Females associate most closely with their calves, but same sex association in females is not as common as in males (Smolker et al., 1992). These associations make up the structure of dolphin societies (Tavolga, 1983).

Male bottlenose dolphins form groups of alliances that are generally groups of two or three (Smolker et al., 1992). They engage in aggressive and sexual behavior with each other often to establish bonds or to court females (Dudzinksi, 1999). Male groups are closely associated with other male groups rather than with females (Smolker et al., 1992). On the other hand, females associate closely with their calves up until the calves are two to four years old (Smolker et al., 1992). The first year of life of a calf has been

observed to be critical for development and it often stays directly near its mother (Gubbins et al., 1999). Association patterns in dolphins are an indication of future social interactions and behaviors (Smolker et al., 1992).

Sexual Behavior

Studies have suggested that sexual behavior prevails in the majority of interactions among dolphins (Ostman, 1991). Dolphin sexual behavior begins as early as six weeks of age (Ostman, 1991). Dolphins copulate year round and with a variety of partners of the opposite or same sex (Ostman, 1991). Due to the promiscuous nature of dolphin sexual behavior, it is suggested that these interactions have more than one function (Ostman, 1991).

Many researchers have observed violent behavior during sexual interactions (Lilly, 1963). During courtship, the dolphins will exchange bites and scratches across their entire bodies (Lilly, 1963). Observation of wild dolphins has supported reports that these interactions are used aggressively among heterosexual and homosexual pairs (Ostman, 1991). Male-male sexual behavior is consistently associated with aggressive behavior (Ostman, 1991). It is commonly supported that sexual interactions between males are used as displays of dominance and in strengthening relations or hierarchy (Ostman, 1991).

Aggressive behavior

Aggression in bottlenose dolphins is prevalent and includes a variety of behaviors including chasing, head jerks, biting, jawing and charging (Scott et al., 2007). Male to male aggression is directly proportional to their dominance relationship (Ostman, 1991). The more dominant male in a subgroup will exhibit higher levels of aggression and attack

other males more frequently (Ostman, 1991). Females also receive aggression from juveniles and adult males in order to establish or preserve consortships (Scott et al., 2007). However, accounts of female-female aggression are very low (Scott et al., 2007). The majority of female aggression is directed towards their calves or in protecting their calves, but these instances are generally few (Scott et al., 2007).

Play behavior

Studies show that an important step in early development is the behavior of play (Bekoff, 2001). There is a "socialization period" in which social skills are readily learned (Bekoff, 2001). Play behavior is common among juvenile dolphins for physical and social development (Bekoff, 2001). It is also suggested that play may teach young dolphins how to prepare for unexpected situations in the future (Bekoff, 2001). During play, juveniles perform behaviors used in other contexts like predatory or courting behavior (Bekoff, 2001). They must develop signals that allow them to discriminate when an action is play or when it is genuine (Bekoff and Allen, 1998). There may be subtle differences found in actions when they are playful from when they are genuine (Bekoff and Allen, 1998). Play experience may help juveniles learn about how to interpret others' intentions (Bekoff and Allen, 1998). When actions during play differ slightly from other contexts, it allows the young to establish boundaries of how rough to act together and how to settle conflicts (Bekoff, 2001). Play allows juveniles to learn species-specific behaviors in an environment that is safe (Bekoff, 2001).

Communication

Communication is essential in any complex social system for the exchange of information (Paulos et al., 2008). Cetacean social signals directly correlate to

communication displays (Pryor, 1986). Communication displays indicate the internal emotions and intentions of the communicator (Pryor, 1986). Communication displays are most common in courting, aggression, greeting, distress and some other common behaviors (Pryor, 1986). Pryor argues that "every overt or perceivable behavior that a social mammal engages in may be said to be communicative, in the sense that the behavior can convey information to conspecifics (1986)". Communication comprises exchange of information using specific signals that assist in common goals (Dudzinksi, 1999). The challenge of a scientist is to decode these signals (Marler, 1961).

Understanding social behavior of animals rests on the ability to decode how communication displays manage interactions and associations among a group (Dudzinksi, 1999). Much like human communication, cetaceans use signals in more than one context and can combine symbols (Dudzinksi, 1999). A dolphin may use one brief signal to communicate information, or use many signals together to emphasize a message such as using jaw claps, threats and whistles to reinforce aggression (Dudzinksi, 1999). The common problem is to understand the content of these signals and how they are interpreted among dolphins (Marler, 1961). One way to do this is using syntax, by observing the context of a signal and interpreting the response of the receiver (Marler, 1961).

Due to water disturbance and high noise of the environment, dolphins are adapted to communicate in multiple ways (Marler, 1961). Dolphins may use visual systems to communicate through eye contact while swimming or leaping (Marler, 1961). Dolphins may use their bodies to communicate through gestures, postures and movement (Pryor, 1986). Dolphins also have high tactile sensory receptors and communicate through

contact behaviors (Pryor, 1990). When vision and auditory senses are limited, tactile behaviors help input information to coordinate and maintain social structure (Pryor, 1990).

In bottlenose dolphins, tactile behaviors most often involve the mouth (Tavolga, 1983). Development of mouthing behavior most likely begins when dolphins are calves, learning to suckle (Tavolga, 1983). From this early stage, mouthing behavior develops into jawing, biting, tooth raking and open jaw threats (Pryor, 1990; Tavolga, 1983). Contact behaviors are most common among females and their calves, juvenile groups, and males courting (Pryor, 1990). Research indicates that tactile behaviors are used to enforce social bonds or defend young and in aggressive or sexual behavior (Paulos et al., 2008). Contact may also be used when dolphins join and depart as a type of greeting, or when swimming together (Paulos et al., 2008).

Some of the most extensive research on a mouthing behavior was on tooth raking (a behavior in which a dolphin drags one's teeth across another's body) to reveal which groups are receivers of most tactile aggression (Scott et al., 2005). In the study it was determined that the most raking occurred on cycling females, adult males, and juveniles (Scott et al., 2005). Scott et al. attributed this prevalence to sexual oppression of females and to male competition (Scott et al., 2005). High raking in juveniles was associated with their engagement in play behaviors and sexual practice (Scott et al., 2005). Juveniles are learning rules of interaction and social behavior, so they use tactile behavior more frequently (Dudzinski, 1999). Juveniles reaching sexual maturity are more likely to receive tactile behaviors due to new sexual behavior (Dudzinski, 1999).

The problem of interpreting communication signals, is interpreting its part in exchanging information. On interpreting mouthing behaviors, the most definitive research has been associated only with tooth raking which was assumed to be aggressive. Mouthing behaviors occur in a variety of other social situations. Mouthing behaviors also includes mouthing, biting and open mouth displays. This project will increase understanding of these behaviors and how these signals function in the social structure of the bottlenose dolphin.

Methods

The data has been collected from the 2009 video data recorded at the Roatan Institute for Marine Sciences (RIMS) at Anthony's Key Resort in Roatan, Honduras in 2009 (Figure 1.1).

Figure 1.1. A map of Roatan Institute for Marine Sciences and Anthony's Key Resort in Roatan, Honduras. The dolphin encounter labeled here is the RIMS enclosure housing the dolphins examined in this study.

In 2009 there were nineteen dolphins housed in the 300 m^2 enclosure at RIMS and three additional calves were born in the fall. The dolphins were videoed opportunistically with an underwater camera by Dr. Stan Kuczaj. In this project, a television was used to view the video so that the video could be paused in order to record data. The 2009 video recordings consisted of 10 total hours of footage.

The video was observed for mouthing behaviors and the data was recorded on detailed data sheets (Figure 1.2).

Date	Time Started	Initiator	Sex	Age	Receiver	Sex	Age	Behavior	Context	Body Part	Duration

Figure 1.2. This figure is an example of the data sheet utilized to record the dolphins' behaviors.

The three types of behaviors (Figure 1.3) - open mouth, mouthing, and biting - are defined as:

Open mouth display (OM) - dolphin opens mouth widely, usually in orientation to another dolphin or object

Mouthing (M) - dolphin has mouth around body part of another dolphin but is not biting down

Biting/Raking (B/R) - dolphin closes mouth with force around another dolphin, or rubs/slides its jaw along another with teeth

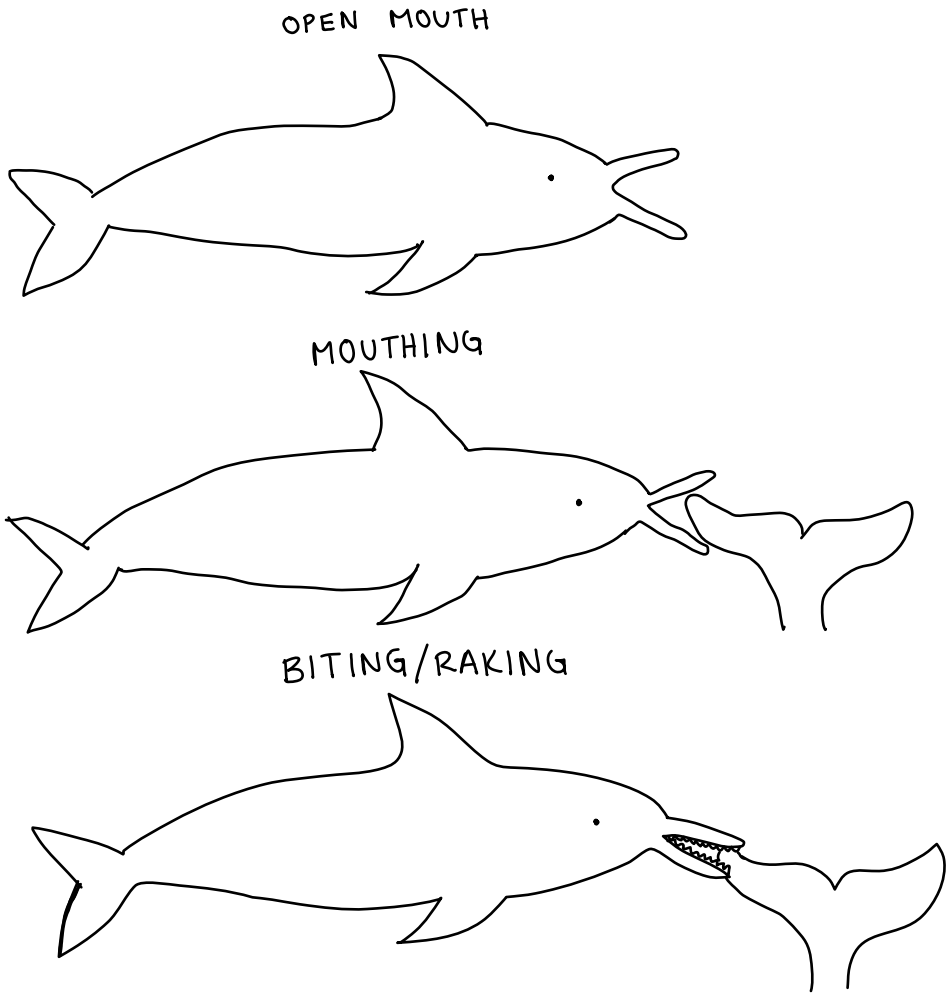


Figure 1.3. Depictions of the three mouthing behaviors observed in the experiment.

The dolphins can be identified by permanent markings that have been recorded for each individual. The dolphin's sex and age were determined by identifying the dolphins. The contexts were defined as follows:

Aggressive - display that includes abrupt vertical head movement, squawks, and/or chase

Herding - display that occurs in a pair swim when one displays directed ahead or slightly to the side the second dolphin is on

Orient - display to another that occurs when both are in the vicinity and one orients to another but it is not social, aggressive, or social-sexual in nature

Socio-sexual - display that occurs during attempted mounting or copulation

General - not directed at another, typically occurs when individual has been mounted

Specific - directed display at another

Social - display that includes side or ventral to surface body orientation and may include melon bumping and/or rubbing

Swim by - display directed at another as they pass by each other and neither dolphin stops or stays in vicinity

Unknown – Unknown action such as off screen, indescribable, or too far away (includes behaviors directed to the camera or other objects)

The time documented was a record of the time stamp given on the video recording. The duration was recorded as the seconds when the behavior starts to when it ends. The possible targeted body parts were rostrum, face, lateral side, dorsal fin, back, belly/ventral side, genitals, pectoral fin, peduncle, keel, fluke and unknown (does not

include camera or objects). If a behavior was directed towards the camera or object, a description of the object was recorded (e.g. camera, sea grass, flippers, etc.). This information was recorded over five months. After completing this initial data record, the data was then reviewed with a graduate student's help for accuracy and to acquire further dolphin identifications for an additional one month.

Results

During data recording interactions with the camera and other objects were included. Interactions with the camera and objects are important to consider as acts of curiosity towards the dolphins' surroundings and towards humans. However, due to the vague context association and the fact that the primary focus of this study is dolphin-dolphin interactions, behaviors to the camera and objects were not analyzed in the following results with the other behaviors. There were nine juveniles, nine adults and one calf at RIMS in 2009 when this video data was collected. Additionally three new calves were born in the fall, during which a quarter of the data was collected. There were nine males and ten females, and the three additional calves were all female. Therefore, the age and sexes were evenly matched except for the new calves. However, the new calves were listed as "unidentified" therefore these occurrences only impact the age and context data, not the sex data. Also, although there were three new calves in the fall, the original calf is male and made up 84% of the observed behaviors.

Firstly, I found that the open mouth behavior was exceedingly the most often performed, as displayed in Figure 2.1. This was the expected result and it was also found that open mouth is used in many different contexts as shown in Figure 2.2.

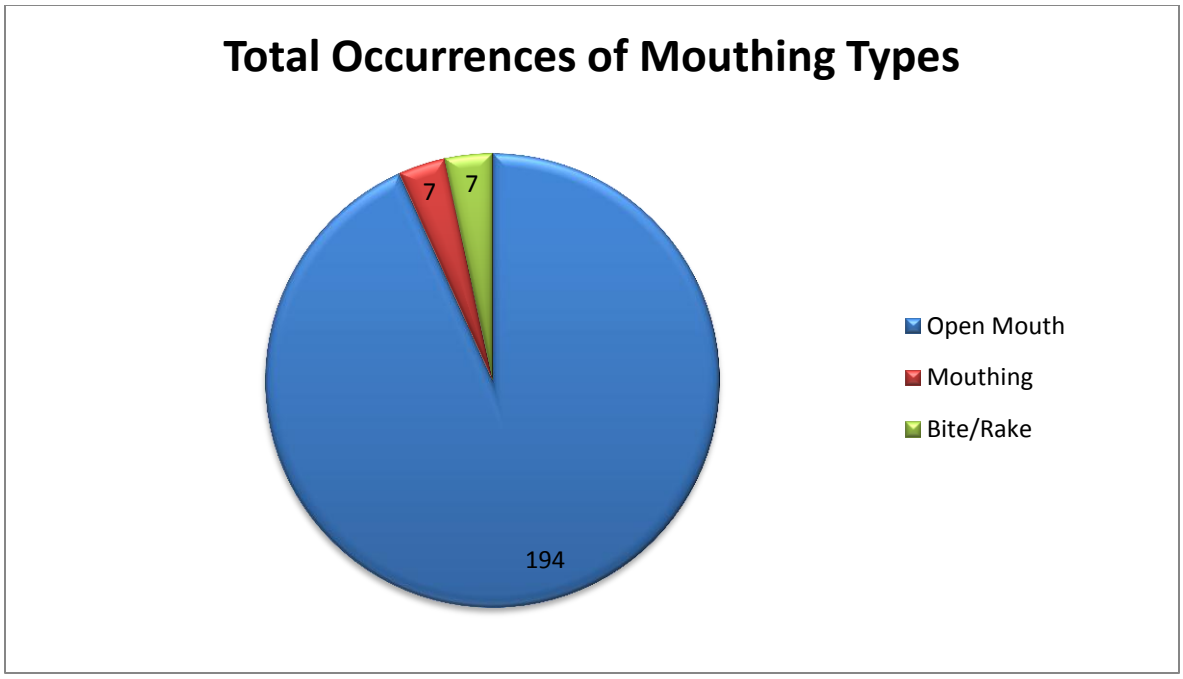


Figure 2.1. This graph is a breakdown of the number of mouthing behavior types in all contexts.

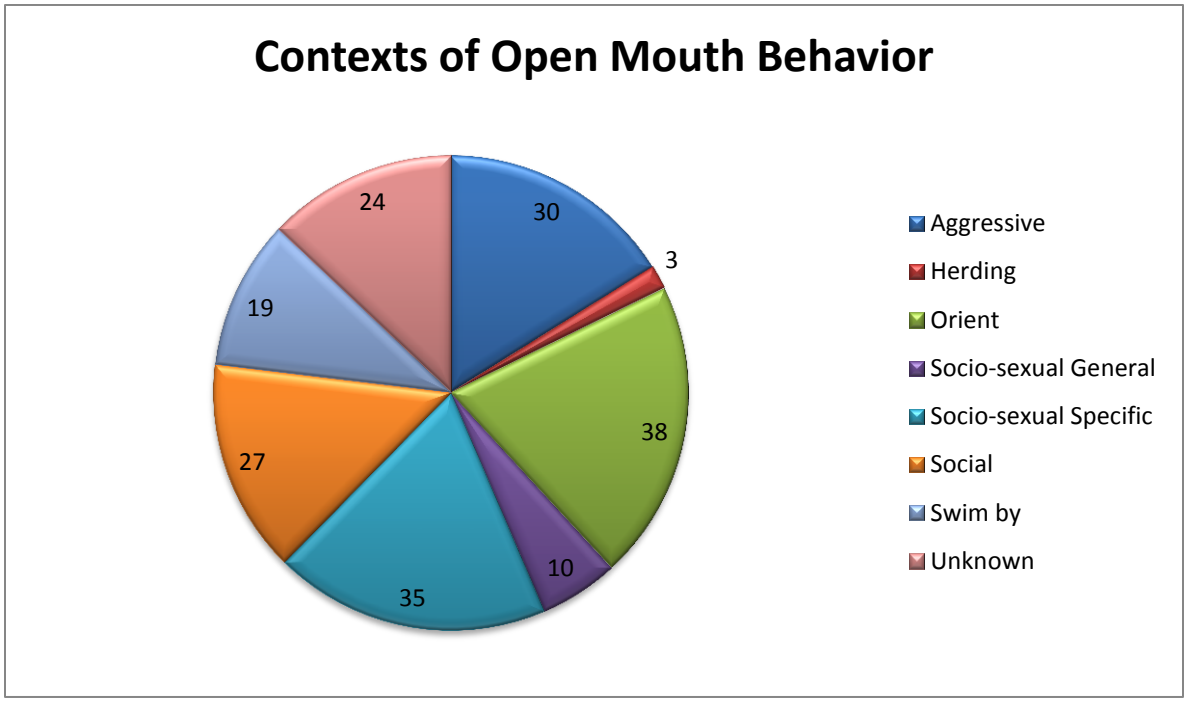
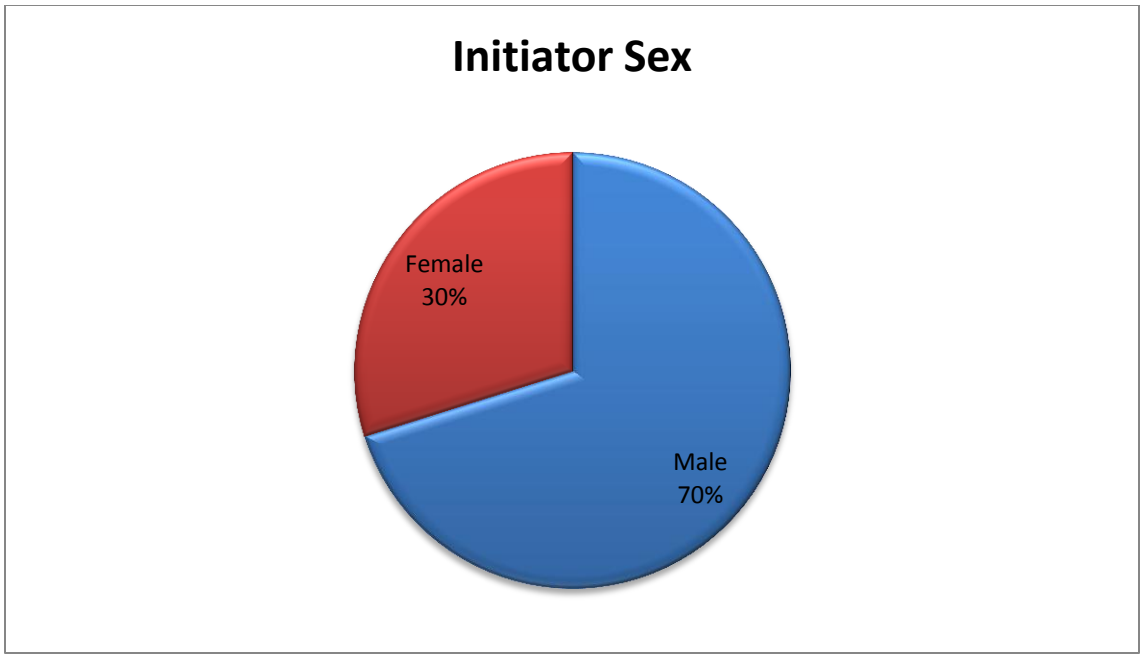


Figure 2.2. This graph depicts the number of times open mouth behavior was observed in each possible context.

Next, when comparing the sexes of initiators and receivers, I found that males were more often observed mouthing than females for all contexts. For this data, it is also important to account for the fact that not all dolphins could be identified during every occurrence of a behavior. Therefore, Figure 2.3 and 2.4 only include the dolphins which were identified.



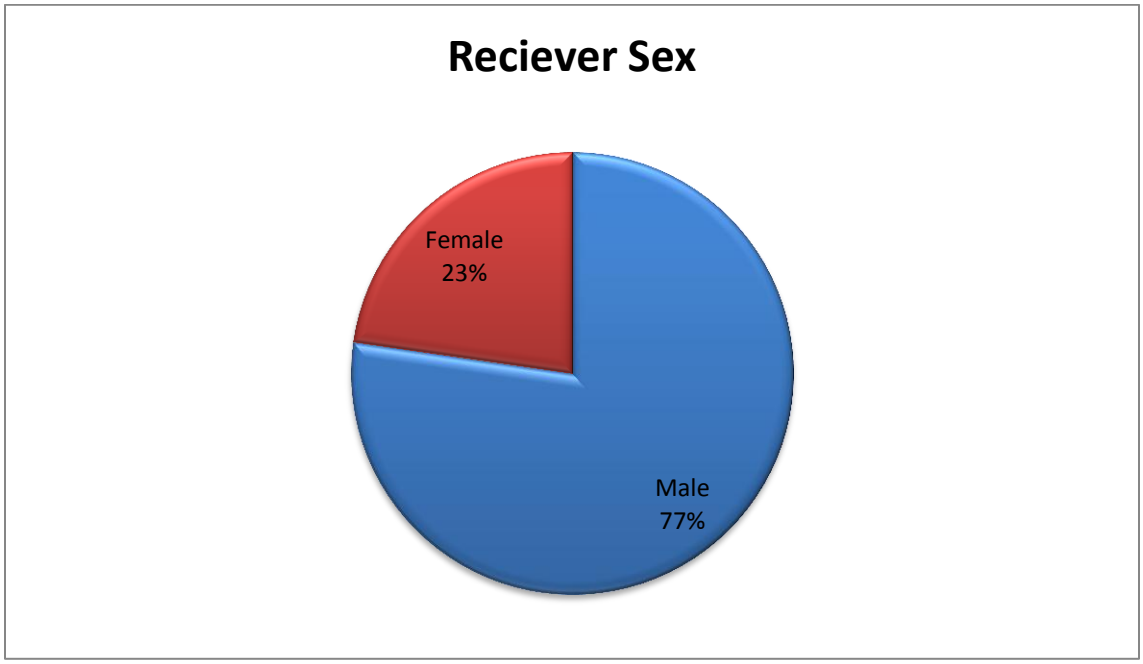


Figure 2.3 and 2.4. These two graphs provide a percentage comparison of total initiator and receiver sexes across all behaviors and contexts.

I also found it important to examine the targeted body parts in each behavior. I found that the lateral side, face and rostrum were the most targeted body parts and the keel was never targeted. This is depicted in Figure 2.5.

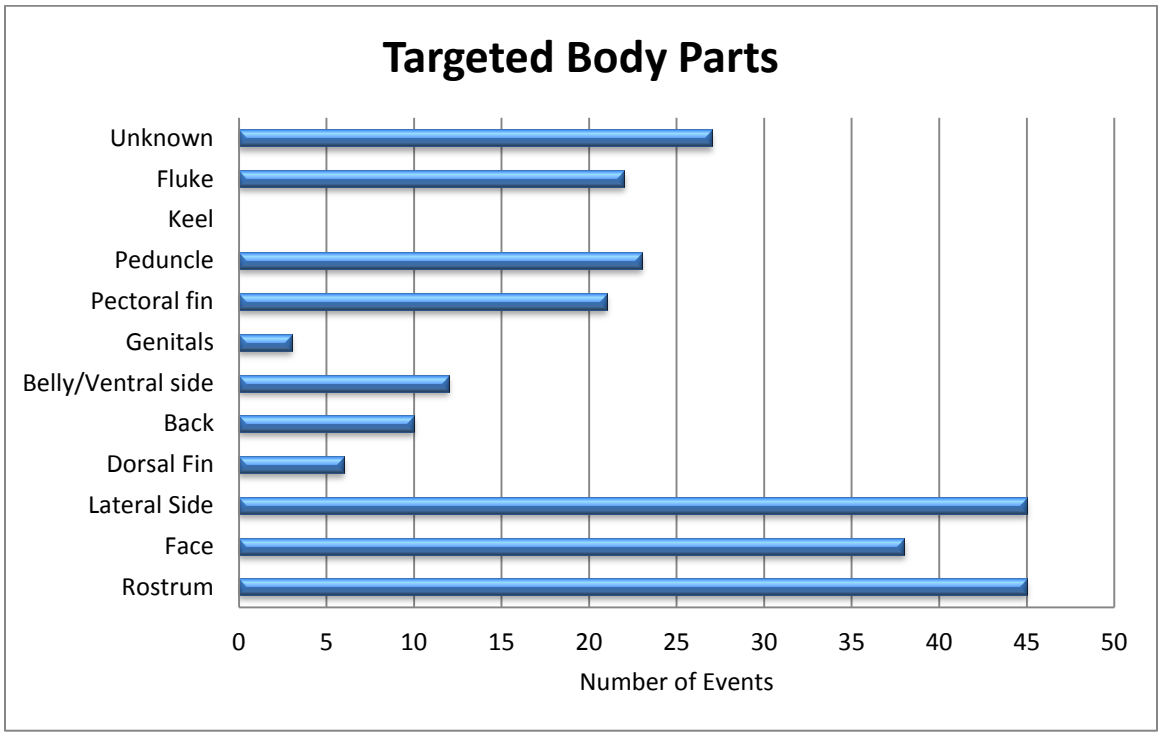


Figure 2.5. This graph depicts the targeted body parts across all contexts and mouthing types. **Note: In this graph "Unknown" indicates a body part that is off-screen, unidentifiable or too far away.

Finally, I analyzed the context occurrences of behaviors according to initiator and receiver ages. I found that juveniles initiated mouthing behaviors most often and in the most contexts. Adults and calves initiated the same amount of behaviors. This information is displayed in Figure 2.6.

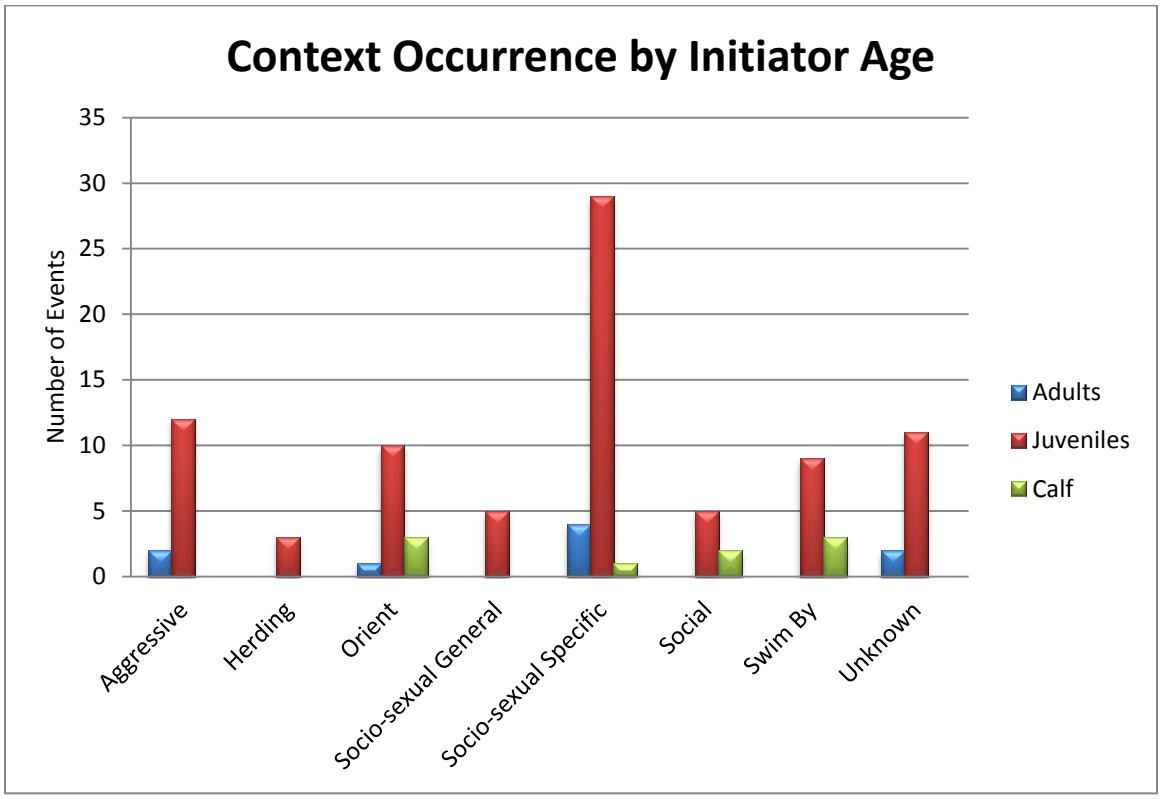


Figure 2.6. This is a graph of initiated mouthing behavior occurrences in all contexts broken down by initiator age.

I also found that juveniles received the most occurrences of mouthing and mostly in the aggressive context. Juveniles and calves received equal amount of occurrences of socio-sexual specific behavior. Adults received the least amount of behaviors and juveniles received the most. This information is displayed in Figure 2.7.

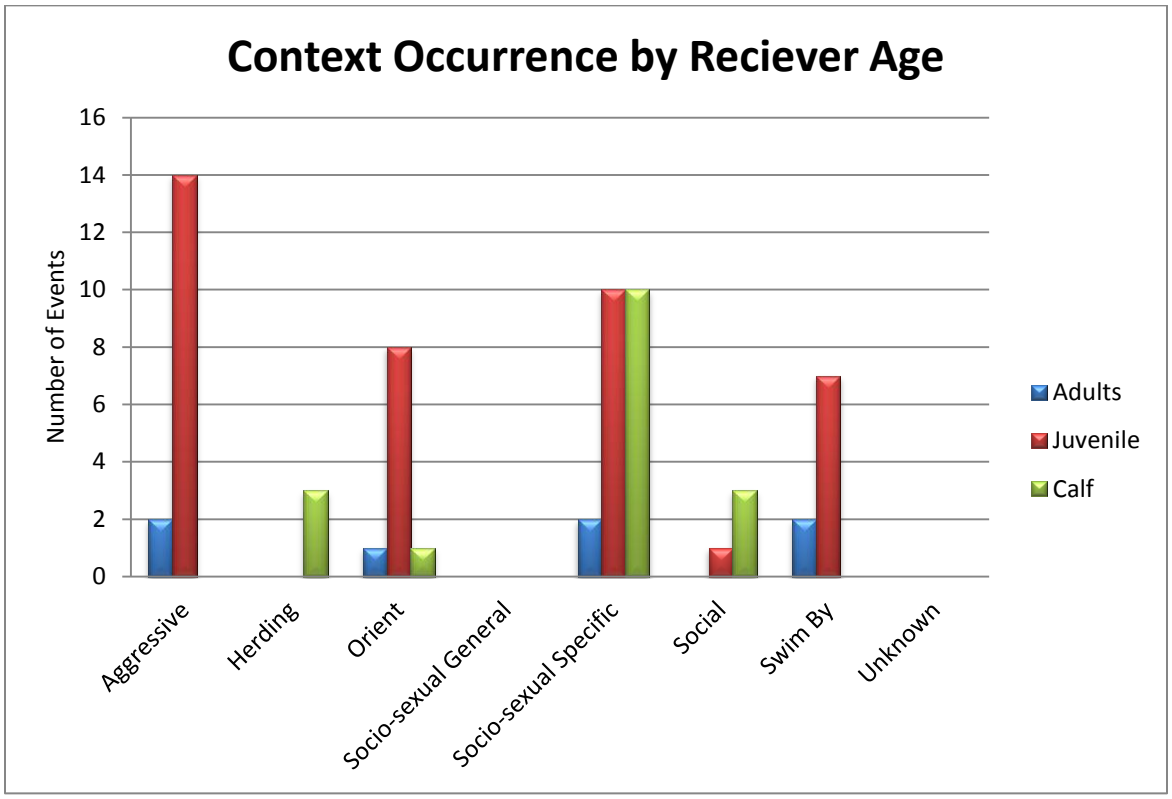


Figure 2.7. This is a graph of received mouthing behavior occurrences in all contexts broken down by receiver age.

Discussion and Conclusion

As originally stated, this projects aims to examine social functions of mouthing behaviors based on three main questions:

1. How often does each type of mouthing behavior occur?

2. What sex and age of dolphins are doing the mouthing behavior?

3. In what contexts does the mouthing behavior occur?

In my results I found that open mouth occurs the most often. This seems to be because open mouth behavior occurs in multiple contexts and appears to be a more versatile social signal. The open mouth behavior was observed mostly in the orient context. As observed in Smolker et al. bottlenose dolphins have complex social structure characterized by their interactions and associations (1992). This context is most likely a common behavior because the dolphins are maintaining their social structure and order. Socio-sexual specific behavior was also observed frequently. In this study, open mouth was the most common type of mouthing in the socio-sexual specific context, whereas in previous studies such as Ostman in 1991 biting and raking was seen most often. Ostman found males were most likely to mouth to each other in aggressive and sexual situations (1991). This study also observed that males were most likely to exchange mouthing behaviors. Additionally, open mouth behavior was observed in the aggressive and socio-sexual contexts most often behind orient.

The study of mouthing behavior previously has focused on male behavior and has shown evidence that juveniles are most often performing mouthing behaviors (Ostman, 1991; Scott et al., 2005; Smolker et al., 1992.). When the sex of dolphins initiating and receiving mouthing behaviors was analyzed in this project, it was found that males are

most often mouthing in both initiator and receiver roles. This was expected because males have complex dominance relationships that are often maintained through social signals and dominance displays (Dudzinksi, 1999; Smolker et al., 1992). Research also indicates that tactile behaviors are used to enforce social bonds and in aggressive or sexual behaviors (Paulos et al., 2008). Therefore, it is logical to observe males mouthing more often than females in a wide variety of contexts. It seems that males are generally using the mouth more as a tactile sensory signal than females in the social structure.

The targeted body parts were important to examine because they correlate with the mouthing behaviors that are most often observed. For example, orient was the most often observed open mouth context. This coincides with the fact that areas of the head including lateral side, face and rostrum were the most commonly targeted body parts. Also the fluke was commonly targeted which correlates with chasing during aggressive interactions which was the third most common open mouth context. Surprisingly however, genitals were the least commonly targeted (other than keel which was not targeted at all), despite socio-sexual specific context being the second most common open mouth context. This observation could be better analyzed in a study focused on sexual behavior and social signals.

The age of dolphins doing mouthing behaviors was unexpectedly varied. Juveniles were more likely to mouth in every context as initiators. However, adults and calves were initiating mouthing equally as often but adults were more likely to mouth in a sexual context and calves were more likely to mouth in a social context. This makes sense because adults are focused on reproduction and calves are learning how to socialize and are learning social structure (Bekoff, 2001). Juveniles are becoming sexually mature

and seem to be pushing the boundaries of the social structure. This is indicated by their likeliness to mouth in socio-sexual specific contexts and aggressive contexts. This correlates with sexual maturity and male dominance hierarchies.

Juveniles were also most likely to be the receiver of mouthing behaviors. The juveniles were mostly receivers of mouthing behavior in the aggressive context, most likely due to dominance relationships and courtship. Also, calves and juveniles were equally as often receivers of mouthing behaviors in the socio-sexual specific context. There were only half as many calves as juveniles, and only one calf for three fourths of the experiment time. This affects the results because although there were fewer calves, they were receiving the same amount of socio-sexual behaviors. These instances were most likely initiated by juveniles who are reaching sexual maturity and are likely to initiate mouthing in a socio-sexual specific context to all other ages. Also, the primary calf was a large male and was most likely more often receiving behaviors due to his size being closer to that of a juvenile.

Interpreting communication signals, specifically mouthing behaviors, is difficult in interpreting its part in exchanging information. Previously the most definitive research on mouthing behaviors has been associated only with tooth raking which was assumed to be aggressive. This study has shown that mouthing behaviors in fact occur in a variety of other social contexts. Mouthing behaviors also includes mouthing, biting and open mouth displays and in fact most often includes open mouth rather than biting or raking. This project increases the understanding of these behaviors by examining how often, by which sex and age groups and in what context different types of mouthing signals are used to communicate. From this study it is apparent that mouthing behavior plays a complex role

in the social communication of bottlenose dolphins. I think future studies focusing on juvenile interactions would be enlightening due to the high frequency of behaviors initiated and received by juveniles in this study. Also, studies focused on reproduction and socio-sexual contexts would be helpful in determining captive and wild dolphin behavior. As stated earlier, the genitalia were some of the least targeted body parts, despite high socio-sexual behavior. This phenomenon could be an area for future research. Furthermore, all of these research experiments would be helpful to one day examine in a wild environment. This experiment and future experiments add to the growing knowledge of these animals and their behavior. This information is important in assessing, caring for, and communicating with captive dolphins as well as comparisons and associations to wild dolphins. Further studies on mouthing behaviors and signals can assist us in understanding how these signals function in the intricate social life of the bottlenose dolphin.

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