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A Study of Object Play in Captive Bottlenose Dolphins (Tursiops truncatus)

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Honors College Thesis: A Study of Object Play in Captive Bottlenose Dolphins (*Tursiops truncatus*)

by

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STUDY OF OBJECT PLAY IN CAPTIVE DOLPHINS

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Abstract

Behaviors related to play are positively reinforcing as they promote the continued exhibition of play behaviors in a variety of animal species. Play in animals is thought to contribute to the development and practice of skills animals require across their lifespan (i.e., foraging, mating, etc.). In bottlenose dolphins (*Tursiops truncatus)*, several categories of play can be observed such as solitary play, social play, locomotor play, predatory play, and object play. The aim of the present study was to observe how variables of age-class, sex, object type, and play sociality influenced dolphin object play by utilizing video data from a semi-captive bottlenose dolphin population at the Roatan Institute for Marine Sciences. Results from this study were consistent with the hypothesis that juveniles would play the most of any age group. Females and males showed no significant difference in time spent playing with objects. The dolphins played with seaweed most often, and their play sociality included human-facilitated play more than social or solitary play. The results of this study show that further research needs to be done on dolphins in order to better understand their play habits. This research is important in areas of species conservation, wildlife management, and bringing awareness to the public of animals and their complex needs.

Keywords: Bottlenose dolphin, object play, *Tursiops truncatus*, variables of play

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Introduction

The influence of play on the behavioral and cognitive development of mammals is important because research suggests individuals that play are increasingly more likely to survive and reproduce (Bateson, 2014). Play is observed in the behavioral repertoire of many mammalian species as a fun and positively reinforcing behavior with no observed purpose, causing many researchers to become increasingly interested in its functions and implications. Recent research has demonstrated that play boosts flexibility and creativity, which in turn can lead to innovations in behavior (Ford, 1983; Kuczaj & Makecha, 2008). These innovative behaviors created through play allow for adaptation in other contexts (i.e., tool use, forming alliances; Lancy, 1980). Flexible variation in behavior can thus increase survival and reproduction rates in many species.

Many animal populations in the wild are declining, and understanding the various functions of a species' behavioral repertoire aids in preserving their habitats (Swaisgood, 2007). Research on play behaviors in nonhuman animals has provided important information and insight on the behavioral development of several species (Paulos, Trone, & Kuczaj, 2010). For example, research on captive cetaceans has led to many important regulations on facilities that house these animals in order to increase their wellbeing and longevity (Hill, Guarino, Dietrich, & St. Leger, 2016). Through understanding play patterns in various species, environmental enrichment and skill development can be used in order to keep captive animals psychologically and physically healthy (Kuczaj et al., 2002). The present study examines age-class, sex, and sociality of bottlenose dolphins (*Tursiops truncatus*) in relation to object play. The outcome of

this research can help researchers to better understand play as an indicator of welfare and wellbeing as it is related to the age and sex of individual dolphins.

What is Play?

While it has been difficult to form a working definition of play (Kuczaj, Lacinak, & Turner, 1998), researchers and observers usually recognize play behaviors fairly well (Kuczaj & Eskelinen, 2014). Play is not defined or described by specific actions because different species play in a variety of ways, and there is no obvious function to this type of behavior (Bekoff, 1984). Scott Eberle (2014) attempted to define play as a reinforcing positive process that an individual engages in while still developing muscles, skills, and affect. It has been speculated that play is reinforcing because it generates sensory stimulation (i.e., activating an animal's sense of touch, taste, olfactory, auditory, and visual; Wells, 2009), creating arousal for the animal in a non-stressful manner (Baldwin & Baldwin, 1978).

Early definitions of play suggested that it was a functionless behavior (Bekoff & Allen, 1998). More recent research asserts that this definition is inaccurate because it is possible that play serves several various functions across taxa (Breuggeman, 1978; Kuczaj & Horback 2013). Play can potentially help individuals develop social skills (i.e., alliance formation, mate acquisition; Bateson, 2014). Play also allows for the practice of behaviors such as hunting and predator avoidance without the potential for failure (Mackey, Makecha, & Kuczaj, 2014). Play can also work to enhance cognitive development though environmental and sensory stimulation (Kuczaj, Makecha, Trone, Paulos, & Ramos, 2006). These varying beneficial outcomes from play behavior suggest that the long-term effects of engaging in play behaviors may outweigh the immediate product of those behaviors (Kuczaj & Makecha, 2008).

Contexts for play are difficult to operationally define because they are reliant on the absence of many situational variables (i.e., fear, hunger, coercion, sustenance), but several researchers have described several common features that tend to be found in play (Lancy, 1980). Bateson (2014) stated there are five defining features of play: (1) it is spontaneous and reinforcing, (2) it is the antithesis of work, (3) it holds the potential for new actions and behaviors, (4) these novel actions are repeated by the individual and imitated by others, and (5) it occurs in the absence of stressful situations. A more simplistic but still multi-part description of play states that play usually involves one or more of these actions: (1) behavior modification, (2) imitation of a behavior, and (3) repetition of said behavior by a single individual (Kuczaj et al., 1998). Both of these descriptions have the common factors of modification, imitation, and repetition of the behavior, but they do not fully account for all of the possible behaviors that have been reported as play.

Play is very diverse and multifaceted, and it can be broken into several different categories: social play, solitary play, predatory play, locomotor play, and object play (Bekoff & Byers, 1998). Solitary play occurs when a single animal is engaging in play by itself, and it is important because it allows the animal to have control over its activity without outside influence, allowing for flexible thought (Greene, Mellilo-Sweeting, & Dudzinski, 2011). Human children that play with blocks or do puzzles by themselves are engaging in solitary play (Lloyd & Howe, 2003). A specific type of solitary play that occurs in a social context is parallel play (Kuczaj & Horback, 2013). Such instances occur when an animal is playing near other animals but does not directly interact with them, a phenomenon commonly seen in dolphins and children (Weaver & Kuczaj, 2016). While there is no interaction, this kind of play allows for the imitation of novel

play behaviors because the animal doing the observing can reproduce this behavior at a later time (Kuczaj & Horback, 2013).

Social play occurs when two or more animals interact with one another (Deakos, Branstetter, Mazzuca, Fertl, & Mobley, 2010). For example, wrestling, tackling, and chasing in Belding's ground squirrels (*Urocitellus beldingi*) is categorized as social play (Nunes, Weidenbach, Lafler, & Dever, 2015). Social play can allow young animals to prepare for social behaviors (i.e., mating, alliance formation) they may be involved in as adults (Mackey et al., 2014). For example, young male dolphins tend to engage in mating behaviors with other males, which has been hypothesized as a form of sexual play geared toward practice for future mating behaviors (Mann, 2006). An important aspect of social play is the behavioral signals that precede and occur throughout play bouts as a method of assuring other individuals that the displayed behavior is play and not mistaken for another dominating or threatening behavior (Bekoff & Allen, 1998). Black-handed spider monkeys (*Atelis geoffroyi*) shake their heads to initiate social play with conspecifics and to reaffirm play throughout the bout (Pellis & Pellis, 2011). In some species, dominant individuals will indicate they are not trying to assert their dominance by handicapping themselves during a play bout with a less dominant individual (Bateson, 2014; Kuczaj & Eskelinen, 2014). Canid species exhibit a similar handicap with the play bow, where the dominant individual will place itself at a lower and thus exposed position to the sub-dominant animal (Bekoff & Allen, 1998). Social play in young animals is vital to developing self-regulation and the ability to read affective states of other individuals (i.e., own social group, conspecifics in other social groups, and other species such as prey; Kuczaj & Horback, 2013).

When an animal engages in predatory activities without eating its target (i.e., stalking), the animal is considered to be engaging in predatory play (Greene et al., 2011). Predatory play

behaviors are thought to help animals develop or hone their hunting skills (Kuczaj & Horback, 2013). Domestic dogs (*Canis familiaris*) choose to play with objects they can tear apart, much like they would do with prey (Bradshaw, Pooley, & Rooney, 2015). When given a choice between arbitrary objects and those that look like mice, American kestrels (*Falco sparverius*) are more likely to choose to play with objects that most resemble their prey species (Negro, Bustamante, Milward, & Bird, 1996). Predatory play has also been reported in cats (*Felis catus*) that stalk and toy with their typical prey animals but do not kill them (Biben, 1979). Many of the stalking sessions cats engage in with their prey species end in chases (Caro, 1981), which also involves exorbitant movement.

Locomotor play is described as an excessive series of movements whose functions are relatively unknown (Walker & Byers, 1991). This sort of behavior is beneficial because it aids in the development of the muscles and cardiovascular system (Kuczaj & Horback, 2013). Locomotor play has occurred in mice (*Mus domesticus*) that repeatedly jump vertically for no obvious function or purpose (Walker & Byers, 1991). Locomotor play has also been reported in dairy cow (*Bos taurus*) calves that run, jump, and kick—seemingly out of exuberance (Luu, Johnsen, de Pasillé, & Rushen, 2013). Crab-eating foxes (*Cerdocyon thous*) and bush dogs (*Speothos venaticus*) toss around and chew on sticks and stones both alone and with conspecifics (Biben, 1982). This kind of play involves excessive movement but it also includes another form of play that involves objects.

Object play occurs when an animal approaches and manipulates an object in its environment (Greene et al., 2011). This type of play has been reported in a wide array of species including parrots (*Psittacus erithacus*; Auersperg et al., 2014), humpback whales (*Megaptera novaeangliae*; Owen, Dunlop, & Donnelly, 2012), and geckos (*Chondroactylus turneri*;

Barabanov, Gulimova, Berdiev, & Saveliev, 2015). Cichlid fish (*Tropheus duboisi*) housed in aquaria engage in object play by pushing thermometers in their habitat back and forth (Burghardt, Dinets, & Murphy, 2015). Nahallage and Huffman (2011) reported rhesus macaques (*Macaca mulatta*) manipulating stones in a variety of ways, such as cuddling, tossing, and mouthing the stones. Minks (*Neovison vison*) have been reported to repeatedly lift, carry, or manipulate objects such as balls, ropes, or nest boxes (Dallaire & Mason, 2016). Object play is considered to help in manipulative-cognitive development skills of animals (Kuczaj & Horback, 2013).

Each of the aforementioned types of play are not mutually exclusive, and overlap is commonly observed. When dogs run with or toss sticks and bones into they air while alone, they are engaging in solitary object play (Pal, 2010). Object and locomotor play overlap when beluga whales (*Delphinapterus leucas*, Jones & Kuczaj, 2014) and Orinoco dolphins (*Inia geoffrinensis*, Gewalt, 1989) create bubble rings while swimming upwards, float to the surface horizontally, and flip and pop the bubbles or allow them to pass by to the surface. Play can be observed and expressed in multiple differing combinations, marking it a diverse and intriguing behavioral type whose function and purpose warrants further study across all taxa.

Play in Dolphins

Dolphin play is diverse, occurring at all levels of development, in different social situations, and in varying environments and contexts (Kuczaj & Eskelinen, 2014; Mackey et al., 2014). Calves are highly social with their mothers in the first few months of their lives, engaging in play behaviors such as chasing each other and exchanging objects (Connor, Wells, Mann, & Read, 2000). Calves then appear to go through a period of engaging in mostly solitary play until the end of their first year (Mackey et al., 2014). These forms of solitary play include simple

object play (i.e., touching things with their fins or rostrums) and head stands (Hill, 2003; Kuczaj & Eskelinen, 2014). As the calves begin to wean, solitary play decreases as the frequency of observed social play increases (Mackey et al., 2014).

Juvenile and subadult dolphins tend to seek social and physical challenges by participating in play with an older peer or adult (Kuczaj & Eskelinen, 2014). In Shark Bay, Australia, a possible play interaction included juvenile dolphins imitating adult male dolphin herding behavior by switching their roles as the herder and one being herded (Connor et. al, 2000). As these young dolphins play around each other in social contexts, they learn ways to communicate whether they want to play or not by using specific play signals (Kuczaj & Horback, 2013). Kuczaj and Horback (2013) proposed that a dolphin floating horizontally in the water could also serve as a visual signal (i.e., presenting itself so that another dolphin may playfully push/interact with it). As dolphins age, they engage in less frequent, but more intricate forms of play (i.e., object play consisting of grabbing on to the object or tucking it under fins; Hill, 2003; Kuczaj & Eskelinen, 2014). This complex play is thought to enhance cognitive development of dolphins through increased environmental and sensory stimulation (Kuczaj et al., 2006).

Many adult dolphins engage in play with younger conspecifics, such as mothers who participate in reciprocal chasing with their calves (Mann & Smuts, 1999). Gewalt (1989) described adult Orinoco freshwater dolphins creating bubble rings and manipulating them. Adult bottlenose dolphins engage in more solo object play than other age-classes and types of play (Greene et al., 2011). Overall play decreases in the already developed adult dolphin, which supports the notion that play behaviors may aid in the developing body and mind of younger dolphins (Kuczaj & Eskelinen, 2014). Older dolphins tend to avoid novel stimuli (Kuczaj,

Winship, & Eskelinen, 2015; Lopes, Borger-Turner, Eskelinen, & Kuczaj, 2016) and habituate to familiar objects (i.e., decrease interaction due to repeated exposure; Kuczaj et al., 1998), causing less play to be observed in these cases (Delfour & Beyer, 2012). Differences are not only witnessed in age, but they are also expressed in the sex of dolphins as well.

The sex of dolphins can affect the contexts in which they play. Males typically engage in rough and tumble play and play fighting with each other; this kind of aggressive play behavior usually causes the males to have more scarring and rake marks than females (Marley, Cheney, & Thompson, 2013). Free-ranging males have been known to form alliances in order to fend off predators and acquire mates, and their social play may be meant to foster the cultivation of such alliances (Paulos et al., 2010). Males tend to focus more on ranging and forming alliances for obtaining females, while females focus more on maternal care and filling ecological niches in their habitat (Mann et al., 2008). Primates also follow this pattern, as seen when juvenile male chimpanzees (*Pan troglodytes)* used sticks in order to play-fight with one another, while juvenile female chimpanzees carried sticks around and patted them like they were infants (Kahlenberg & Wrangham, 2010). Greene et al. (2011) reported wild female dolphins engaged in more solitary object play than males. This sort of object play may have led to the interest in novel behaviors, causing other dolphins to mimic these new behaviors (Kuczaj et al., 2006).

Interest in the play of others can lead to innovations in culture through transmission (Kuczaj et al., 2006). Cultural transmission occurs when novel behaviors are adopted and imitated throughout a social group (Rendell & Whitehead, 2001). For example, humpback whales sing the same song, but that song will evolve and change throughout all the whales in that population during a breeding season (Payne & Payne, 1985). Beluga whales and humpback whales will follow their mothers during their first migration from their breeding to feeding

grounds, and they follow the same route throughout their lifespan (Katona & Beard, 1990). Female bottlenose dolphins in Shark Bay, Australia use sponges on their rostrums in order to forage for food (Smolker, Richards, Connor, Mann, & Berggren, 1997). However, the reported instances have all been limited to one matriarchal lineage of dolphins (Krützen et al., 2005).

Through stimulus enhancement, cultural transmission of behaviors is more readily adopted. Stimulus enhancement occurs when the observation of an action by one individual leads an observer to increase its proportion of behavior directed toward the location or object of the other individual's activity (Heyes, Ray, Mitchell, & Nokes, 2000). For example, a long-tailed macaque (*Macaca fascicularis*) was reported to use a tool, and other macaques became interested in objects that were similar to the tool being used (Zuberbühler, Gygax, Harley, & Kummer, 1996). Zuberbühler et al. (1996) also reported that many of the macaques that became interested in similar objects later became successful tool users themselves. Stimulus enhancement has been observed in dolphin object play, especially in calf-calf and calf-mother contexts (Kuczaj & Eskelinen, 2014). Through stimulus enhancement, different types of play (i.e., parallel, social) can occur when one dolphin watches another and becomes interested in what the other dolphin is interacting with.

Play in dolphins is very diverse, and can include both solitary and social forms of play. Kuczaj and Horback (2013) describe a form of solitary play where a calf was dropping a crab and picking it back up repeatedly. A humpback whale was reported to pass a net from her rostrum to her pectoral fin repeatedly (Deakos et al., 2010). A young captive rough-toothed dolphin (*Steno bredanensis*) was observed mimicking a variety of non-dolphin sounds he had heard (Kuczaj & Makecha, 2008). Social play in cetaceans is very common as well. Reciprocal chasing as a form of play is reported in orcas (Kuczaj et al., 1998) and several species of

dolphins (Mackey et al., 2014; Mann & Smuts, 1999; Paulos et al., 2010). Bottlenose dolphins and orcas (*Orcinus orca*) have also been reported to intentionally beach themselves, which is then followed by other conspecifics working together in order to nudge or push it back into the water (Guinet, 1990; Paulos et al., 2010). Bottlenose dolphins and rough-toothed dolphins have also been reported to engage in play fighting (Kuczaj & Eskelinen, 2014), which includes elements of roughness and is commonly regarded as "rough-and-tumble play" (Pellis & Pellis, 2007). Not only do cetaceans engage in social play with their conspecifics, but they also have been noted to engage in play behaviors with other species as well. One such report was of a dolphin repeatedly being lifted out of the water by a humpback whale and then sliding down the whale's rostrum back into the water (Deakos et al., 2010). Bottlenose dolphins have been reported to circle and engage in play herding with Cape fur seals (*Arctocephalus pusillus*; Tayler & Saayman, 1973). Similarly, short finned pilot whales (*Globicephala macrorhynchus*) have also been reported to surround and herd sperm whales (*Physeter macrocephalus*; Weller et al., 1996). The herded species are not prey for the pilot whales and bottlenose dolphins and were not alarmed by the herding actions, causing these interactions to be determined play.

Social play is also thought to be a contributing factor to a dolphin's ability to engage in cooperative behaviors (Kuczaj & Highfill, 2005). Cooperation occurs when two animals work together in order to achieve a common goal (Chalmeau & Gallo, 1996). Kuczaj, Winship, and Eskelinen (2015) presented to two dolphins a novel device that required cooperative behaviors (i.e., tugging on each side of the device alternatively or simultaneously) in order to open it. After the two dolphins successfully opened the device multiple times, they continued to open it together and would even be seen swimming and carrying the apparatus around the water together. While dolphins have socially manipulated objects in order to reach a goal, both object

and social play have also been recorded together, such as in the instance of dolphins rubbing rope together as a form of social play (Félix, 2015). Kuczaj and Highfill (2005) reported social and object play with dolphins where multiple individuals were swimming together while passing around a plastic trash bag. Dolphin object play occurs very often in overlap with the other types of play as well. For example, there have been several observed instances where cetaceans have used the movement of water to create bubble rings and swim through them, engaging in both locomotor and object play (McCowan, Marino, Vance, Walke, & Reiss, 2000; Pace, 2000). Yamamoto, Furuta, Taki, and Morisaka (2014) observed a dolphin repeatedly drop the object it possessed, then move quickly in order to create flowing water, causing the object to move through the water column in a novel manner.

Dolphins tend to incorporate objects into their play very often, and they will play with a wide array of objects depending on individual differences (Kuczaj & Eskelinen, 2014). Object play in dolphins occurs with many parts of the body, including the pectoral fins, rostrum, mouth, and dorsal fin (Paulos et al., 2010). Objects can be classified as naturally occurring or man-made. For example, naturally occurring objects include seagrass, shells, leaves, and sticks. Man-made objects are items humans produce and can include the fins of a diver, toys (i.e., balls, hoops, and ropes) placed in a habitat, or debris that is found in the water. Objects can also be classified as animate or inanimate. Animate objects are living and moving elements, such as sea cucumbers or sponges (Paulos et al., 2010). Bottlenose dolphins, orcas, and harbor porpoises (*Phocoena phocoena)* have also been observed chasing live fish and tossing them repeatedly without consuming them as prey (Defran & Pryor, 1980; Kuczaj et al., 1998; Tavolga, 1966). Inanimate objects are non-living or not moving, such as plants, leaves, seaweed, and debris in an environment (Greene et al., 2011). Dolphins may play with inanimate objects because their focus

is on their desire to manipulate these objects (Kuczaj & Horback, 2013), and they may play with animate objects because these objects are thought to pique their curiosity (Kuczaj & Eskelinen, 2014). Object play is an important component of developing and assessing environmental enrichment techniques. If animals are unable to be engaged in stimulating activities, they become bored, which is aversive to these animals (Kuczaj et al., 2002). Environmental enrichment is used in order to stimulate animals in ways that benefit them and improves their biological functioning (Newberry, 1995). Environmental enrichment calls for a mix of predictability and novelty in situations, such as introducing a variety of objects to create moderately discrepant events (Kuczaj et al., 1998, 2006).

Research has been conducted in order to observe the significance of object play in dolphins. Delfour and Beyer (2012) explored whether a dolphin's object choice is based on preference or a more arbitrary reason by introducing a variety of objects to the dolphins and assessing whether the frequency of object play with specific objects was statistically significant or not. The results indicated that there seems to be a form of intrinsic reinforcement that drives a dolphin's object choice, meaning that individual dolphins generally have individual preferences. Greene et al. (2011) compared object play in captive and wild dolphins. Both the captive and wild dolphins were documented and categorized by their object choice, age group, and sex. The researchers found non-significant correlations in their results, but they experienced difficulty defining the age and sex of many of the dolphins due to poor water visibility or objects blocking their view from the camera, which serves as a possible confounding factor for the study. It seemed, though, that males tended to have a higher frequency of mutual play than females. Adults tended to engage in more solo play than younger dolphins. Additionally, juveniles had a higher frequency of play than any other age group (Greene et al., 2011).

Present Study

Object play will be examined in a group of semi-captive dolphins at the Roatan Institute for Marine Sciences (RIMS) in Roatan, Honduras. In this study, the only humans present during data collection were researchers, and they will be incorporated into analyses as facilitators to object play. Age, sex, type of object, and whether play is social with dolphins, social with humans, or solitary will be documented and categorized. I hypothesize that there will be a higher frequency of object play in young dolphins, more specifically the juvenile group; and that there will also be a higher frequency of object play in females. It is also hypothesized that human-made objects will be sought out more than natural objects. In regards to sociality, I hypothesize that social play will be engaged in more often, allowing for a familiar environment with the potential for novel elements. The results from this study will allow us to better understand how to encourage play and development in dolphins of different age groups. The present study will further improve upon our understanding of object play by exploring whether object choice and play types differ among genders and ages of dolphins among varying levels of the development continuum.

Method

Facility and Subjects

Data collection took place at the Roatan Institute for Marine Sciences in Roatan, Honduras, based on the northwest side of Roatan Island. The dolphins are housed on the northern side of the island on Bailey's Key. Their enclosure is a sea pen that has a surface area of approximately 300 m^2 and a depth that ranges from the shoreline to roughly seven meters deep. The sea floor is made up of coral, sand, and sea-grass beds (Figure 1). The population at the time of data collection consisted of 30 dolphins (15 males and 15 females) and varying age-class (i.e., calves (dependent and nursing), juveniles (dependent and not nursing), subadults (independent but not sexually mature) and adults (sexually mature; Lopes et al., 2016).

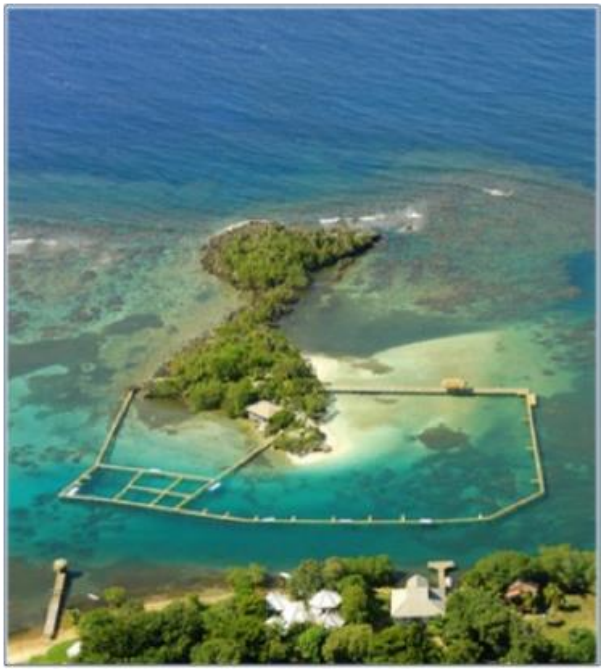

Figure 1. Aerial photograph of *Roatan Institute for Marine Sciences, Dolphin Enclosure, Roatan, Honduras.*

Table 1

List of RIMS Dolphins and Information.

Name	Sex	Age Class
C1	F	Calf
C2	M	Calf
C3	F	Calf
C4	M	Calf
C5	F	Calf
C6	F	Calf
C7	M	Calf
J1	M	Juvenile
J2	F	Juvenile
J3	M	Juvenile
J4	M	Juvenile
J5	F	Juvenile
S1	M	Sub-Adult
S2	F	Sub-Adult
S3	M	Sub-Adult
S4	M	Sub-Adult
S5	F	Sub-Adult
S6	M	Sub-Adult
A1	F	Adult
A2	M	Adult
A3	M	Adult
A4	F	Adult
A5	F	Adult
A6	F	Adult
A7	M	Adult
A8	F	Adult
A9	M	Adult
A10	F	Adult
A11	F	Adult
A12	M	Adult

Data Collection and Analysis

All data was collected at the Roatan Institute of Marine Sciences (RIMS) opportunistically throughout the year 2013. Dr. Stan Kuczaj and other members of the Marine Mammal Behavior and Cognition Laboratory collected underwater video and audio data using a Nauticam M16 with an Amphibico hydrophone adapter. Data were collected using focal follows, which started when an animal entered the line of vision of the camera and continued until it

exited the field of view (Dudzinski, Gregg, Paulos, & Kuczaj, 2010). These focal follows were considered focal-animal sampling, subgroup-follow, and all-event sampling (Altmann, 1974). Data was collected opportunistically from 5:30am-4pm during several excursions taken to the facility by Dr. Stan Kuczaj in 2013. Only data where all of the dolphins were housed in the main enclosure was used for analysis. During the course of study, dolphins were recorded participating in their normal daily activities, and any objects that occurred in the enclosure were those that passed through naturally.

47,889 seconds of video data from RIMS in 2013 were reviewed in order to record instances of object play in the dolphins. From this total amount of data, 2,351 seconds of object play were recorded and used for analysis. A total number of 183 object play interactions were recorded in all dolphins (see Table 2). The mean duration for these play bouts was 13 seconds (range: 1 – 128 s, median = 4 s). The criteria for including a dolphin's information in analyses required that the dolphin play a minimum of ten seconds total. As an outlier with more than 10 minutes of recorded object play, the data from C5 was removed from categorical statistical analyses as well. In all, 17 dolphins were retained for analyses.

Table 2
Total frequency and time of object play for each category

Category	Frequency	Time (s)

Female	105	1625
Male	70	671
UnID/Mixed	8	55
Calf	57	757
Juvenile	68	1169
Subadult	13	92
Adult	25	135
UnID/Mixed	20	198
Solitary	76	586
Social	8	101
Human	85	1505
Human/Social	14	159
Seaweed	86	1443
Flipper	60	191
Stick/Leaf	21	507
Other	16	210

Event sampling was used in order to code every instance of object play. An event was considered object play if a dolphin showed physical interest and manipulated an object in its environment for any period of time. If a dolphin left the object for more than ten seconds and returned to the object, it was considered a different event. If a dolphin switched from one object to another, it was considered a separate event. Each event was coded individually, and the events were categorized according to object type and sociality of play. First, the type of object was identified and then separated into four categories: seaweed/seagrass, leaf/branch, flipper of human, and any other objects. Each instance of play was also labeled as solitary, social, human, and human/social play (Table 3). Then, in each event, the dolphin involved was identified and labeled by age group and gender. Several ANOVA tests were used in order to deduce independence between variables in regards to age class, play type, and object type. The Bonferroni correction was then used in order to study any further association between variables that were investigated in the ANOVA tests. A t-test was used when examining the differences between the sexes.

Table 3
Operational definitions of coded behavior

Behavior	Operational Definition
Solitary	Single dolphin manipulating an object
Social	Two or more dolphins interacting with same object at the same time
Human	Single dolphin interacting with human
Human/Social	Two or more dolphins interacting with human with same object at the same time

Results

Age Class

In results from an ANOVA analysis, there was a significant effect of age-class in overall time spent engaging in object play (F (3, 13) = 10.875, p = 0.001). Post hoc tests using the Bonferroni correction revealed that overall time spent engaging in object play was significantly different between calves and juveniles (p = 0.002), subadults and juveniles (p = 0.003), and adults and juveniles (p = 0.007). There was no significant difference in time spent engaging in object play between calves, adults, and subadults (p > 0.05).

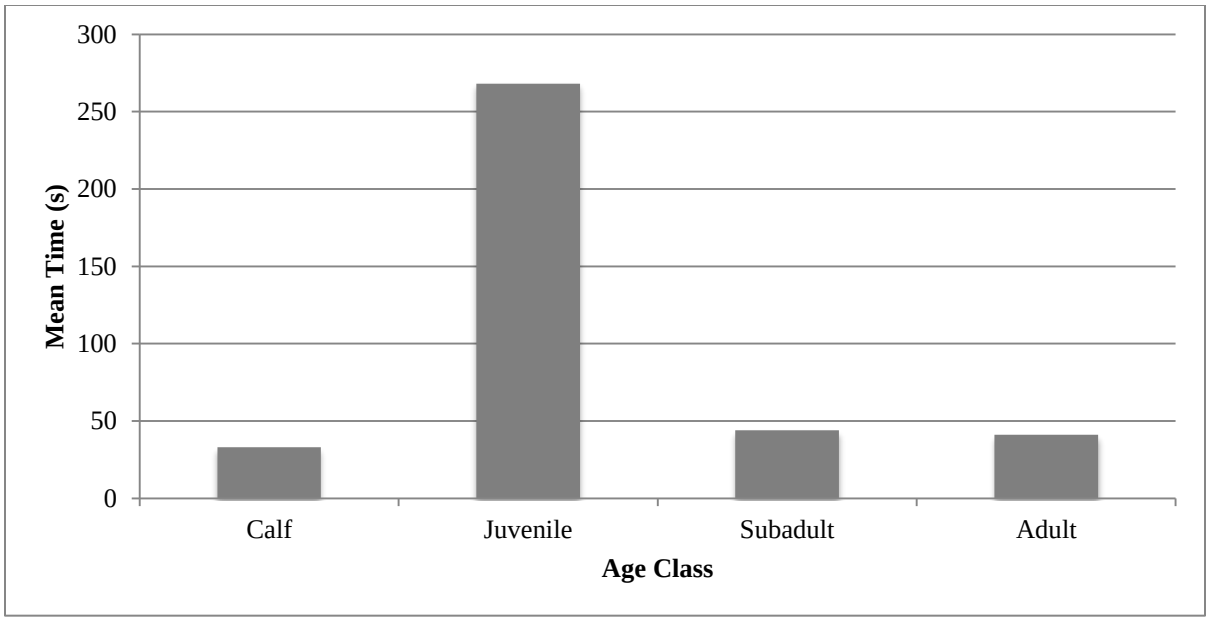

Figure 2. *Mean duration of object play by age class*

Sex Differences

Results from a paired t-test indicated there was no significant difference between males (M = 65, SD = 71) and females (M = 98, SD = 130) on time spent engaging in object play (t (14) = -0.590, p = 0.563).

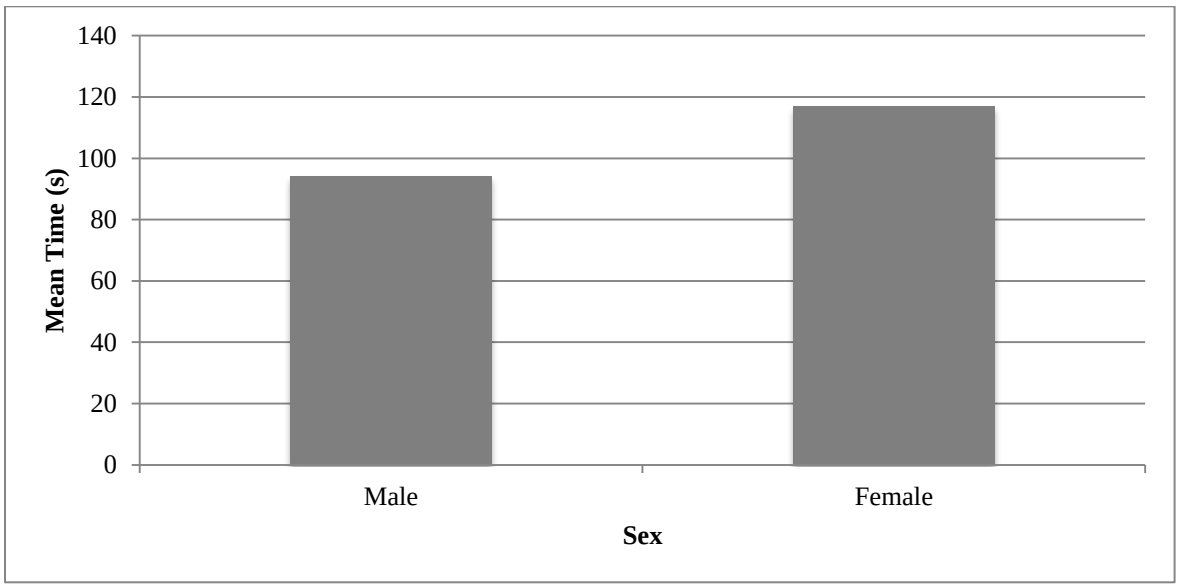

Figure 3. *Mean duration of object play for each sex.*

Sociality Type

Results from an ANOVA indicated there was a significant effect of type of social situation observed with object play (F (3, 64) = 3.925, p = 0.012). Post hoc tests using the Bonferroni correction revealed that overall time spent engaging in object play was significantly different between social (dolphins only) and human contexts (p = 0.019), and human and human/social (both human and dolphins engaged) contexts (p = 0.048). There was no significant difference in time spent engaging in object play between solitary and social, solitary and human, and solitary and human/social contexts (p > 0.05).

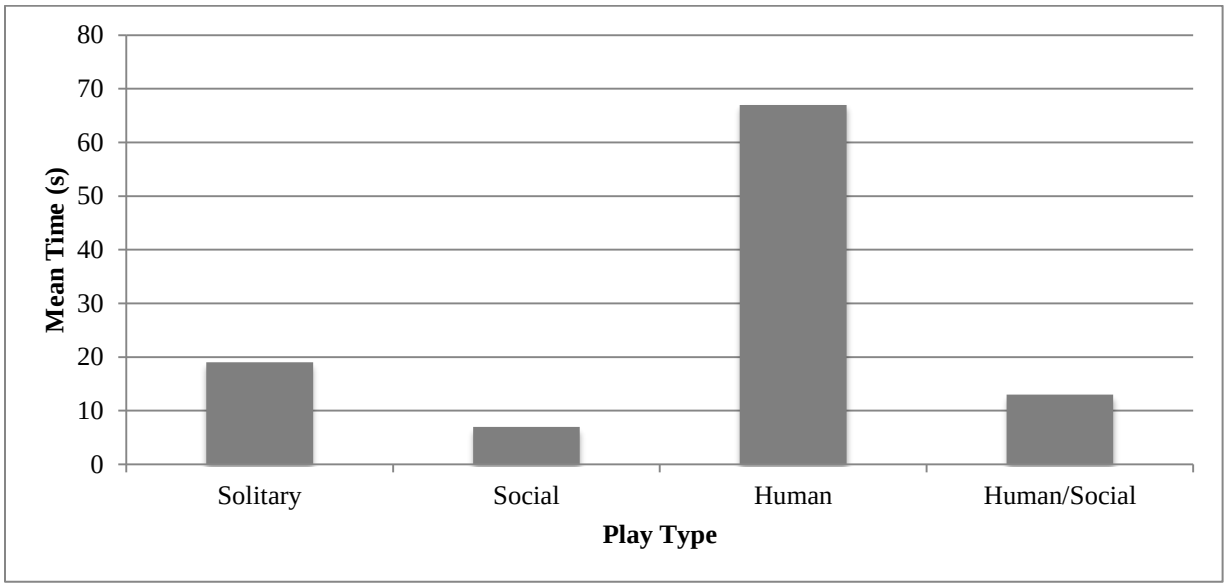

Figure 4*. Mean duration of object play according to sociality type.*

Object Type

According to results from an ANOVA, there was no significant difference in type of objects used for play (F (2, 48) = 2.211, p = 0.121). There was a marked difference between the mean time spent in seaweed object play compared to leaf stick, seaweed object play compared to flipper object play, and flipper object play compared to branch object play, but none of these were statistically significant.

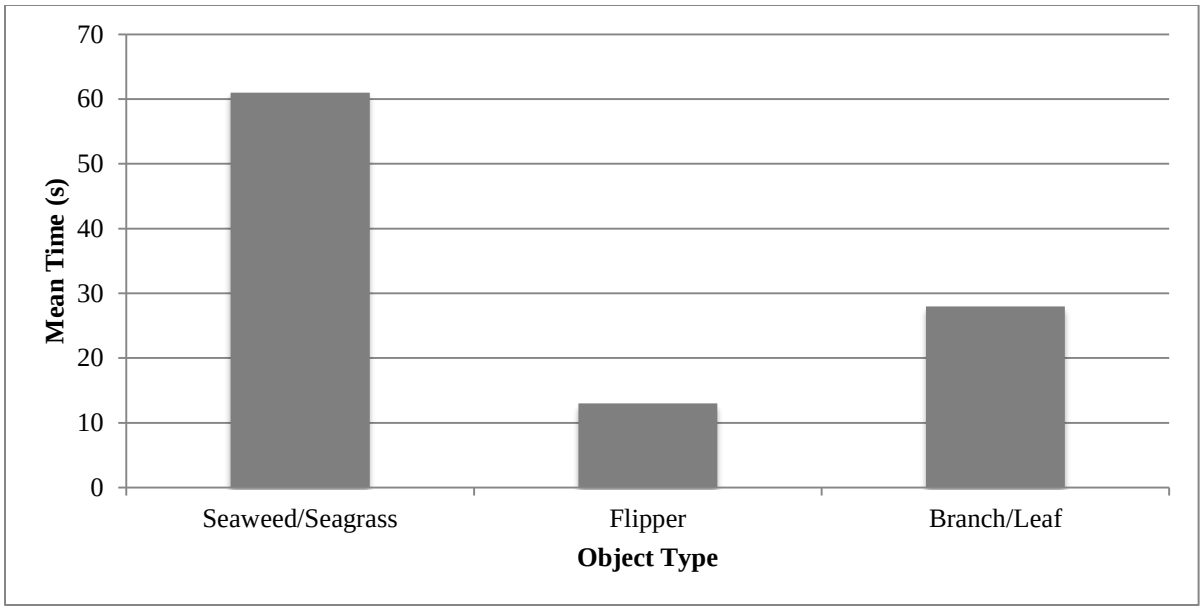

Figure 5*. Mean duration of object play according to type of object interaction*

Extra Playful Dolphin: C5

From the data, the calf C5 engaged in markedly more object play than the other dolphins, with C5 engaging in 770 seconds of play while the others averaged 70.8 seconds duration. Dolphin C5 was considered an outlier, and her data was excluded from group analyses. She engaged in 44 different bouts of play with a mean time of 18 seconds (range: 1 – 128 s, median = 6 s). She spent almost half of her time engaged in play with humans. She spent approximately a third of her time engaged in solitary play, and spent close to the same percentage of time engaged in social play as with human facilitated social play. C5 spent a majority of her observed time playing with seaweed. In decreasing order, she played with branches and leaves, human-made objects, and other objects.

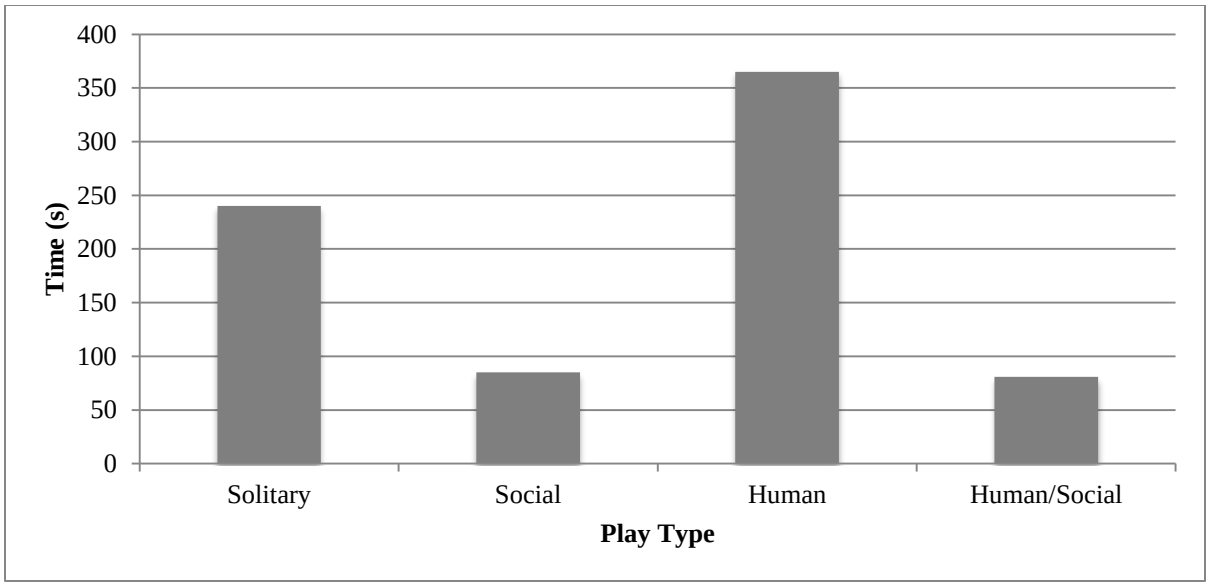

Figure 6*. Time C5 engaged in each sociality type of play*

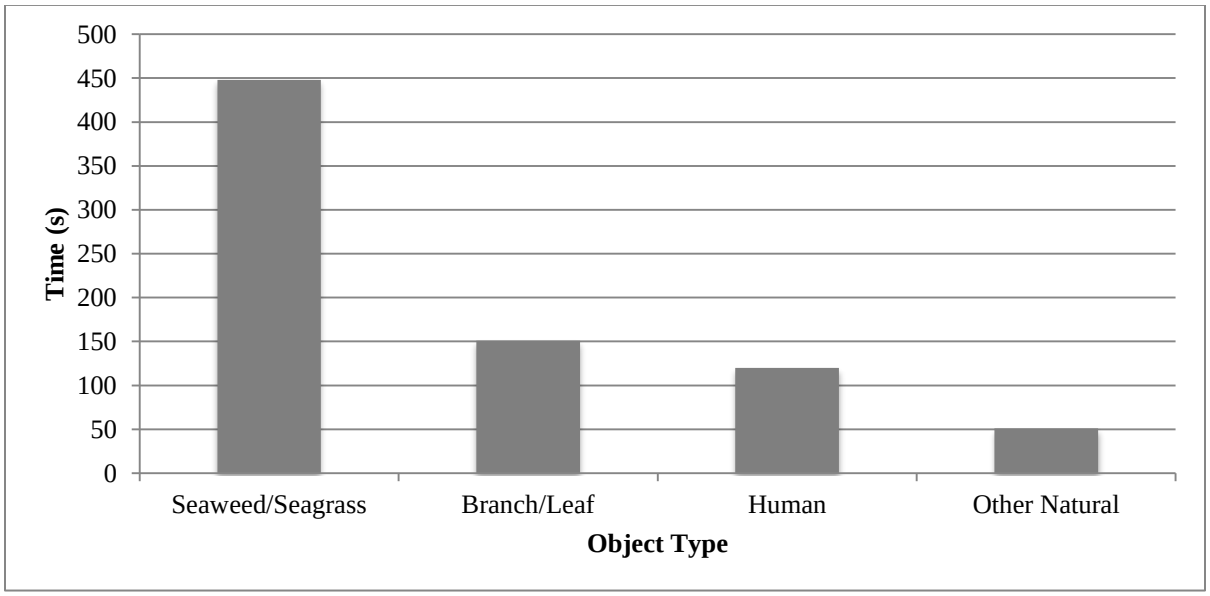

Figure 7*. Time C5 spent engaged with object types*

Discussion

The goal of this study was to identify individual differences between age class, sex, sociality, and the objects dolphins seek out when engaging in object play. It was found that there were significant trends in play based on the age class of the animals as well as the form of sociality. There were observable differences present in the choice of object used in play bouts,

but this difference was non-significant. No significant or marked difference was noticed between the sexes.

Previous studies have observed juvenile cetaceans engage more in play than any other age-class (Greene et al., 2011; Hill & Ramirez, 2014; Kuczaj et al., 2006). Results from the current study aligned with this hypothesis, with a significant difference in time engaged in play between juveniles and calves, juveniles and subadults, and juveniles and adults. There were no significant differences between any other age-class comparisons. The elevated play levels of juveniles in this study are consistent with results from both captive and wild dolphin studies (e.g., Greene et al., 2011; Paulos et al., 2010). Juveniles are commonly seen to play most perhaps because they are improving their coordination and manipulative skills in order to prepare for adult activities such as food acquisition (Blois-Heulin et al., 2015, Mackey et al., 2014). Calves and adults had close to the same amount of time playing with objects. A potential explanation for this occurrence is that calves tend to mimic adults with which they have high association levels (Lopes et al., 2016). Sub-adult and adult dolphins may not have played as much due to habituation to the objects available in the enclosure (Kuczaj et al., 1998).

It was hypothesized that females would play more than males, but results were inconsistent with this notion. Females spent an average of 23 seconds more engaging in object play, but no marked or significant difference existed. These findings were consistent with Greene et al. (2011), where there was no significant difference in frequency of object play between sexes in the captive population alone, but found that across both a wild and captive population male dolphins had a slightly higher frequency of play than females, paralleling similar results in adult rhesus macaques (Breuggeman, 1978). In this study, all instances of adult female object play were solitary, with the exception of A1 and her calf C4 playing together. In contrast, almost half

of the male object play events were social with other male dolphins, many of these events with males in younger age classes. Because object manipulation was a specific parameter for this study, results may have been different if any dolphins watching a manipulation were included as well. This would have accounted for parallel play and stimulus enhancement. A specific example of stimulus enhancement that was observed included C5 playing with a large branch for 30 seconds and leaving the branch. Very soon after, J5 became interested in the same branch and began manipulating it; C5 then joined her, creating a social play situation caused by stimulus enhancement.

Significant differences were found in the sociality of play in this study, but not where predicted (i.e. dolphins would engage in social play the most frequently). It was found that dolphins actually preferred to play with humans or alone more than with other dolphins. There was a significant difference between human facilitated and social play. There was also a significant difference between human facilitated play and human/social play, with human facilitated play being engaged in more often. There was no significant difference between human and solitary play or between solitary play and social or human/social play. In this study, the dolphins generally interacted with the humans as a form of "fetch," with the dolphin bring an object to the human, the human throwing the object, and the dolphin retrieving the object. Similar occurrences were recorded with wild bottlenose dolphins passing seagrass back and forth with humans in Monkey Mia, Australia (Mann & Smuts, 1999). Dolphins playing ball toss with humans have been observed at the Marine Life Oceanarium in Gulfport, Mississippi (Trone, Kuczaj, & Solangi, 2005). Seeking out human facilitated object play can be accounted for by the assumption that humans allow for more novel elements in play. The dolphins are almost always exposed to each other but only occasionally to humans, meaning the humans can provide a more

foreign and interesting experience for the dolphins. It has been proposed that humans may even serve as a form of environmental enrichment because dolphin-human interaction tends to have a correlation with increased welfare in dolphins (Trone et al., 2005).

There was a marked difference between the kinds of objects that the dolphins played with, though no statistically significant differences were found. Seaweed was played with more than leaves or man-made objects. Leaves were played with more than man-made objects. These results were opposite from the prediction that human-made object would be played with the most, though this outcome may be skewed because the only available human-made objects were flippers, which were connected to the human and not particularly available to manipulate. These results did align with other observations that biological debris was the most commonly sought out objects in captive and wild dolphins (Greene et al., 2011) As a result of using a natural enclosure, seaweed was the most available object to be played with. There tends to be a difference in object choice related to age because juvenile dolphins generally tend to seek out novel stimuli more often than their older counterparts (Lopes et al., 2016). Due to a completely natural enclosure with seldom occurring new objects, habituation to the natural objects that are always in the enclosure is very possible to have occurred in this population (Kuczaj et al., 1998).

The dolphin calf C5 was exceptionally playful, with an observed time that was more than a quarter of the total observed play time of all the dolphins. While many of her play events were solitary, she also spent a large portion of her time with humans, playing fetch and doing her best to interact with them. She seems to be an extra curious and physical dolphin, because she repeatedly sought out the human to throw an item so she could just swim after the object and bring it back. C5's brother, dolphin J1, engaged more frequently in play than any of the other males in the study. J1 interacted with a human in more than half of his events. Personality

profiles completed on J1 by Frick (2016) indicated that he scored medium-high for traits of curiosity, contact seeking, and exploratory levels when interacting with humans. J1 also had high contact-seeking and playful levels in relation to object interaction. Contrarily, J1 and C5's mother, A4 was considered to have a medium-low score for the evasive trait regarding interaction with humans and medium-low score for the trait of playful with objects. While these may seem quite different from J1 and C5, it is important to note that A4's was the lowest evasive score while her object play score was the highest of the adult females (Frick, 2016). It seems that individual differences (i.e., personality) in dolphins may additionally influence behavior in this context.

Like many studies, there were limitations that must be taken into account when interpreting the data and generalizing the results to other populations. The overall sample size was small, with almost half of the dolphins not included in analyses due to lack data. The dolphins may evade humans and cameras they are unsure of due to personality traits such as being introverted or neophobic (Delfour & Beyer, 2012; Frick, 2016; Lopes et al., 2016). The $300m^2$ size of the enclosure allowed dolphins to swim far enough away that they were not visible on camera unless they swam close enough to the researchers to be in view. Another limitation of this study is the unequal age class distribution, with twice as many adults as calves, juveniles, and subadults. With only thirty dolphins, results were also limited to a relatively small sample size that may not be representative to the entire population.

In the present study, there was no control as to what type and how long an individual was exposed to an object or how long it was recorded as data were opportunistically collected. Future research could use a more controlled methodology such as introducing various object types and different exposure times in order to further see how object play is prevalent in dolphins. With

more data and controlled object choices, the factors studied in this research could also be analyzed further for relatedness between groups as well as studying what kinds of play the different age classes and sexes of dolphins prefer.

Dolphin play is an important part of research in regards to well-being and development. By observing how dolphins play, we can better understand the variables of their play preferences. This is important because individual characteristics of dolphins should be taken into account when assessing their environmental enrichment (Delfour & Beyer, 2012). We can learn about specific species through our studies of them. These studies will not only allow researchers and caretakers advance in their captive enrichment efforts, but they will also aid conservationists in wildlife management of these species. Through these studies, the public can be made aware of the behaviors, actions, and troubles of specific species, allowing these people to be involved in these enrichment and management efforts.

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