12-12-2016

Behavioral Effects of Envrionmental Enrichment Devices of Tursiops truncatus

Stephanie Maiorano
smaiora@bgsu.edu

Behavioral Effects of Environmental Enrichment Devices on Captive *Tursiops truncatus*

Stephanie A. Maiorano

Bowling Green State University

Sea Life Park, Hawai'i

ABSTRACT

Many studies on environmental enrichment devices have been conducted throughout the years on both terrestrial and marine animals in captivity. However, little is known on the effect that submergible enrichment devices have on cetaceans in captivity. This study examines two male Atlantic bottlenose dolphins (*Tursiops truncatus*), Kaiko'o and Nalu, at Sea Life Park, Hawai'i and their interaction with the Magic Box: a device consisting of a submergible vegetable crate weighed down with a weight, flipped upside down with fish underneath. A total of 7 trials were conducted, with data collection on their surfacing behavior before and after the Magic Box was placed into the environment, as well as how often they interacted with the device while it was in the water. The results are inconclusive, as Kaiko'o's time spent at the surface decreased whereas Nalu's surfacing behavior was unaffected.

INTRODUCTION

The industry of captive marine mammals is a relatively new phenomenon. Cetaceans have only been on display for the public beginning in the 1860s and 1870s, with the first successful exhibit for cetaceans created by Marine Studios in 1938 (Mann et al, 2000). Marine

Studios was originally created as a means to produce safe underwater movies, however, with the large interest from the local community, Marine Studios realized that they could increase their profits tremendously by charging people to view the cetaceans on exhibit (Mann et al, 2000). Since then, advancements in husbandry care and training techniques allowed the industry to grow greatly to what it is today. Furthermore, the introduction of cetaceans in captivity allowed scientists to begin to better understand the complexity of these creatures, as it allowed them to spend more time studying them up close for extended periods of time, a task nearly impossible to accomplish when studying wild populations. During the 1950s and 60s, scientists were very interested in learning more about their cognitive abilities, as they were intrigued with how large their brain was in comparison to their body size, as it was hypothesized that larger brains correlate with greater intelligence (Clark, 2013). One of the most predominate scientists who was studying dolphin brains during that time was Dr. John Lilly with his theory that larger brains lead to more power; however, he quickly lost respect from other scientists when he began hypothesizing that cetaceans had their own language (Mann et al, 2000). By the 1970s, there were many conflicts over studying cetaceans in captivity. Some of the factors that contributed to the decline in research included the increasing costs to complete the research in combination with the loss of appreciation of behavioral studies as more interests concerning the genetics of the organisms evolved. Moreover, some people in the public began to see that dolphins were being used as "just another experimental animal" and began to lose their trust in scientists and the way the scientists were treating the animals during their experiments. As a result, studies involving social behaviors was declining and virtually nonexistent during the 1970s (Mann et al, 2000). Although scientists were able to make some discoveries on cetaceans prior to the 1970s, such as discovering echolocation in the 1950s (Clark, 2013), many factors about their

intelligence and welfare in captivity is still unknown. For instance, it is still unknown how much of a cetacean's cognitive abilities are affected by the simplistic, predictable enclosures, which at the same time are essential for meeting safety and hygiene standards for the animals as well as for the trainers (Clark, 2013).

One of the many challenges of conducting studies of animals using enrichment deceives is determining whether or not it is truly enriching. Limitations arise when observing animals in a captive setting due to the small sample size with vast differences among the individuals in the enclosure (Clark and Smith, 2013). There has also been some debate on the usage of environmental enrichment devices, due to how in some instances, the animal has to be trained to use the device, which can be interpreted as losing its ability to provide any cognitive enrichment as it eliminates the use of problem solving and allowing the organism to figure out the device by itself (Clark and Smith, 2013). Moreover, by training an animal to interact with a device, it decreases the exploratory behaviors of investigating in a certain enrichment device, which has been hypothesized that greater exploratory behaviors are linked to a greater state of well-being while in captivity (Clark and Smith, 2013). Nevertheless, many studies have been conducted with animals, both aquatic and terrestrial, using environmental enrichment devices, all of which may provide some support to the benefit of using enrichment deceives to increase the animal's health and welfare while in captivity. As stated by Delfour and Beyer (2011), the use of environmental enrichment should allow the organism to display its entire ethogram, as well as to help encourage desirable behaviors while decreasing undesirable behaviors. In terrestrial animals, many studies provide support that engaging in objects associated with a task to be solved maintained the interest of the animals to a point where they would continue the task without receiving any food as a reward. For instance, a study conducted by Clark and Smith

(2013) using captive chimpanzees showed that engaging in a maze device constructed out of PVC pipes was greater when trying to retrieve inedible toys out from the maze compared to pieces of food. This study inspired Clark et al (2013) to perform a similar study with bottlenose dolphins. In their experiment, both male and female dolphins had the opportunity to try and retrieve a rubber ball and a gelatin ball out from an underwater maze device made out of PVC pipes. Although the males were the only ones to interact with the device, there were many behaviors that were displayed which support the idea that the device provided some enrichment for the dolphins: a rostrum-sliding strategy which provides support for the idea that the device promoted problem-solving strategies; increased vigilance which provides support that the device provided a cognitive challenge as the dolphins were more interested in exploring their enclosure; and bubble production as a result from interacting with the device which correlates to possible excitement from the dolphins figuring out how to manipulate the device to retrieve the balls (Clark et al, 2013). These few examples indicate that cognitive, enriching devices for captive animals should not be food motivated, but rather should be able to maintain the animals' interests when the food is absent. Many other studies have been conducted with cetaceans, however, a majority of the studies have been conducted with floating objects, compared to submergible objects, which have been studied far less. Although floating objects may arouse immediate interest and encourage playful interaction with the device, it has been questioned whether or not floating objects serve as something that can be enriching. A study conducted by Delfour and Beyer (2012) examined the duration of 6 dolphins and their engagement with

Nalu playing with a basketball.

various floating objects in their enclosure. Their results indicate that during a 15 minute observation period, each dolphin had an average duration of 1 min interaction time with a floating object, which provides support that floating objects may not be as enriching as once believed (Delfour and Beyer, 2012). It was thus hypothesized by Clark et al (2013) that submergible objects that involve the cetacean to complete a task may promote the behavior of spending more time below the surface of the water. Another study that investigated the use of underwater enrichment was completed by Berglind (2005) and his creation of an environmental enrichment device consisting of a submerged hose actively gushing out water. As noted by Clark (2013) to be the most advanced enrichment device for dolphins thus far, Berglind hypothesized that through the random movements the hose made while underwater, in combination with water constantly flowing out of the hose, could increase the dolphins' sonar activity, and therefore, increase hunting behavior while in captivity (Berglind, 2005). Providing environmental enrichment devices for animals in captivity are a necessity in order to provide the stimulation and enrichment needed to allow the animals to achieve their highest state of wellbeing.

The purpose of this study is to create a submergible device that can provide enrichment as well serve as a cognitively challenging device for the Atlantic bottlenose dolphins in the Aloha Area, Kaiko'o and Nalu, at Sea Life Park, Hawai'i. As defined by Clark (2013), a cognitive enrichment device creates "…a task (or tasks) whose use (1) engages evolved cognitive skills by providing opportunities to solve problems and

Nalu on the left, and Kaiko'o on the right, gazing towards the Magic Box.

control some aspect of the environment, and (2) is correlated to one or more validated measures of wellbeing." By designing an environmental enrichment device (EED) to be submerged, it is hypothesized that it can promote the behavior of remaining below the surface of the water, as long as Nalu and/or Kaiko'o are interested in and are interacting with the device. The overall setup of the EED, which was later named the Magic Box, consists of a crate at the bottom of the environment, flipped over, with fish underneath. This will create a challenge that Nalu and Kaiko'o will have to solve: first, to realize that there is fish underneath the Magic Box and second, to figure out how to retrieve the fish form underneath through manipulating the Magic Box. Their surfacing behavior will be observed to determine if interactions with the Magic Box will decrease the amount of time that they spend at the surface of the water.

METHODS

Two male Atlantic bottlenose dolphins (*Tursiops truncatus*) located at Sea Life Park Hawai'i were studied in this experiment. Nalu, a 6 year old, and Kaiko'o, a 35 year old—by the time the observations were complete—were located in the Aloha pools for the duration of the experiment, which consisted of the show pool connected to the holding pool via a channel (Fig. 1).

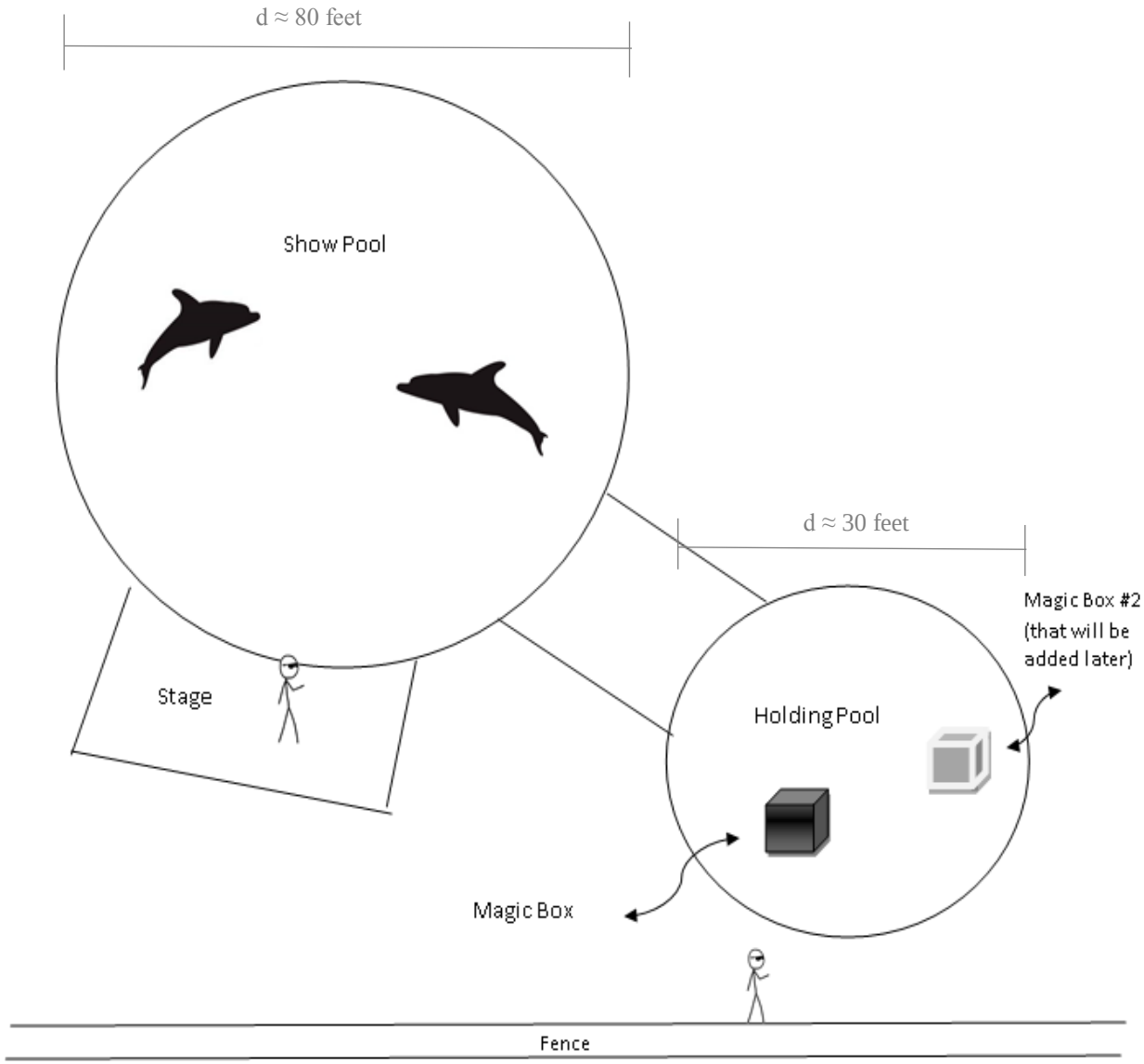


Figure 1 shows the layout of the Aloha area where Nalu and Kaiko'o reside and where the study took place. This diagram also shows where the Magic Box will be placed in the environment and where the second one would have gone if time allowed. The show pool is approximately 80 feet in diameter with a depth of approximately 14 feet, while the holding pool was approximately 30 feet in diameter with a depth of 6 feet.

Baseline Behavior

Behavioral observations were conducted, with observations being recorded via instantaneous sampling. The surfacing behavior of Nalu and Kaiko'o were recorded every 30 seconds for a duration of 5 minutes. If they were located at the surface, which entailed having some part of the body above the surface of the water, they were recorded to be "at surface." If they were beneath the surface, which entailed being completely submerged, they were recorded to be "not at surface." These behavioral observations occurred at random times throughout the day over a span of several weeks. A total number of 97 initial observations took place. These behavioral observations were also taken immediately before each new introduction of the Magic Box into the environment. A copy of the chart that was used to keep track of the surfacing behavior is seen in Table 1.

Table 1 is a copy of the behaviors observed of Nalu and Kaiko'o, whether they were located at the surface or not at the surface at a given moment in time. Each observation is referred to an instance, and after observations have been completed, the total number of "at surface" instances will be calculated and the total number of "not at surface" instances will be calculated. For each trail, there is a possible of 11 instances that will be recorded throughout the 5 minute observation period.

Dolphin Observed:		
Time & Date:		
	At Surface	Not at Surface
0:00		
0:30		
1:00		
1:30		
2:00		
2:30		
3:00		
3:30		
4:00		
4:30		
5:00		

Construction of the Magic Box/Environmental Enrichment Device (EED)

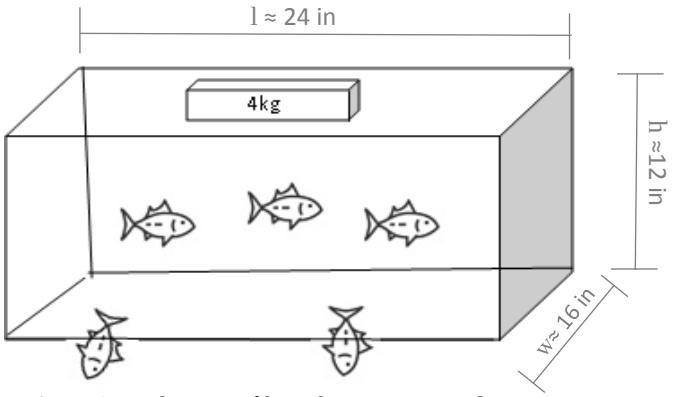


Figure 2 is a diagram of how the Magic Box, also referred to as the environmental enrichment device (EED), was assembled and how the fish was placed underneath the device while in the environment.

A vegetable crate obtained from Safeway was used. The crate was washed with soap and water, and then was sprayed with a 200ppm chlorine solution. A 4-kilogram weight was attached to the bottom of the crate and was secured with zip ties.

Introduction of the Magic Box

On the introduction of the Magic Box, two people (with at least one being a trainer), were present. Once seen that Nalu and Kaiko'o were both in the show pool, the gate connecting the two pools was closed and the Magic Box was placed into the holding pool by someone diving down and placing it in the correct location. Three whole capelin (*Mallotus villosus*) were placed underneath the Magic Box and two whole capelin were placed half way underneath the Magic Box (Fig. 2). Once the Magic Box was in place, the gate was opened and Nalu and Kaiko'o were observed for fifteen minutes, with behavioral observation dealing with interactions with the device was collected. An all occurrence sampling took place, with tallies being marked for every time Nalu or Kaiko'o appeared to be gazing towards the Magic Box and if they were interacting with the Magic Box, which consisted of making physical contact with the device (Table 2). The Magic Box was placed in the holding pool on the following days and times: Friday, August 5th at 11:35am (Trail #1); Saturday, August 6th at 9:47am (Trail #2); Wednesday, August 10 at 11:40am (Trial #3); Thursday, August 11th at 4:15pm (Trial #4); Friday, August 12th at 11:35am (Trial #5) and 2:22pm (Trial #6); and Saturday, August 13th at 9:50am (Trial #7).

Top: In holding pool with the EED in one hand and capelin in the other. **Bottom:** Diving down and placing the capelin underneath the EED.

Table 2 is a copy of the chart that was used to record the behavior of Nalu and Kaiko'o while the environmental enrichment device (EED), aka the Magic Box, was in the water. Any behavior that appeared as if they were gazing in the direction towards the EED were tallied under "gazing at EED." If any physical contact was made with the EED, it was considered "interacting with the EED."

Dolphin Observed:								
Time & Date:								
	0-0:59	1:00-1:59	2:00-2:59	3:00-3:59	4:00-4:59	5:00-5:59	6:00-6:59	7:00-7:59
Gazing at EED								
Interacting with EED								
	8:00-8:59	9:00-9:59	10:00-10:59	11:00-11:59	12:00-12:59	13:00-13:59	14:00-14:59	
Gazing at EED								
Interacting with EED								

Post Behavior

Once the 15 minute period elapsed, the gate was closed after Nalu and Kaiko'o swam out of the holding pool. If Nalu and Kaiko'o did not readily swim out of the holding pool, the trainer called both dolphins to station in the show pool while the other observer closed the gate. The Magic Box and any leftover fish was removed by a Shepard's hook and a net, or by someone diving down to retrieve the items. Once all of the items were removed, the gate was opened, and another behavioral observation documenting surfacing behavior for five minutes was recorded.

If Targeted Behavior was Achieved

Once Nalu and/or Kaiko'o learned how to flip over the Magic Box and had several sessions of successfully flipping over the crate, a second crate would be added into the environment. With each new session of the two Magic Boxes being placed in the environment, the items under the crate would begin to vary alternating between placing fish and toys underneath the crates. The toys that would be placed underneath will be toys Sea Life Park has already acquired, and can include rings and any other submergible toys that can fit inside of the

crates. One session would have fish underneath one crate and nothing underneath the other, another session would have one crate with toys and one without, and another session would have one with fish and one with toys. Moreover, once the dolphins seemed to have mastered the concept of flipping over the crates and associating the engagement with the device with a primary or secondary reward, additional weights will be added to the crates to make the process of flipping the Magic Boxes more challenging for the dolphins.

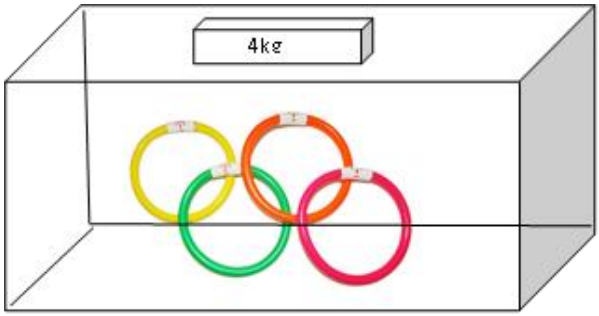


Figure 3 is a diagram of how the second Magic Box would look when in the environment. Instead of fish under the crate, any type of submergible toy already approved by Sea Life Park that fits could be placed underneath.

RESULTS

The Magic Box was introduced into the holding pool a total of 7 times and the total number of instances where Nalu and Kaiko'o were either at the surface or not at the surface

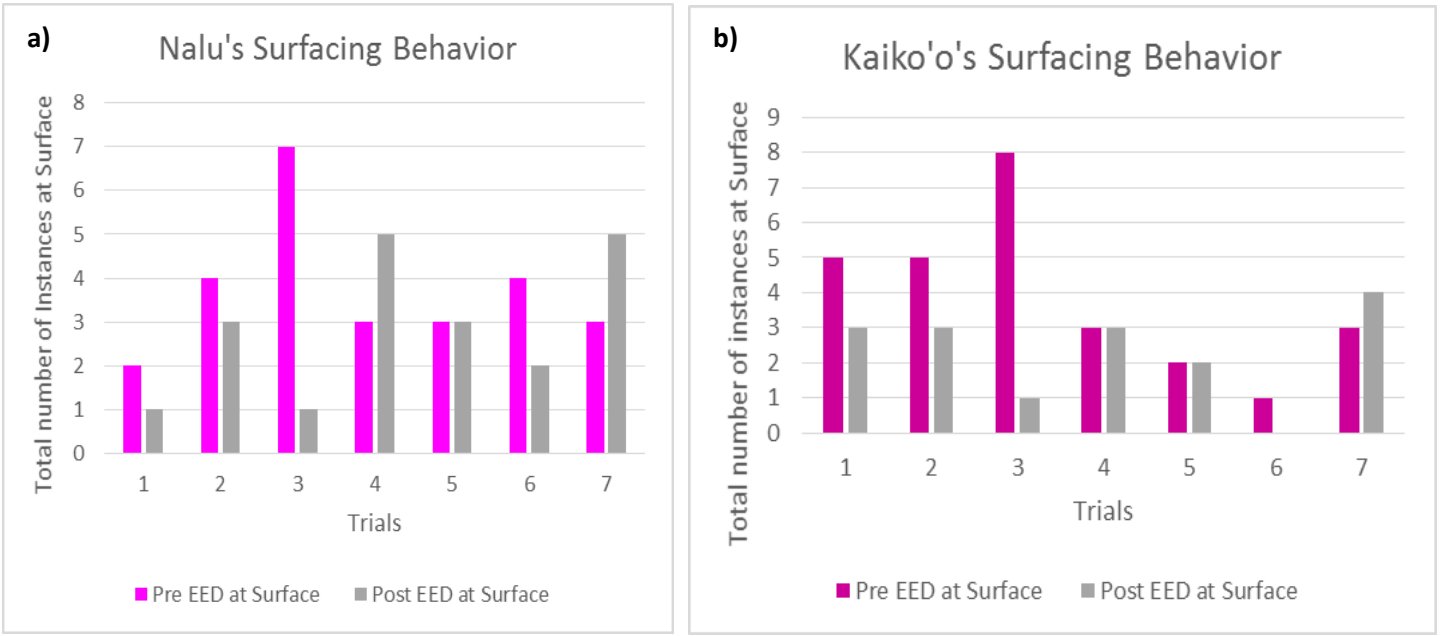


Figure 4 (a) and (b) charts the surfacing behavior immediately before the EED was placed into the environment and immediately after it was removed from the environment. The trail number corresponds to the day and time that the particular observation occurred. Each observation lasted for a duration of 5 minutes, with a total number of 11 instances being recorded. The total number of instances that Nalu and Kaiko'o were seen at the surface are plotted above.

before and after the Magic Box was in the water was plotted (Fig.4). To determine whether or not the Magic Box had an effect on the amount of time Nalu and Kaiko'o spend at the surface, the average difference between the pre-surfacing behavior and the post-surfacing behavior was calculated (Fig. 5). The total number of instances that Nalu and Kaiko'o spent at the surface before the Magic Box was placed in the water was subtracted with the number of instances that Nalu and Kaiko'o spent at the surface after the Magic Box was removed from the environment. The value obtained from each trial was then averaged. Based on the calculations, any value above zero would support the idea that the presence of the Magic Box would decrease the amount of time spent at the surface, and any value below zero would support the idea that the presence of the Magic Box would increase the amount of time spent at the surface. The average difference between Nalu's pre and post surfacing behavior was 0.857 instances. The standard error was then calculated with a value of ± 1.033, creating an error range of -0.176 to 1.89. This indicates that the Magic Box did not affect Nalu's surfacing behavior. The average difference between Kaiko'o's pre and post surfacing

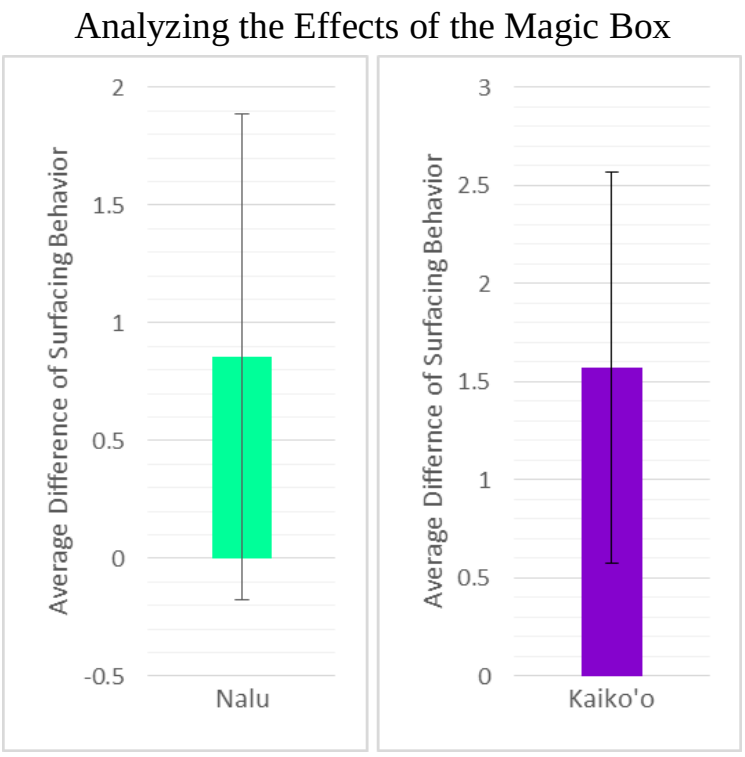


Figure 5 charts the mean of the differences of pre and post surfacing instances for Nalu and Kaiko'o. The differences between the instances recorded for the Pre EED and Post EED was calculated for each trial, and then the average of all the values were calculated. The average difference of instances for being at the surface for Nalu was 0.857 instances, with a standard error of ± 1.033. This indicates that the EED may not have had much of an effect on Nalu's surfacing behavior, as the error bar dips below zero, indicating an increase at the surface. The average difference of instances for being at the surface for Kaiko'o was 1.571 instances, with a standard error of ± 0.997. This indicates that the EED may have had a slight effect on Kaiko'o, favoring a decrease in time spent at the surface.

behavior was 1.571 instances. The standard error was then calculated with a value of ± 0.997, creating an error range from 0.574 to 2568. This indicates that the Magic Box had some effect in being able to decrease the amount of time that Kaiko'o spends at the surface.

When the surfacing behaviors of both Nalu and Kaiko'o were charted on the same graph, it showed how they both have similar surfacing behaviors (Fig. 6). As Nalu or Kaiko'o spent more time at the surface, the other would follow, and vice versa.

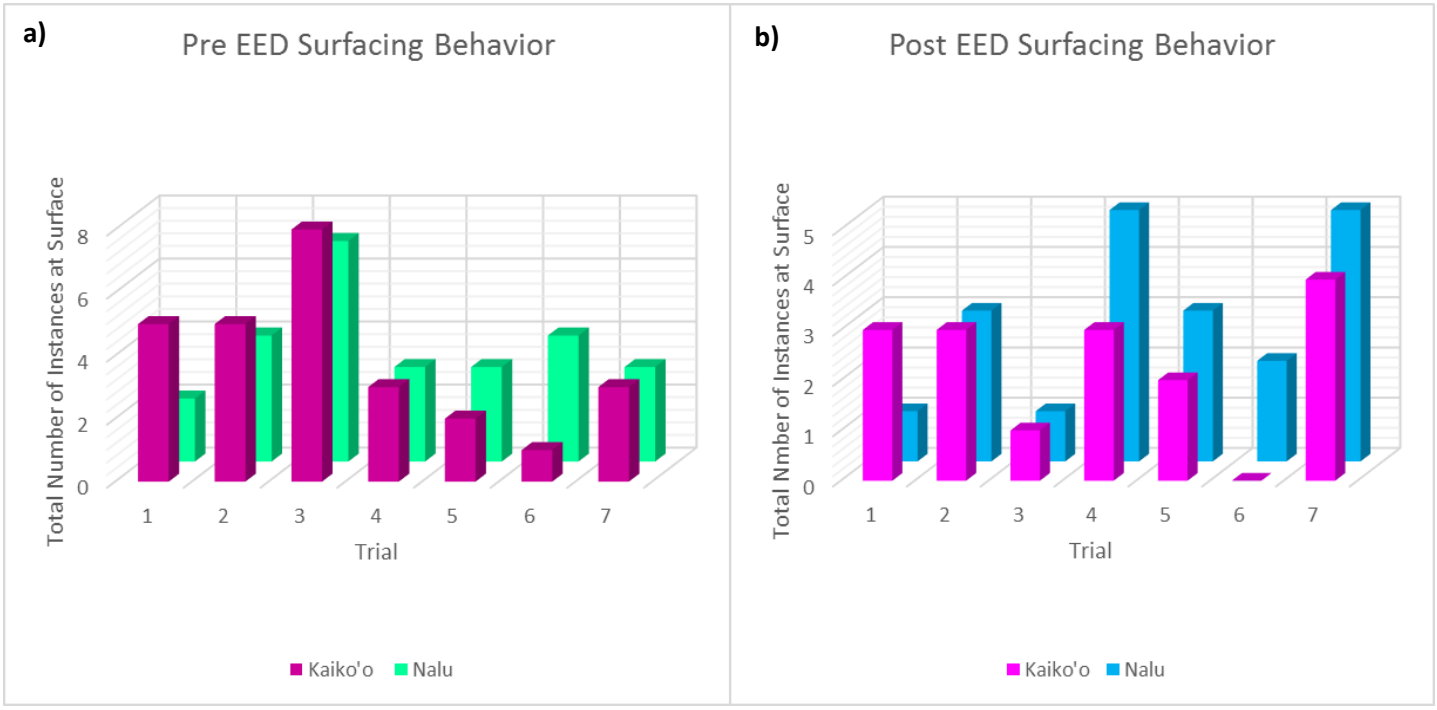


Figure 6 (a) and (b) combines data from Figure 5 to analyze the possible effect on surfacing behavior Nalu and Kaiko'o may have on each other. Both figures indicate that as one would spend more time at the surface, the other would follow.

While the Magic Box was in the water, the behaviors were recorded, whether they were gazing in the direction towards the device or if they were interacting with the device, which entailed making physical contact (Fig. 7). During trial #1, Nalu immediately ate the two pieces of fish that were sticking out from the Magic Box and one that floated out from underneath. For trial #2, Nalu again was able to immediately get one of the fish that was sticking out of the Magic Box. During this session, Kaiko'o was able to retrieve two fish that ended up floating out from underneath. Up until this point, both Nalu and Kaiko'o would swim into the holding pool,

gaze towards the Magic Box, and then swim out. However, during trial #3, which occurred 4 days after trial #2, Nalu and Kaiko'o were finally seen interacting with the Magic Box more often, as they were taking turns nudging and pushing the crate around the bottom of the holding pool. During trial #4, which was the only trial that occurred at the end of the day, both Nalu and Kaiko'o spent the majority of their time swimming around the holding pool, making occasional glances at the crate as well making some physical contact with the crate. During this session, the lead trainer present was sounding her bridge whistle when either Nalu or Kaiko'o were interacting with the Magic Box, in hopes to encourage Nalu and Kaiko'o to keep interacting with the device. For trial #6, I stacked three rings on top of each other and placed them underneath one of the sides of the Magic Box, in hopes to show Nalu and Kaiko'o that the crate could be raised slightly and that the crate could be flipped over. However, right when the gate to the holding pool was opened, the water current with the combination of both dolphins swimming shifted the crate enough that the crate was no longer tilted by the rings. During trail #7, I put four rings under one side of the crate, however the rings ended up sliding out from underneath the crate again. However, it was during this interaction where Nalu was interacting with the Magic Box the most and even pushed it to one side of the holding pool and then pushed it back towards the middle of the area. Figure 7 plot the number of times that Nalu and Kaiko'o were gazing and interacting with the device. As seen in Nalu's graph, with each new introduction with the Magic Box, he seemed to be more interested with the device, as the number of directed gazes towards the Magic Box and the number of interactions with the device increased. Kaiko'o on the other

hand was interested with the device for the first few trials, and then lost interest, as the number of times interacting and gazing toward the device decreased.

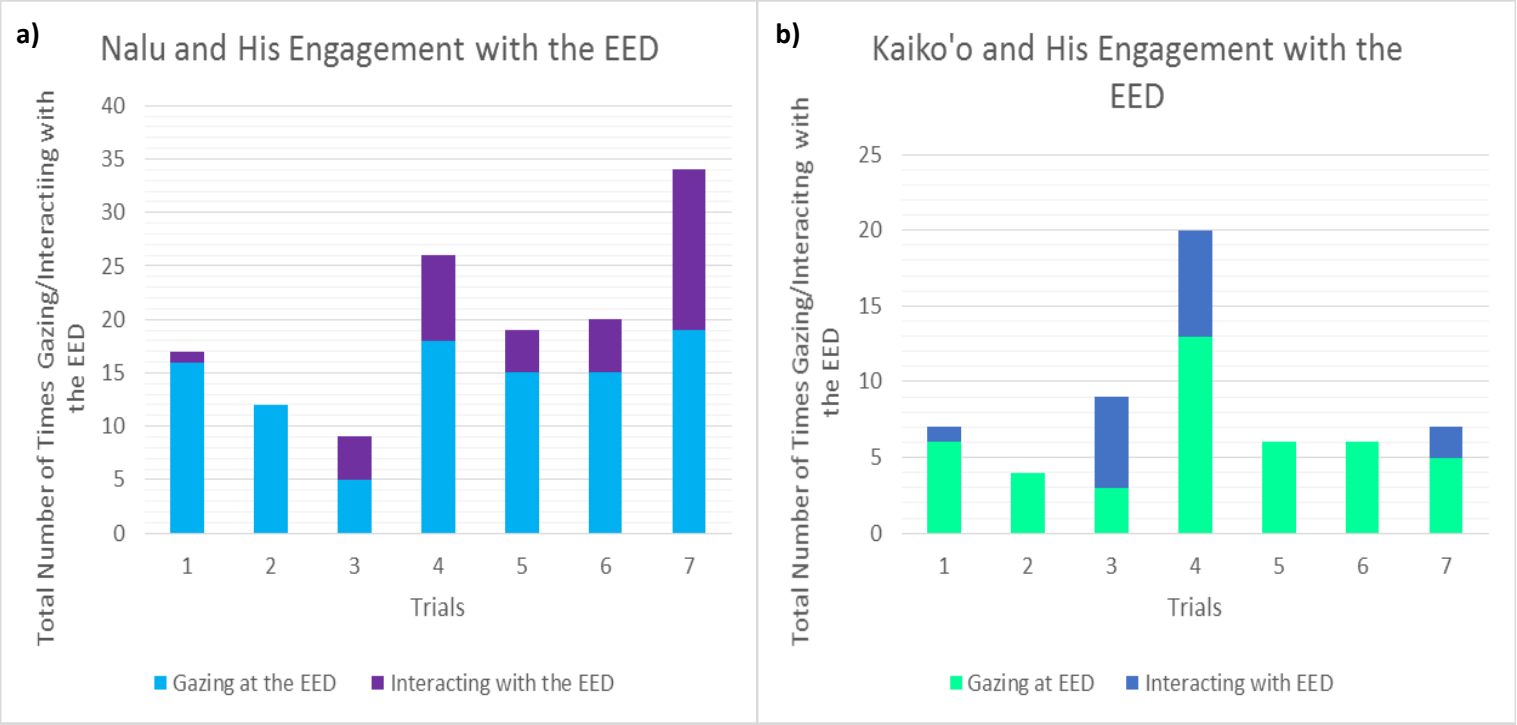


Figure 7 (a) and (b) documents Nalu's and Kaiko'o's behavior while the EED was in their environment. Observations were recorded for the full 15 minutes that the device was in the water. The total number of times when either dolphin had their gaze directed towards the EED or when either dolphin made any physical contact with the device, which was considered interacting with the EED, was recorded. The trial number corresponds to a particular day and time that the observation took place. As the number of trials increased, as seen in figure (a), Nalu became more interested in the EED, as the number of interactions and gazing instances increased. For Kaiko'o on the other hand, had increasing interests up until trail 4 and after trial 4, Kaiko'o may have become habituated with the device.

DISCUSSION

The results provide support that the Magic Box did have a slight effect on surfacing behavior for Kaiko'o, as his time spent at the surface of the water decreased, whereas Nalu did not have much of an effect from the Magic Box, regardless of the fact that he spent more time engaged with the device. With each new introduction of the Magic Box into the environment, Nalu was becoming more interested with the device as his interactions with the device increased, whereas Kaiko'o slowly built up interest, and then lost interest towards the end of the study.

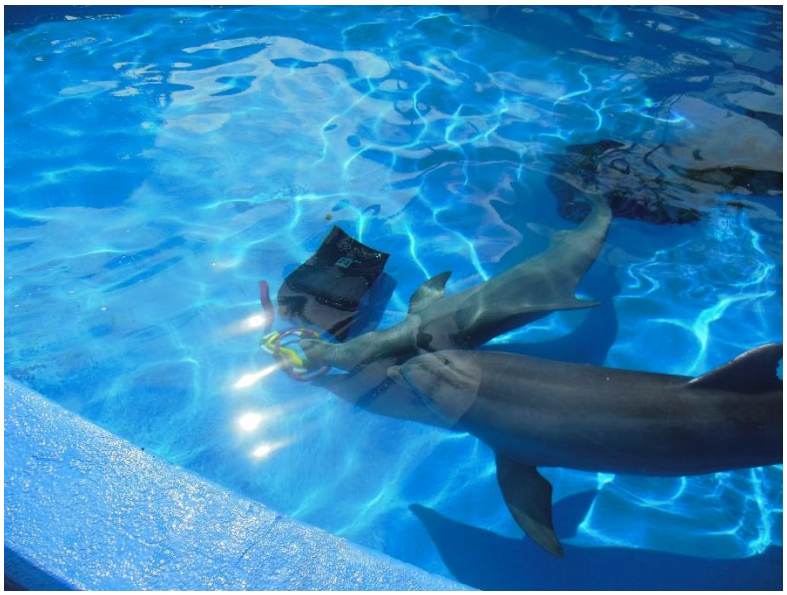
This is most likely a result of the vast age difference between Kaiko'o and Nalu. Nalu being only six years old during the study, compared to Kaiko'o at thirty-five years old, Nalu most likely had more energy and was more curious, which resulted in him spending more time interacting with the Magic Box. Delfour and Beyer (2011) mention in their article that younger animals tend to be more playful, however, they also mention how dolphins of all ages are known to display playful behaviors. Another interesting find was the results for the surfacing behavior of Nalu and Kaiko'o examined together. As seen in Figure 6, the amount of time that Nalu and Kaiko'o spent at the surface correlated with one another, for as one spent more time at the surface, the other followed and vice versa. Nalu and Kaiko'o have always lived in the same environment together, and therefore, can conclude that they most likely formed a relationship with one another. As a result, they seemed to spend a good portion of their time swimming together throughout their environment. This study was conducted with both of them together, due to space constraints and providing the safest introduction and removal of the Magic Box into the water. Being together evidently influenced their pre and post surfacing behavior, however when Nalu and Kaiko'o were exposed to the Magic Box, being together did not seem to influence how the other interacted with the Magic Box, as their amount of interactions differed from each another.

Creating the Magic Box in a way that it could be both cognitively challenging for the dolphins as well as enriching was a challenging process. In a study by Delfour and Beyer (2011), they provide evidence that objects that are simple and easy to manipulate are more likely to keep a dolphin interested, as it would not get frustrated as easily. Moreover, objects that remain in the environment for shorter periods of time, rather than for long periods of time are more likely to increase the object's enriching effects, as habituation does not have as much of an

effect (Kuczaj et al, 2002). Keeping this in mind was the main reason why I tried to keep the construction of the Magic Box fairly simple. Moreover, with all of the holes in the crate, Nalu and Kaiko'o could potentially use their echolocation to see through the crate and then try to figure out how to retrieve the objects from underneath. This design, I believed was simple yet challenging enough to provide some enrichment for Nalu and Kaiko'o. Furthermore, since the Magic Box was only in the environment for 15 minutes at a time, I believe it gave Nalu and Kaiko'o enough time to interact with the device without becoming habituated with the device. However, it is not clearly understood if this device successfully provided a cognitive challenge for Nalu and Kaiko'o. The fact that neither Nalu nor Kaiko'o figured out how to flip over the crate provides some support that the device did provide a challenge. Moreover, the challenge I created was either too challenging for them at that time, or I did not provide them with enough time to figure out how to flip over the Magic Box. Furthermore, as demonstrated by Nalu, the device appeared to keep Nalu engaged as he spent an increasingly amount of time interacting with it, as if he was trying to figure out what the Magic Box was supposed to do.

Due to time restraints, I was unable to introduce the second crate into the environment. I ended up spending most of the summer taking baseline behavior while finalizing my protocol that by the time that the Magic Box was approved, I only had about a week left to put the Magic Box in the environment. During those times that the Magic Box was in the water, Nalu and Kaiko'o learned to push the crate around in order to retrieve the fish out from underneath, however, they were not able to figure out how to flip over the crate. Although it was initially planned to have the two observers as far away from the water as possible, while still being close enough to still have a good view of the device, this did not turn out to be the case. In order to more accurately record if Nalu and Kaiko'o were making any physical contact with the device, I

ended up standing close to the edge, overlooking where the Magic Box was in the water. As a result, Nalu and Kaiko'o most likely detected the presence of me and any other observers standing close by during the time the device was in the water. Something to try in future studies is to have Nalu and Kaiko'o become accustomed to having some sort of underwater camera in the water, such as a go-pro, so their interactions with the device could be videotaped, allowing observers to stand further away, unnoticed by the dolphins. However, further investigation would have to go into how to attach the underwater camera in the environment while not creating a safety hazard for the animals. If this can be achieved, it will allow us to get a better view of what Nalu and Kaiko'o are doing with the device and would allow the observer to stand further away. Future studies can continue the procedure of putting rings underneath the Magic Box to help tilt it, in order for Nalu and Kaiko'o to learn that the crate can be flipped over. Once Nalu and Kaiko'o figure out how to flip over the crate, the second crate can be added into the environment. With having one crate with fish underneath and one without, future studies could be conducted to see how long it takes the dolphins to retrieve the fish underneath the correct crate.



Both Nalu and Kaiko'o gazing in the direction towards the Magic Box. Here, dive rings were used to try and tilt the crate, however they ended up sliding out from underneath the crate.

This device is inconclusive with its results in its ability to provide a cognitively challenging enriching device and its ability to affect the surfacing behavior of the individual

being observed. Many more studies can be performed to see if similar submergible objects can produce clearer results. According to Clark (2013), submergible objects as enrichment devices has been used far less than those that float on the surface, and therefore, not many studies have been performed to know about their significance. By conducting more studies with underwater enrichment devices, we would be able to better understand the effect it can have on dolphins living in a captive setting and provide more opportunities to make captivity more enriching for marine animals.

ACKNOWLEDGMENTS

I would like to give special thanks to the staff at Sea Life Park, Hawai'i, for helping me develop my EED, especially Jeff Pawloski the Animal Curator, Kandace Campbell the Education Supervisor, and the trainers in the Aloha Area, including the lead trainer Martha Hill, and trainers Azu Zarate and Katie Russell. Lastly, a special thanks to professors Dr. Daniel Wiegmann and Dr. Verner Bingman at Bowling Green State University for helping me analyze and interpret the results of the EED.

REFERENCES

Berglind, M. (2005). Acoustic enrichment for dolphins in pool environment. *Cms.Ifm.Liu.Se*. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Acoustic+enrichment+for+dolphins+in+pool+environment#0

Clark, F. E. (2013). Marine mammal cognition and captive care : A proposal for cognitive enrichment in zoos and aquariums. *Journal of Zoo and Aquarium Research*, *1*(1981), 1–6.

Clark, F. E., Davies, S. L., Madigan, A. W., Warner, A. J., & Kuczaj, S. a. (2013). Cognitive enrichment for bottlenose Dolphins (Tursiops truncatus): Evaluation of a novel underwater maze device. *Zoo Biology*, *32*(6), 608–619. http://doi.org/10.1002/zoo.21096

Clark, F. E., & Smith, L. J. (2013). Effect of a cognitive challenge device containing food and non-food rewards on chimpanzee well-being. *American Journal of Primatology*, *75*(8), 807–816. http://doi.org/10.1002/ajp.22141

Delfour, F., & Beyer, H. (2012). Assessing the effectiveness of environmental enrichment in bottlenose dolphins (Tursiops truncatus). *Zoo Biology*, *31*(2), 137–150. http://doi.org/10.1002/zoo.20383

Kuczaj, S., Lacinak, T., Fad, O., Trone, M., Solangi, M., & Ramos, J. (2012). Keeping environmental enrichment enriching. *International Journal of Comparative Psychology* (15), 127–137. http://doi.org/10.5811/westjem.2011.5.6700

Mann, J., Connor, R., Tyack, P., & Whitehead, H. (2000). *Cetacean societies: Field studies of dolphins and whales.* Chicago, IL: University of Chicago Press.