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Comparing Object Play in Captive and Wild Dolphins

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Examining the role of play as related to individual and group social development is important to understanding a species. The purpose of our study was to examine whether there is a difference in the frequency of object play exhibited by dolphins from two groups – one captive and one wild. Data were collected with underwater video, with resulting videos event sampled for bouts of play involving various objects used by dolphins. From 159 hr of video data, roughly 102 min featured object play: 75 min of dolphins from RIMS and 26 min for dolphins near Bimini. A total of 304 bouts of object play were documented from or between dolphins at RIMS, while 73 bouts were observed by or between dolphins around Bimini. Juvenile dolphins engaged in solo and mutual play more than twice that of other aged dolphins from both study groups, although this result was not statistically significant. Similarly, male dolphins at RIMS exhibited object play slightly more than females, though this difference was not significant: at Bimini, male dolphins were not observed to play with objects during interactions with conspecfics (mutual) and engaged in object play about half as often as female spotted dolphins. Combining both study groups, dolphins played with about 23 different objects that were grouped into six categories: biological debris, human made objects, inanimate objects, other (e.g., wood, etc), people, and trash. The RIMS dolphins played most with all objects except people while Bimini dolphins interacted with sand more than any other object. Dolphins have been shown to exhibit higher cognitive functions, of which complex play is one example. The role of play in animals is considered important to development and maintenance of social relationships and to learning skills required ultimately for survival.

Play is a broad activity that includes a variety of specific actions and occurs as both a solitary and social activity (McDonnell & Poulin, 2002). Byers and Bekoff (1998) define play as motor activity that appears purposeless, though these behavior patterns might also be used in other contexts. For example, Loizos (1967) states that juvenile play involves more complicated patterns of chasing, jumping, and wrestling on and around many different features of the environment. Thus, play is often defined as an activity with no apparent function to the animal(s) involved except for a sense of pleasure, combined with elements of surprise

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(McDonnell & Poulin, 2002; Pace, 2000).

Play is important to all social animals because it allows an individual to practice skills and behaviors that will be essential for its survival as an adult (Loizos, 1967). Play enables animals to develop flexible kinematic and emotional responses to unexpected events in which they might experience a sudden loss of control; play might function to increase the versatility of movements used to recover from sudden shocks such as loss of balance and falling over (Spinka, Newberry, & Bekoff, 2001). Play can also be used to enhance the ability of animals to cope with unexpected stressful situations (Spinka et al., 2001). Play enhances the formation of long-term social attachments, in addition to learning the proper use of signals within their own social structure (Pellis & Pellis, 1987).

Play is generally divided into locomotor, predatory, social and object play (Bekoff & Byers, 1998). Though these distinctions help to categorize the different types of play, they are not mutually exclusive. Solitary play can occur in each of the play types defined by Bekoff and Byers, and is important to consider because of its significance and difference from social play. Object play may be an example of higher cognitive functioning as a form of creativity in species that exhibit this type of play behavior (Kuczaj & Walker, 2006). Locomotor play is typically used to describe dramatic or exaggerated movements (Bekoff & Byers, 1998); jumping and leaping by mammal species and soaring in many bird species are examples of locomotor play (Burghardt, 2005; Goodall, 1986; Lusseau, 2006). Predatory play involves actions that could be associated with agonistic social activity or predation activity for survival. It has been suggested that animals might only need minimal play practice to become competent predators (Martin & Bateson, 2007). Predatory play is not limited to mammals; swallows (*Tachycineta bicolor,* Ringelman, 2007), herring gulls (*Larus argentatus,* Gamble & Cristol, 2002) and kingfishers (*Alcedo atthis*, Ashmole & Humberto, 1968) have all been observed to engage in predatory play scenarios.

Many mammals, especially young individuals, engage in social play. Social play is an activity directed toward another individual with whom actions from other contexts are used in modified forms and in altered sequences (Bekoff 1997, 1999; Martin & Caro, 1985). When animals engage in social play, they are using actions that come from activities such as mating and aggression (Bekoff, 2004). Animals participating in social play exchange a wide variety of actions with one another that include chasing, wrestling, running and biting, among other behaviors (Bekoff, 2001; Bekoff & Byers, 1981). Social play might be a safe way to teach young animals the skills necessary for successful participation in future aggressive social competition. Social play might also simultaneously strengthen bonds between group members, a process that serves to limit the amount of actual aggression between kin or peers (Bekoff, 1995).

The differences between solitary and social play should be investigated to better understand the significance of individual and group play behavior among social animals. The significance of solitary play for contextually flexible communication may rest on the role of solitary play in the ontogeny of flexible thought (Kuczaj & Makecha, 2008). An animal’s interaction with the environment during solitary play could facilitate cognitive growth and flexibility because the player has control over the play activity without the outside influence of other animals (Kuczaj & Makecha, 2008). In contrast, the significance of social play for the emergence of communication systems is believed to be more direct (Lancy, 1980; Sutton-Smith, 1980): social play is impossible without the cooperation of others and cooperation cannot happen unless there is successful communication (Kuczaj & Makecha, 2008). Garvey and Berndt (1977) support this idea; in order for children to play with others they must communicate about more than simply taking part in the play behavior.

Object play is defined as the involvement of inanimate objects of various types in an animal's environment (Bekoff & Byers, 1998). Play objects can include rocks, twigs, grass, branches, leaves, etc. (Fagen, 1981). Captive animals will often use human-made toys as enrichment, but when there are no human-made toys available, animals will use other types of objects naturally found in their environment. Object play occurs in many animal species such as loggerhead turtles (*Caretta caretta*, Burghardt, 2005; Melgren & Mann, 2000), canids, (Bekoff & Byers, 1981), and both captive and wild dolphins (e.g., Delfour & Aulagnier, 1997; Norris, 1994).

Object Play and Dolphins

Object play has been documented in both captive and wild dolphins (Bel'kovich, Ivanova, Kozarovitsky, Novikova, & Kharitonov, 1991; Yeater & Kuczaj, 2010), with individuals observed carrying both animate and inanimate objects on their rostrum, melon, dorsal and pectoral fins, and flukes (Kuczaj & Yeater, 2006; Pryor, 1975; Taylor & Saayman, 1973; all co-authors' personal observations). Objects include balls and buoys provided by trainers, feathers and seaweed found in the environment, or bubbles and bubble rings they create (Bel'kovich et al., 1991; Gewalt, 1989; Marten, Shariff, Psarakos, & White, 1996). Bottlenose dolphins *(Tursiops* sp*.)* and pilot whales (*Globicephala melas*) often carry objects like seaweed, fish or plastic toys in their mouths (Brown & Norris, 1956; Caldwell, 1956; Para, 2007; Tizzi, Castellano, & Pace, 2000). In The Bahamas, free-ranging Atlantic spotted dolphins (*Stenella frontalis*) carry sea grass, fish, sea cucumbers and pieces of coral (Herzing, 1997; KMS, KD personal observations, 2003-2011). Play by young captive dolphins suggests that the actual behaviors were characterized by their creativity (Kuczaj & Trone, 2001; Kuczaj & Walker, 2006; McBride & Hebb, 1948; Tavolga, 1966). Kuczaj, Makecha, Trone, Paulos, & Ramos (2006) found that dolphin calves were the main actors engaging in innovative play behavior within a group of captive dolphins. These authors also concluded that peers may be important for both cultural innovation and transmission.

Object play is a fundamental prerequisite for the emergence of the skillful use of tools (Jay, 1968; Parra, 2007). While several studies have recorded dolphins playing with various items, these actions are typically attributed to object play and not tool use (Brown & Norris, 1956; Caldwell, 1956; Mann & Smuts, 1999; Para, 2007; Slooten & Dawson, 1994; Tizzi et al., 2000). Some object interactions might be related to object manipulation or tool use (Krutzen et al., 2005). The difference between tool use and object play relates to the motor activity directed toward a particular object: no obvious direct benefit to the individuals involved would be expected if the activity were play, while tool use most often has a specific function related to a particular activity, e.g., foraging (Mann et al., 2008; Martin & Caro, 1985; Smolker, Richards, Connor, Mann, & Berggren, 1997).

Object play may be a basis to comprehend and observe higher cognitive processes in dolphins. Object play is a type of play that incorporates novel experiences, which is a cognitively demanding process and thus may have evolved in species that possess the required cognitive abilities (Kuczaj, 2008; Spinka et al., 2001). It is important to look at object play in both captive and wild dolphin populations; including data from both environments and study groups facilitates a comparison of object play by dolphins in different settings. Additionally, if differences were not identified between these groups, then we could potentially pool the data, facilitating a more comprehensive examination of the extent, functions, and underlying mechanisms of cetacean play (Paulos, Trone, & Kuczaj, 2010). Lastly, looking at how the environment might factor into the frequency and diversity of object play allows an avenue to increase our understanding of how the environment might influence play behavior.

Present Study

In this study, the frequency of occurrence of object play interactions is examined for two dolphin groups (one captive and one wild) with results from both groups compared. This study focuses on solo and mutual play actions and interactions between dolphins. Bouts of object play are investigated from video data collected during a long-term study of two different dolphin groups. We hypothesize that there is a greater number of instances of, and higher diversity in, observed object play interactions by both sexes within the captive study group as compared to the wild dolphin study population. There is also a higher frequency of occurrence of object play interactions in young (i.e., calves and juveniles) individuals at both study sites as compared with older dolphins. By looking at the frequency of object play in captive versus wild dolphin groups, we learn more about the prevalence and diversity of object play among dolphins, as well as provide insight to its function.

Method

Study Animals and Sites

Two groups of dolphins were included in this study. A group of 20 captive bottlenose dolphins (*Tursiops truncatus*) ranging in age from several months to 30+ years was observed at the Roatan Institute for Marine Sciences (RIMS) on Roatan, Honduras. The dolphins resided in a natural lagoon enclosure with depths ranging from shore to 8 m. There is an overall 1:1 ratio of males:females in this group, but a 2:1 ratio of adult females:adult males and a 1:2 ratio of juvenile females:juvenile males.

The wild Atlantic spotted dolphin (*Stenella frontalis*) study group was observed between 8 to 16 km NW of Bimini, The Bahamas, along the western edge of the Great Bahama Bank. These spotted dolphins ranged in age from calf to adult with a study population of roughly 90 identified individuals. There is an overall 2:1 ratio of females to males in the Bimini study group: the adult ratio is 3 female (F):1 male (M) while for juveniles the ratio is nearly 1:1, but slightly skewed toward females. More than one-third of catalogued individuals are of unknown sex; three-quarters of individuals of unknown sex are adults.

Data Collection

Instances of object play were documented from video collected during longitudinal studies ongoing by the Dolphin Communication Project (DCP) at both field sites. All video data were recorded using a mobile video/acoustic system (MVA, Dudzinski, Clark, & Würsig, 1995). At Bimini, data were collected from 2004 to 2009; at RIMS data were collected between 2003 and 2009. Event sampling from all video data was employed to record object play instances (Altmann, 1974; Mann, 1999).

Object play was categorized as either solo or mutual. Solo play is defined as one dolphin playing with an object. Mutual play featured two or more dolphins sharing, playing with an object. The primary dolphin engaged in object play was the first identified individual observed to initiate play, or to come into view playing, with an object. One or more other dolphin(s) who might participate in play with an object in association with the primary dolphin was defined as an associate (with two or more dolphins yielding associate 1, associate 2 … associate N). The sex and age category for each individual involved in play with an object was documented, whenever confirmed. Dolphin ages for both study groups were broadly categorized as adult, sub-adult, juvenile, and calf [see Dudzinski (1996) and Brunnick (2000) for spotted dolphins]. We followed Shane, Wells, and Würsig (1986) for bottlenose dolphin age ranges (age ranges are comparable between species). The type of object was also documented and included various species of fauna (e.g., fish, crabs, people), wood, air bubbles, plastics, or vegetation. Vegetation included sea grass, seaweed, and various leaves or seedpods. Object types were grouped into categories and included: biological debris (e.g., seaweed), human-made (e.g., flipper), inanimate (e.g., rock), other (e.g., dead fish), and trash (e.g., plastic bag).

Statistical Analyses

Bouts of object play were used for all statistical tests and comparisons. A bout of object play began when a dolphin made contact with an object or approached an object within one meter and investigated it and ended when the dolphin dropped or left the object. If the object was left or ignored for a minimum of 10 s, but then the dolphin returned to show interest or contact on the same object, these object play bouts would count as different bouts. If a dolphin was interacting with an object and physical contact was intermittent but the dolphin still displayed interest in the object, it was considered a single bout.

The Pearson's chi-square test was used to examine independence between variables when analyzing object play bouts between dolphin ages, sexes, play types (solo vs mutual play), and study site, and was also used to examine results within each study group for object play and to compare results regarding object type with respect to dolphin age, sex or play type between study sites. Cramer's V test was used to further examine the measure of association between the variables analyzed via the Pearson's chi-square test.

Results

A total of 159 hrs of video data were reviewed to document bouts of dolphin object play: these data include 81 hrs from RIMS and 78 hrs from Bimini. From the total 159 hrs of data, a total of 1:42:12 (h:min:s) of object play was observed and analyzed. This further divides into 1:15:53 from RIMS and 0:26:19 from Bimini that presented object play interactions. A total of 304 bouts of object play were observed between or by dolphins at RIMS and 73 bouts of object play were documented from or between dolphins around Bimini (Table 1). The mean duration for object play bouts for dolphins at Bimini was 19 s (range: 1 - 79 s, median = 14 s), while at RIMS the mean duration for bouts of object play was 15 s (range: 1 - 77 s, median = 10 s).

Table 1
Frequency of object play for each study group according to type of play and age and sex of the dolphin initiating play.

		Type of Play		
		Solo	**Mutual**	**Total**
RIMS	**Adult**	32	5	37
	Subadult	21	6	27
	Juvenile	74	34	108
	Calf	29	13	42
	unID Age	50	40	90
	Male	85	31	116
	Female	75	27	102
	unID sex	46	40	86
Bimini	**Adult**	3	1	4
	Subadult	4	3	7
	Juvenile	6	7	13
	Calf	0	0	0
	unID Age	32	19	51
	Male	3	0	3
	Female	6	6	12
	unID sex	36	22	58

Solo and Mutual Object Play – Bimini vs. RIMS

Atlantic spotted dolphins at Bimini were not significantly different from the bottlenose dolphins at RIMS with respect to how they engage in solo and mutual object play. While not significant, dolphins at both study sites engaged in more solo object play (60% Bimini, 67.8% RIMS) than mutual object play (40% Bimini, 32.2% RIMS, Table 1).

Age Variability with Play Type – Solo vs. Mutual Object Play

Age was not significantly related to play type during solo or mutual object play for spotted dolphins observed at Bimini. However, these two variables were related for the dolphins at RIMS ($\chi^2 = 13.77$, df = 4, $p < 0.01$; Cramer's V = 0.21, $p < 0.01$). Adult dolphins at RIMS engaged in significantly more object solo play (15.5%, Table 1) than expected by chance alone and in less mutual object play (5.1%, Table 1) than expected by chance alone. Also, when object play observations by dolphins of unidentified age were included in the analyses of age versus play type between study sites, this age category also engaged in more solo object play (24.3%, Table 1) and more mutual object play (40.8%, Table 1) than expected by chance.

For both study sites, observations of dolphins often resulted in behavioral observations for which the age of a specific participant dolphin could not be ascertained. Situations with poor underwater visibility (e.g., because of bubbles or suspended silt particulates) or items (e.g., swimmers, boat) blocking the view of a specific dolphin contributed to the observers inability to confirm the age or sex of some dolphins engaged in object play. When the unidentified samples were excluded from the analysis for dolphin ages engaged in solo and mutual object play, these variables were not statistically significant for dolphins at Bimini or at RIMS. Because the sample of unidentified age dolphins at both study sites was substantial, future focus at confirming the age of as many involved dolphins might yield a different result for how dolphins of different ages engage in solo and mutual object play.

Though not statistically significant, juvenile dolphins at RIMS engaged in both object solo play and object mutual play more than twice as much as each of the other age categories (Table 1). Similarly at Bimini, juvenile dolphins also engaged in solo play twice as much as adults and more than sub-adults; dolphin calves were not observed to engage in solo play around Bimini during this study (Table 1).

Sex Variability with Play Type – Solo vs. Mutual Object Play

Sex was not significantly related to play type during solo or mutual object play for spotted dolphins observed at Bimini; however, these two variables were related for the dolphins at RIMS ($\chi^2 = 11.188$, df = 2, $p < 0.001$; Cramer's V = 0.192, $p < 0.001$). Male dolphins at RIMS engaged in significantly more object solo play (41.3%) while dolphins of unidentified gender engaged in significantly less object solo play (22.3%, Table 1) than expected by chance alone. Conversely, male dolphins engaged in significantly less mutual object play (31.6%) than expected by chance alone, while dolphins of unidentified sex engaged in significantly more mutual play (40.8%) than expected by chance alone.

More than 80 cases of object play (both solo and mutual) were documented at RIMS and 58 instances of object play for dolphins at Bimini for which the sex of the participating dolphin was not confirmed (Table 1). When the unidentified samples were excluded from the analysis for dolphin sex as engaged in solo and mutual object play, these variables were not statistically significant for dolphins at Bimini or at RIMS. Because the sample of unidentified sexes at both study sites was substantial, future focus at confirming the sex of as many involved dolphins is a goal that might yield a different result for how dolphins of different sexes engage in solo and mutual object play.

Male dolphins at RIMS seemed to engage in both solo and mutual play with similar, though slightly more, frequency to that of females (Table 1), though with no significant difference identified between the sexes. Similarly, female dolphins at Bimini seemed to participate in solo play twice as much as male dolphins for cases when the sex of the playing dolphin was determined (Table 1).

Object Categories

Combining both study groups, dolphins used 23 different object types during documented object play (Table 2). The frequency with which each object was used by dolphins from each study group was examined and these objects were broadly grouped into six categories to facilitate further statistical analysis. Assigned categories include: biological debris, human-made objects, inanimate objects, other (e.g., wood, sea cucumber, etc), people, and trash (e.g., plastic bag).

Object category was significantly different ($\chi^2 = 57.911$, df = 5, $p < 0.001$; Cramer's V = 0.392, $p < 0.001$) for several object types than expected by chance between study sites (Table 2). Biological debris was observed significantly more at RIMS (52.6%) and significantly less at Bimini (35.6%) than expected by chance alone (Table 2). Human-made objects were observed significantly more at RIMS (29.3%) and significantly less at Bimini (9.6%) than expected by chance alone (Table 2). On the other hand, inanimate objects were observed significantly less at RIMS (11.8%) and significantly more at Bimini (45.2%) than expected by chance alone (Table 2). Similarly, people as objects during play were observed significantly less at RIMS (0.3%) and significantly more at Bimini (4.1%) than expected by chance alone (Table 2).

With respect to frequency of object category and use by dolphins, biological debris seemed to be preferred by dolphins during both solo and mutual play followed by human-made and then inanimate objects at both sites (Table 2). The RIMS dolphins played more with all objects in all categories except for dead fish, humans, and sand, as compared with dolphins from around Bimini (Table 2). People (e.g., researcher while holding the MVA and other divers at Bimini) represented the least played with object type by dolphins at both study sites (Table 2). The RIMS dolphins played most with varying object types from all categories except people, while Bimini dolphins played with inanimate objects at a frequency almost equal to that of the RIMS dolphins (Table 2). The dolphins from Bimini exhibited no interaction with trash.

The type of object used was also examined in relation to whether the bout was solo or mutual play between study sites. More play was documented with all object categories for solo versus mutual play at both study sites (Table 2); however, these results were significantly different for some but not all object categories at both study sites [Bimini: $\chi^2 = 16.194$, df = 4, $p < 0.001$ (Cramer's V = 0.471, $p < 0.001$); RIMS: $\chi^2 = 11.816$, df = 5, $p < 0.05$ (Cramer's V = 0.187, $p < 0.05$)]. Dolphins at RIMS engaged in more solo object play with biological debris (56.8%) but less mutual object play (52.9%) than expected by chance alone; however, RIMS dolphins engaged in less solo object play (9.2%) and more mutual object play (17.3%) with inanimate objects than expected by chance alone. At Bimini, dolphins engaged in less solo object play (26.7%) and more mutual object play (50%) with biological debris, more solo object play (15.6%) and less mutual object play (0%) with human-made objects, and less solo object play (0%) and more mutual object play (14.3%) with other objects than expected by chance alone (Table 2).

When comparing the two different study groups and their potential object category preference, there was a significant difference between the object categories at RIMS versus Bimini ($\chi^2 = 45.90$, df = 11, $p < 0.001$, Table 2). For example, dolphins at RIMS played the most with biological debris (e.g., seaweed) as compared to dolphins at Bimini (Table 2). On the other hand, dolphins at Bimini played proportionately more with inanimate objects (e.g., sand) as opposed to other object categories than did RIMS dolphins (Table 2).

Table 2

Frequency of occurrence of object play with respect to study group for object category according to solo and mutual/stealing play episodes.

		Solo	**Mutual**	**TOTAL**
RIMS	**Biological Debris**	117	43	160
	Human-made	55	34	89
	Inanimate Objects	19	17	36
	People	1	0	1
	Other	8	4	12
	Trash	6	0	6
	TOTAL	206	98	304
BIMINI	**Biological Debris**	12	14	26
	Human-made	7	0	7
	Inanimate Objects	23	10	33
	People	3	0	3
	Other	0	4	4
	Trash	0	0	0
	TOTAL	45	28	73

Discussion

Dolphins from two study sites – one captive and one wild – were compared to one another with respect to the type and frequency of their object play interactions. Object play was defined as a solo or mutual interaction that involved a particular object. Within each study group, there were trends in frequency of object play by dolphins; however, the results were not statistically significant for either age or sex for solo and mutual play within each study group. Still, overall, dolphins from both sites engaged in substantially more solo play compared with mutual play with objects. The type of object selected by dolphins did differ between study sites: dolphins at RIMS played the most with biological debris (e.g., sea grass, seed pods), while dolphins at Bimini played more with inanimate objects.

For solo and mutual play, males from RIMS had a higher frequency of object play as compared to females, but at Bimini the females played more with objects. The results from RIMS where males had a higher frequency of occurrence of object play interactions support the work of Gibson and Mann (2008). Gibson and Mann (2008) suggested that early social experience might influence the ability of males to maintain and form alliances later in life. In contrast, female dolphins likely acquire maternal skills from their mothers or other older females that will aid them later in life when faced with caring for their own offspring; thus, female experience gained via interaction with one's mother or other females may be sufficient with respect to a play outlet. Future research using a larger sample size, with fewer individuals of unknown sex, may yield a different result for the Bimini population.

When looking at the differences in age categories for solo and mutual play, adults engaged in more solo object play than was expected by chance. This might be an artifact of the high number of unidentified aged dolphins playing with objects because this result was not found when the unidentified dolphins were excluded from analysis. Also, though not statistically significant, juveniles play the most of any age category for both study sites. This trend is supported by results from Kuczaj et al. (2006) who observed spontaneous play behaviors of a group of captive bottlenose dolphins. They found that each individual calf's behavior became more complex with increasing age. This could suggest that dolphin play facilitates the ontogeny and maintenance of flexible problem solving (Kuczaj et al., 2006). Our results also support observations for play documented in studies of other mammals: Byers (1984), Gibson and Mann (2008), and Meaney, Stewart, and Beatty (1985) found immature males to play more than females, especially in mock fighting and rough-play activities. Tizzi et al. (2000) looked at the development of play behavior in dolphin calves and found that object and bubble play develop in each animal individually as they mature, whereas social play seems present from birth. In the present study, this observation was supported because juveniles from both study groups exhibited a higher frequency of object play interactions than calves. Tizzi et al. (2000) also found that object play occurrences showed higher duration values than social play bouts, though social play was documented more than were bouts of object or bubble play. The researchers concluded that by exploring and manipulating objects found in the surrounding environment, young animals accumulate specific information that may prove useful later in life (Tizzi et al., 2000). Play has evolutionary consequences because it allows young animals to practice behaviors that will facilitate their survival and reproductive success later in life (Kuczaj & Makecha, 2008).

For the various object categories in this study, a significant difference was observed between captive and wild dolphins use of objects. The favored type of object by dolphins seems to have been biological debris such as seaweed and sea grass at RIMS, and inanimate objects that included sand in Bimini. Hasset, Seibert, and Wallen (2008) found that not only did rhesus monkeys *(Macaca mulatta)* have particular toy preferences, but these preferences were distinguished by the sex of the monkey playing with the toy. Hasset et al. (2008) demonstrate that such preferences can develop without explicit gendered socializations and thus, potentially reflect hormonally influenced behavioral and cognitive biases that are sculpted by social processes into the sex differences. In the present study, individuals from the two study groups showed a statistically significant preference for object type; still, more research is necessary in order to determine if these choices were an artifact of the high number of unidentified sex individuals in our sample, or reflect a true trend in potential gender preference in object type. If the latter is true, then the suggestion of hormone-induced selection on play behavior would be interesting to ponder and study at length.

In this study, it seemed that dolphins would interact with whatever was available: there was more free-floating debris along the surface of the water at RIMS as compared to at Bimini. Many of the object play interactions at Bimini included some contact with sand, whereas at RIMS, the majority of object play interactions recorded consisted of either free-floating seaweed or other debris found in the water column. Thus, differences in habitat and water characteristics may play a role in the diversity of interactions between dolphins and their chosen inanimate toys.

Diversity in object type and how the RIMS and Bimini dolphins interact with a given object are supported by past research (Brown & Norris, 1956; Caldwell, 1956; Mann & Smuts, 1999; Para, 2007; Slooten & Dawson, 1994; Tizzi et al., 2000). During play interactions documented in this study, 23 different object types were identified and catalogued into six broad categories. Our observations showed that the dolphins interacted with these objects using different body parts, swimming patterns, and either solo or mutually with conspecifics. This diversity in object play could suggest that dolphins are "creative" in their behavior with toys. Though beyond the scope of the current study, future research could investigate what body parts are used by male and female dolphins of differing ages and if there is more variability in one over the other. Another intriguing future question would be what specific behaviors are displayed during object play interactions—are they individual or age/sex specific? Perhaps male and female dolphins or dolphins of different ages respond and interact with objects in different ways.

One potential confounding factor to our study comparing object play by dolphins between sites pertains to the amount of data collected at each site. There is variance in the amount of screen time for which dolphins are present at RIMS versus Bimini. Video data from RIMS almost always had dolphins on screen (i.e., within the viewfinder), while at Bimini, the percent of on-screen time of dolphins is much smaller. The return on effort (defined as time with dolphins on-screen divided by the total time spent under water on tape) at RIMS is roughly 85% annually, while for data collected around Bimini it ranges between 41.5 and 56.9% (DCP, unpublished data, 2003 – 2009). Thus, our sample size of object play interactions at Bimini was substantially smaller than for play interactions documented at RIMS; the possibility of missed observations of play among dolphins and for dolphins with various objects is a distinct possibility more so for the dolphins observed around Bimini than for our study group at RIMS.

Overall, more object play was documented at RIMS as compared to Bimini. The captive dolphins at RIMS are food provisioned and therefore are not required to spend the same amount of time foraging as would the wild dolphins around Bimini. It is reasonable, therefore, to assume that the RIMS dolphins have more "free time" than do the Bimini dolphins; the RIMS dolphins can spend more time playing and interacting with objects or conspecifics. Alternatively, our sample size was small and our observation period might not have included representative time frames for access to each type of object overall.

When captive bottlenose dolphins are given free opportunity to interact with objects in their pool, they generally spend a considerable amount of time manipulating toys with their fins or carrying them on their rostrums (Defran & Pryor, 1980; Pace, 2000). It was suggested that at least some dolphin play behaviors are collaborative; an example of collaborative play was presented as when young captive dolphins were observed taking turns acting as "pusher" and "pushee" (Kuczaj, Paulos, & Ramos, 2005); however, this collaborative play is not limited to captive dolphins. Kuczaj et al. (2005) observed wild rough-tooth dolphins (*Steno bredanensis*) taking turns trailing a piece of plastic by passing it back and forth to one another.

The function and purpose of play is still highly debated and there is a wide array of different types of play behavior observed in most animal species. Understanding the role of play in individual and social development is important to understanding a species, and this study indicates there is much more to be learned about dolphin object play. Looking forward, scientists should seek to gain a more complete understanding of the role and significance of how dolphins interact and the impact that play has on their lives. A more complete understanding should aid in public awareness, captive enrichment and wildlife management.

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