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Article

Trainer Interaction Can Improve Welfare Outcomes of Toy Enrichment for Isolated Animals: A Case Study

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Abstract: In cases where social animals must be temporarily housed alone, environmental enrichment is particularly important. Providing animals with manipulable objects ("toys") is a common form of environmental enrichment, but its effectiveness can be limited by animal disinterest or habituation. The current study examined whether caregiver interaction could increase the effectiveness of object-based enrichment for a quarantined bottlenose dolphin (*Tursiops truncatus*). Behavioral observations were conducted after a training session, after a trainer toy play session, and between interactive sessions. The results showed that the dolphin floated in place less and played with toys more after interacting with a caregiver than he did at times further removed from caregiver interaction. He was also more likely to play with the same toys that the trainer had played with, showing effects of stimulus enhancement and/or social referencing. Although this study is, of necessity, based on a single animal of a single species, these findings suggest that interacting with a caregiver can enhance the efficacy of object-based environmental enrichment for isolated animals.

Keywords: environmental enrichment; training; human-animal interaction; animal welfare; bottlenose dolphin

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1. Introduction

Over the past several decades, environmental enrichment has become an important and standard husbandry practice at zoos and aquaria throughout the world [1–5]. The basic idea of environmental enrichment is to provide animals with environmental stimuli (e.g., objects, experiences, and situations) that will give them both physical and mental stimulation and enhance their overall well-being [6,7]. There is overwhelming evidence that such enrichment can result in numerous effects indicative of more positive welfare, such as increased activity, expanded habitat use, greater behavioral diversity, and a reduction in stereotypic behavior (e.g., [8–11]).

For both terrestrial and aquatic animals, the most common type of enrichment provided tends to be "toys" or other manipulable objects [6,12–14]. However, although many studies have shown positive benefits of this type of enrichment [10,15,16], others have shown that simply introducing objects into an animal's enclosure may not be sufficient to produce consistent and long-term benefits, both because some animals may be uninterested or avoid novel objects from the beginning [17,18], and because animals may habituate to the objects after some time [19–21].

Another potentially enriching aspect of an animal's environment comes from positive interactions with trainers and caretakers [22,23], as shown by the increasing scientific evidence that positive reinforcement training [24–30] and other enjoyable human-animal interactions [31–34] can have beneficial effects on animal welfare. Such experiences may also directly or indirectly influence animals' interactions with objects. In particular, studies have shown that it is possible to train initially uninterested animals to interact with enrichment objects, and that the animals continue to engage with such objects even after the training has stopped [18,35,36]. Studies have also shown that at least some animals are more likely to approach and interact with objects after seeing human caretakers hold or act positively toward those objects [37–40]. Thus, it may be that human interaction with enrichment objects has the potential to enhance the efficacy of object-based environmental enrichment.

For social animals there is a clear consensus, reflected in both regulations and industry standards, that housing them in appropriate social groupings is important for good welfare [2–4,41]. There are times, however, that providing such social companionship may not be possible, such as during illnesses that require extensive care, quarantine before being introduced to a social group, and rescued animals being nursed back to health before reintroduction back into the wild. In these cases, given the lack of social stimulation from conspecifics, enrichment may be particularly important. It is worth considering, therefore, whether social stimulation from caregivers in this situation might positively impact the effects of object-based environmental enrichment.

The current study tested this hypothesis during a quarantine period for a young bottlenose dolphin who had been rescued from an untenable situation in the wild. During a 5-week period of isolation in a medical pool, the young dolphin was provided with toys, training sessions, and toy play sessions with his caregivers. Behavioral observations recorded his behavior states and locations during three different conditions: after a training session, after a trainer toy play session, and in between sessions. We then examined whether training and/or play sessions affected his activity, space utilization, and interaction with enrichment objects.

2. Materials and Methods

2.1. Subject and Housing

Observations were conducted at the Dolphin Research Center (DRC) in Grassy Key, Florida. The subject was a male bottlenose dolphin (*Tursiops truncatus*) named "Ranger", estimated to be about 2 years old at the time of the study. The previous year, Ranger had been sighted in shallow water, swimming next to his deceased mother in Goose Island State Park in Rockport, TX. Rescued by Texas State Aquarium in June of 2021, the young calf was extremely dehydrated and malnourished. After a rehabilitation period, Ranger was deemed federally non-releasable by National Marine Fisheries due to his young age and lack of hunting abilities, and DRC was chosen to be his permanent home. He arrived on 25 March 2022 and first lived in a quarantined pool (30 ft diameter circle, depth 4.67 ft) as is standard procedure for all new arrivals. For the next five weeks, Ranger's health was monitored as the treated salt-water of the medical pool was slowly replaced by the natural bay water from the Gulf of Mexico. During this time of isolation from other dolphins, Ranger participated in five training sessions daily, during which time he was fed a diet of capelin, Atlantic herring, and Pacific herring. He also participated in at least one play session with a trainer daily, during which no food was provided. Between 4 to 14 floating toys (such as balls, hoops, or cones) remained in his pool at all times except when temporarily removed for Between Sessions observations (see Data Collection section below). Individual toys were added or removed by his trainers multiple times per day, which was not systematically controlled for research purposes. See Supplementary Materials (Table S1) for list of toys used during this period.

2.2. Data Collection

Behavioral observations took place three times daily (once per condition), five days per week for five weeks. During each 10-min. observation, data were recorded using instantaneous scan sampling [42,43] with 30-s intervals. At the start of each interval, observers recorded Ranger's behavior state according to the ethogram shown in Table 1, and location according to the diagram in Figure 1. The ethogram was compiled by adapting the solitary behaviors found in previous studies of dolphin behavior in facilities [44–47], combined with informal observations of Ranger's behavior in the medical pool. The locations came from dividing the medical pool into quadrants as shown in Figure 1. Observations were taken under three conditions:

(a) After Training: the observation began immediately after a training session. To avoid any effects of direct reinforcement for interacting with specific toys in the training session, any toys that were used during that training session were replaced with other toys before the observation started.
(b) After Trainer Play: before the observation, the trainer played with toys with Ranger for approximately 10 min. The observation started immediately after that, with the toys that were used remaining in the pool, along with at least one additional toy added on most days.
(c) Between sessions: the observation took place at least one hour after a training or play session (except one which was approximately 45 min after a session). There were two variations to this condition, which occurred sequentially during the study:
    - Phase 1: No toys (6 April 2022–18 April 2022; 9 observation days): all toys were removed from the pool before the observation started. The Linus Blanket that Ranger used as a comfort object remained in the pool.
    - Phase 2: With toys (19 April 2022–11 March 2022; 16 observation days): near the end of Phase 1, Ranger began showing possessive behavior when toys were removed for the Between Sessions observations. To avoid his rehearsing this possessive behavior, we changed the procedure such that any toys in the pool remained there during the observation.

Table 1. Behavioral states coded.

Behavior	Definition
Object oriented	
Calm object play	Manipulates an object in a calm, non-aggressive manner
Toy aggression	Bites, hits, or kicks an object
Linus Blanket	Floats partially or entirely under a piece of felt (3 ft × 4 ft) at the surface
Floating	
Float Horizontal	Floats horizontally at the surface without moving, oriented either dorsal-up or side-up
Float Vertical	Floats vertically without moving, head up
Swimming	
Swim	Moves steadily through the water in any orientation; no objects involved
Speed swim	Swims quickly

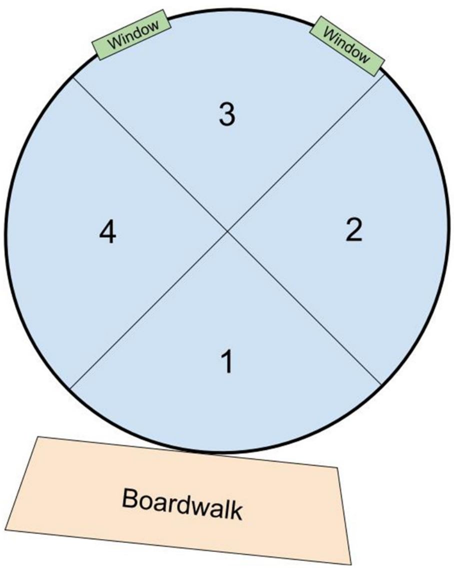

Figure 1. Medical pool diagram with quadrant locations used in observations.

The order of After Training and After Trainer Play observations alternated on consecutive days. Between Session observations took place at any point throughout the day depending on observer availability, and may have been either the first, second or third observation on any given day.

2.3. Statistical Analyses

To examine Ranger's behaviors across conditions, we used separate repeated measure ANOVAs to compare the proportion of intervals that Ranger engaged in each behavior category (swimming, floating, and object-oriented) in each of the three conditions each day. To analyze his utilization of pool space, we calculated a spread of participation index (SPI) for each observational session. First developed by Dickens [48], SPI is routinely used as a measure of an animal's evenness of enclosure use [49]. It ranges between a value of 0 for perfectly proportional use of all the zones in the enclosure (i.e., maximum utilization) to 1 for extremely uneven enclosure use, and is calculated as follows:

$$SPI = \frac{M(n_b - n_a) + (F_a - F_b)}{2(N - M)} \quad (1)$$

where

- N = total number of observations;
- M = mean frequency of observations per zone (N/number of zones);
- n_a and n_b = number of zones with frequencies greater or less than M, respectively; and
- F_a and F_b = total number of observations in zones with frequencies greater or less than M, respectively.

We compared SPI across conditions using a repeated measures ANOVA. Because both of these analyses (behavior states and location) included the Between Sessions condition, separate analyses were conducted for each Phase.

To examine whether Ranger's choice of specific toys to play with on his own was affected by trainer attention to those toys, we divided the available toys in the After Trainer Play session into those that he and the trainer had just played with ("Just-Played") versus those they had not. We then used a 2-tailed paired *t*-test to compare the proportion of toy-playing intervals in which Ranger interacted with Just-Played toys to a chance measure reflecting the number of Just-Played toys in the pool. For example, if three of the five toys in the pool were Just-Played, and Ranger interacted with toys during a total of ten intervals, we would expect him to interact with a Just-Played toy during 6 of those 10 intervals (0.60) by chance. Because this analysis did not involve any data from the Between Sessions condition, we combined the data from both Phases for this analysis.

Finally, to examine whether newness affected which toys he played with, we ran a similar analysis comparing the proportion of toy-playing intervals that Ranger played with toys that had just been placed in the pool ("New") to a chance measure reflecting the number of such new toys in the pool, using only those days in which at least one new toy was placed in the pool for the After Trainer Play session.

3. Results

3.1. Behaviors

Figure 2 shows the overall proportion of observation intervals that Ranger spent in each behavioral state. As shown in the figure, he spent most of his time playing with objects, floating, or swimming, with occasional variations to these three behavior types. For the purposes of analysis, we combine these specific behavioral variations into their larger behavioral categories.

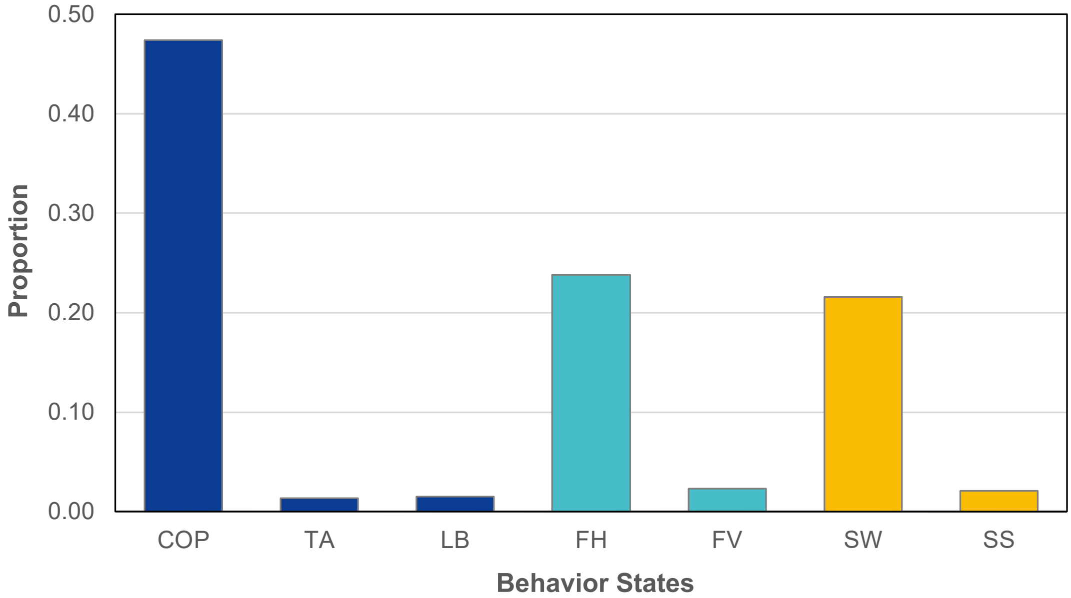

Figure 2. Proportion of intervals Ranger spent in each behavioral state overall. Colors represent larger behavior categories. COP = calm object play; TA = toy aggression; LB = linus blanket; FH = float horizontal; FV = float vertical; SW = swim; SS = speed swim.

Figure 3 shows the mean proportion of observation intervals that Ranger spent interacting with objects, floating, or swimming in each of the three conditions during Phase 1. As shown in the figure, he spent significantly more time interacting with objects After Training and After Trainer Play than he did Between Sessions, $F(2,16) = 21.00$, $p < 0.0001$; Tukey p's < 0.001. He also spent significantly less time floating After Training and After Trainer Play than he did Between Sessions, $F(2,16) = 37.14$, $p < 0.0001$; Tukey p's < 0.001. There was no significant difference between conditions in the amount of time he spent swimming ($p = 0.35$).

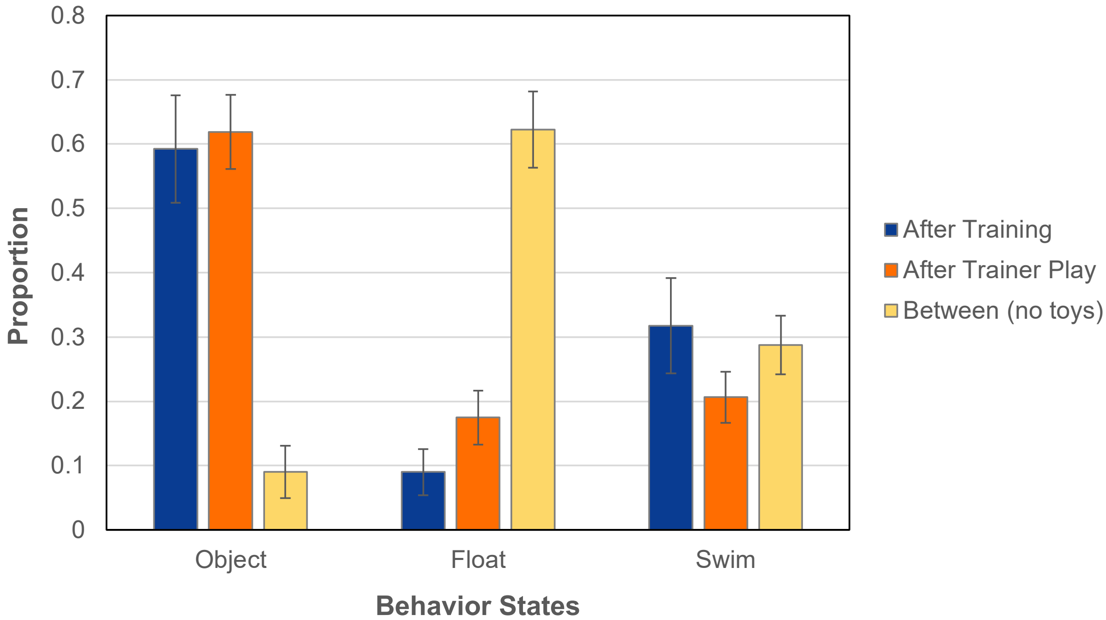

Figure 3. Mean proportion of intervals (+/−SEM) spent in each behavioral category during each condition, Phase 1.

Because there were no toys aside from Ranger's comfort item in the pool during the Between Sessions observations in Phase 1, these results could theoretically be caused either from the trainer interactions during the Training and Trainer Play sessions, or from the lack of toys during the Between Sessions observations. The results from Phase 2 can resolve this ambiguity, as toys now remained in the pool between sessions.

Figure 4 shows the mean proportion of observation intervals that Ranger spent interacting with objects, floating, or swimming in each of the three conditions during Phase 2. While he still spent significantly more time interacting with objects After Trainer Play than he did Between Sessions, $F(2,29) = 6.46$, $p = 0.0048$; Tukey $p = 0.015$; the difference between how long he spent interacting with objects After Training versus Between Sessions only approached significance, Tukey $p = 0.075$. He also still spent significantly less time floating both After Training and After Trainer Play than he did Between Sessions, $F(2,29) = 7.60$, $p = 0.0022$; Tukey p's = 0.002 and 0.014, respectively. Thus, interacting with a trainer, both for training and particularly for object play, resulted in Ranger playing with objects more and floating less immediately afterward when on his own. There was again no significant difference between conditions in the amount of time he spent swimming ($p = 0.91$).

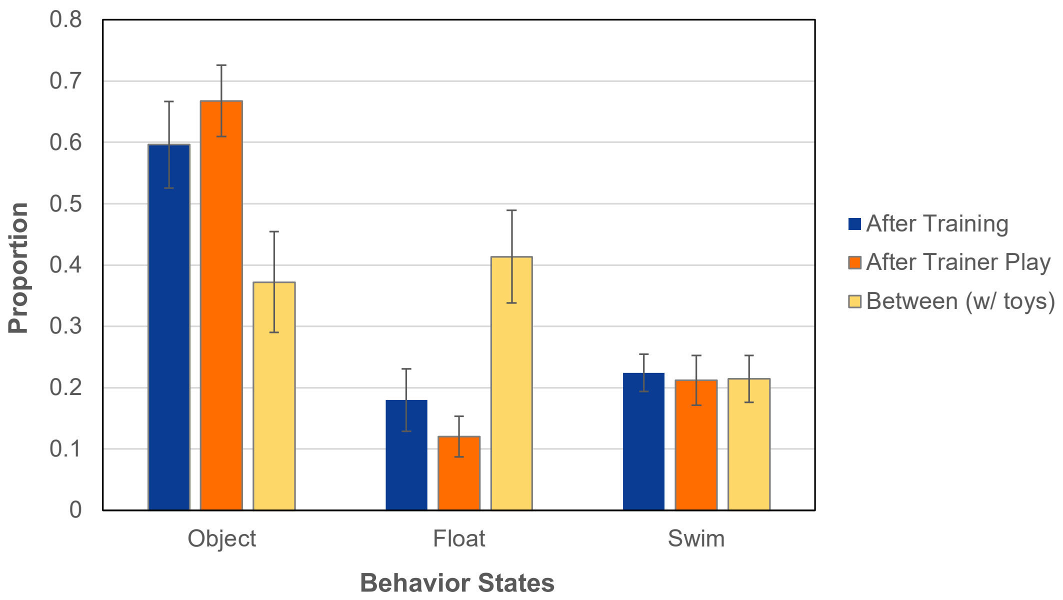

Figure 4. Mean proportion of intervals (+/−SEM) spent in each behavioral category during each condition, Phase 2.

3.2. Space Utilization

Mean SPI scores across conditions and phases ranged between 0.31 and 0.42. A low SPI (close to zero) would mean that Ranger utilized all zones equally, while a high SPI (close to 1) would mean that he spent his time in just a single zone. Thus, a medium low SPI means that he tended to distribute his activity among several zones, but not necessarily in equal proportions. There was no significant difference between conditions in Phase 1 ($p = 0.25$), and while there was a significant difference among conditions in Phase 2, $F(2,29) = 3.36$, $p = 0.049$, none of the pairwise comparisons between conditions showed significant differences, Tukey p's > 0.11. Thus, trainer interaction in either form (training or object play) did not consistently affect Ranger's utilization of space when he was on his own.

3.3. Toy Choice

In the After Trainer Play condition, Ranger interacted with toys that the trainer had recently played with significantly more than would be expected by chance, $t(23) = 2.1$, two-tailed $p = 0.047$. There was no significant effect of newness on which toys Ranger played with ($p = 0.42$).

4. Discussion

The results of this study show that interacting with a caregiver can enhance the efficacy of object based environmental enrichment for isolated animals. Specifically, a young dolphin in quarantine played with toys more and floated in place less after interacting with a caregiver than he did at times removed from caregiver interaction. This was true whether the interaction consisted of a training session involving different toys, or an object play session involving many of the same toys.

In addition to playing more with toys in general, it is notable that Ranger was more likely to play with the same toys that the trainer had played with when that option was available. This result could be attributable to either stimulus enhancement (where an observer is more likely to interact with an object because another individual interacted with that object [50]) or social referencing (where an observer uses another individual's emotional reactions to an object/situation to guide their own behavior towards it [37]). In either case, this is the first experimental evidence we are aware of to show a marine mammal interacting more with particular objects because a human recently interacted with those same objects.

Perhaps surprisingly, Ranger was no more likely to play with toys that were newly placed in his pool than toys that had already been present. This result seems at odds with previous findings that animals tend to habituate relatively quickly to enrichment toys, and are thus are more likely to interact with a known toy when it is newly placed in their environment (e.g., [19,21,51,52]). In those studies, however, only a single enrichment toy was ever present at a time. In the current study, by contrast, multiple toys were always available and the selection of specific toys changed frequently. In such an environment with multiple and variable enrichment opportunities, it may be that a newly placed familiar toy is simply not particularly salient.

It is also notable that the effects of human interaction were at least as strong after a play session (where no food was provided) than after a training session (which included food), showing that interaction with humans can enhance enrichment effects even outside of a training context. Given that the people who played with Ranger were the same people that performed training sessions with him, we cannot know for sure whether an underlying food-provider relationship may be necessary to these effects, however this may be irrelevant for practical purposes, as in almost any animal care situation the people responsible for feeding would be the people most likely to socially interact with the animals as well.

Ranger's utilization of habitat space was not consistently affected by caregiver interaction. This result may not be particularly surprising, however, given that: (a) this study was conducted in the relatively smaller and homogenous medical pool; (b) dolphins typically spend much of their time locomoting [53]; and (c) the location of caregiver interaction was not controlled or varied in any systematic fashion. Future research may wish to examine the effects of caregiver interaction on space utilization more systematically, perhaps especially with terrestrial animals that do not habitually locomote to the same extent.

Because the current results come from a single animal of a single species, it is unclear at this point the extent to which these results may be generalizable to other animals. For isolated animals in particular, the relevant science must necessarily and ethically proceed on a case-by-case basis, as we would not recommend housing social animals in isolation purely for experimental purposes. We would encourage zoos, aquaria, and stranding/rehabilitation organizations to carry out similar research on the potential benefits of caregiver interaction whenever animals must be isolated, both to advance the science and to potentially improve the welfare of the animals concerned.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/jzbg4010008/s1, Table S1: Toy List.

Author Contributions: Conceptualization, all authors; methodology, K.J., E.G., S.B. and A.H.; formal analysis, K.J.; investigation, E.G., S.B., A.H. and L.E.; visualization, K.J. and A.H.; writing—original draft preparation, K.J. and S.B.; writing—review and editing, all authors; project administration, E.G. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Data available upon request to the corresponding author.

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