Assessing the Effectiveness of Environmental Enrichment in Bottlenose Dolphins (Tursiops truncatus)

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Environmental enrichment is often used to improve well-being and reduce stereotyped behaviors in animals under human care. However, the use of objects to enrich animal environments should not be considered to be effective until its success has been scientifically demonstrated. This study was conducted at Asterix Park in France in April 2009. The study investigated the use of 21 familiar objects with a group of six bottlenose dolphins (Tursiops truncatus). The dolphin trainers introduced four different objects into the dolphin pool every day on a rotating basis. Using a focal-object sampling method, we collected and analyzed data from twenty-one 15-min sessions. The results revealed a positive correlation between interest behaviors and interactive behaviors. Some dolphins had “favorite toys”. However, only 50% of objects elicited manipulative behaviors. These findings demonstrate that dolphins do not treat all objects provided to them as “toys”. Behavioral changes in the animals subsequent to the introduction of objects do not necessarily indicate an enrichment effect of the objects; rather, the motivation for the dolphins’ behaviors toward the objects must be investigated. The animals’ behavior must be considered in light of the social context and of the animals’ individual behavioral profiles. The relevance of a constructivist approach to evaluating the effectiveness of enrichment programs is discussed. Zoo Biol 29:1–14, 2011.
INTRODUCTION

Scientific consideration of the welfare and well-being of animals in human care has grown over the past decades. Efforts to decrease the poverty of captive environments have included consideration of the following variables: group composition, diversity of diet, the physical enclosure space, and interactions between keepers, visitors, and animals. Environmental enrichment is the term frequently used to refer to improvement in animals' physical and/or social surroundings. Environmental enrichment has been defined as any technique designed to improve the biological functioning (e.g., increase lifetime reproductive success, increase fitness or overall health) of a captive animal through modifications to the animal's environment [Newberry, 1995]. Researchers in this area have discussed the history of environmental enrichment [Mellen and MacPhee, 2001] and defined the term welfare vs. the term well-being [Broom, 1991; Dawkins, 1990; Delfour and Lassalle, 1996; Fraser, 2009]. Animal welfare refers to the degree to which an animal copes with its physical and social environment: doing well. Well-being refers to the affective states of the animal: suffering, distress, etc., being well. Researchers established criteria for evaluating the two latter parameters in animals. The most recognized criteria are the five freedoms [Brambell, 1965]: F1: freedom from hunger, thirst, and malnutrition; F2: freedom from physical discomfort; F3: freedom from pain, wounds, and sickness; F4: freedom from fear, stress, and distress; and F5: freedom to display the behavioral repertoire of the species.

Environmental enrichment is an approach designed to encourage animals under human care to display their complete ethogram. Environmental enrichment can be used to reinforce the appearance of desirable behaviors (e.g., exploratory behavior, affiliative play, or foraging behaviors), decrease the frequency of undesirable behaviors (e.g., aggressive behavior, stereotypic behaviors, self-mutilation) [Chamove, 1989], decrease bad feeding habits (e.g., coprophagy or regurgitation), and reduce excessive self-directed behaviors [Bloomsmith, 1989]. These objectives are often targeted through multiple enrichment components; the preferred type of enrichment is a function of the given situation. Types of enrichment include (1) visual enrichment (e.g., mirrors or televisions), (2) auditory enrichment (playback of animal vocalizations or music), (3) olfactory enrichment (natural or artificial scents), (4) feeding enrichment (search time, capture, and extraction of scattered, hidden, whole, or live food), (5) tactile enrichment (provision of balls, bags, and various other objects), (6) structural enrichment (changes in the physical space of the enclosure), (7) social enrichment (addition or removal of partner or partners), and (8) human/animal interactions (e.g., positively reinforced interactions between animals and keepers or animals and visitors; husbandry training) [Hoy et al., 2009].

Today, environmental enrichment for captive animals is a widespread practice at zoos, aquariums, and dolphinariums. A search of the scientific literature reveals a number of references to enrichment programs. For example, frozen fish, bones, or carcasses, and different types of spices have been used with several species of felidaes [McPhee, 2002; Skibiel et al., 2007]; destructible (e.g., mirrors; cardboard, paper, plastic, or cloth materials; rubber cones) and indestructible (e.g., Kong toys©, Kong, Golden, CO and rigid plastic balls) objects have been employed as enrichment devices with chimpanzees (Pan troglodytes) [Lambeth and Bloomsmith, 1992; Videan et al., 2005]. A variety of colored objects have been used with chimpanzees and...
gorillas (*Gorilla gorilla*) [Wells et al., 2008], whereas capuchin monkeys were provided with sticks and straws (*Cebus apella, C. capucinus*) to retrieve food (peanut butter or honey) hidden in PVC pipes or submerged in a pool [Fragaszy et al., 2004]. Where marine mammals are concerned, frozen fish or fish from food dispensers seemed to increase desirable behaviors in orphaned Pacific walrus calves (*Odobenus rosmarus divergens*) [Kastelein et al., 2007], whereas for Polar bears (*Ursus maritimus*), the structural design of the enclosure (complex topography and multiple pathways) was demonstrated to be particularly important [Renner and Kelly, 2006]. There is little documentation about tactile and acoustic enrichment for bottlenose dolphins (*Tursiops truncatus*) [Krajnaik, 1996; Berglind, 2005].

In some cases, environmental enrichment programs have had the positive effect of decreasing stereotypic behaviors [Hunter et al., 2002; Montaudouin and Le Pape, 2005; Mason et al., 2007; Smith and Litchfield, 2010]. However, caution must be used to ensure that the enrichment methods are mastered before their application. Recently, several authors have documented the critical need for scientific measurement of the effectiveness of enrichment programs, and of the tangible impact of the program on the subjects’ welfare (physical health) and well-being (mental/psychological health) [Swaisgood and Shepherdson, 2005; Schetini de Azevedo et al., 2007]. Newberry [1995] denounced the lack of rigorous scientific methods used in the 1990s in the implementation of enrichment programs and the interpretation of their benefits to the animals. The adoption of ethological methods permits not only the consideration of animal welfare and well-being, but also the creation of several indices to measure these variables. The primary advantage to this approach is that it uses nonintrusive methods to indirectly or directly (e.g., tests of preferences) investigate animals’ reactions to enrichment programs [Delfour and Lassalle, 1996].

Given the limited documented scientific research about enrichment programs with captive dolphins, we decided to conduct an ethological study on a group of bottlenose dolphins (*T. truncatus*). This study was designed to measure the animals’ interest and behavioral reactions toward objects introduced into their pools. The results are discussed in the perspective of animal well-being. In addition, we suggest the use of a new theoretical framework (constructivist ethology) in which to consider animals’ individual behavioral profiles, in order to better evaluate the needs and experience of each subject.

**METHOD**

This study was conducted at the dolphinarium at Asterix Park in France in April 2009. At the time, the park had six bottlenose dolphins (*T. truncatus*) (Table 1) swimming outside and inside pools (3,240 and 550 m³, respectively).

The dolphinarium is closed to visitors over the lunch break every day from 12:00 to 13:00 hr. During the break, trainers introduced between three and five different objects into the dolphins’ pools. The objects were different every day, as per prior random selection (statistical probability). The dolphins were familiarized with all objects for at least 1 year. They had the opportunity to interact freely with objects placed in their pools without human reinforcement (e.g., whistles, food, vocal encouragement). Twenty-one familiar objects were used (Table 2).

*Zoo Biology*
The observations were recorded using a JVC video camera (JVC France SAS, Carrière sur Seine, France), the durations of the displayed behaviors were calculated using Cyberlink PowerCinema NE (CyberLink Corp (freelance) Shindian City, Taipei, Taiwan) for Everio. The order of the objects introduced to the animals during the observation sessions was determined at random before each respective session (statistical probability). Within each 15 min focal sampling [Altmann, 1974] period, three 5 min segments were recorded, documenting the dolphins’ reaction to the four objects present in the main pool during that segment. All observation sessions were conducted in the outside pool. The total duration of the observations was 315 min. Twenty-one sessions were recorded over 15 days, with each session being 15 min long.

We established a Principal Component Analysis (PCA) to determine which objects elicited interest and/or interaction behaviors [for more details, see Shaw, 2003]. Using SPAD 5.5, we entered the values for each object corresponding to the four following variables: duration of interest behavior, duration of interaction (manipulative behavior), occurrence of interest behavior, and occurrence of interaction. PCA aimed to group objects with similar behavioral responses together in comparing their coordinates for the four variables. PCA resulted in a graphical output where objects were placed depending on the behavioral responses they elicited.

**RESULTS**

**Dolphins’ Behaviors (Interest vs. Interaction) Toward the Objects**

The dolphins displayed significantly more interactive behaviors (i.e., manipulation of the objects) \( M = 58.81, SD = 146.44 \) than interest behaviors (i.e., looking at the objects) \( M = 41.87, SD = 50.32 \) (Mann–Whitney, \( U = 134, P < 0.05 \)). Some objects elicited more interactive behavior than did others [large standard deviation (SD)].

**Interest and/or Interaction Elicited by Each Object**

PCA identified one principal factor, Factor 1 (horizontal axe), with eigenvalue \( \geq 1 \), which explained 90% of the total variance. Any relative contribution of 0.25 (= 1/4) or above was considered relevant for the variable loading on each factor. The strongest contributions to Factor 1 were the variables duration and

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**Table 1. Dolphins: Name, Sex, and Age**

<table>
<thead>
<tr>
<th>Name</th>
<th>Sex</th>
<th>Age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aya</td>
<td>Female</td>
<td>13</td>
</tr>
<tr>
<td>Baily</td>
<td>Female</td>
<td>10</td>
</tr>
<tr>
<td>Balasi</td>
<td>Male</td>
<td>5</td>
</tr>
<tr>
<td>Beauty</td>
<td>Female</td>
<td>( \approx 39 )</td>
</tr>
<tr>
<td>Femke</td>
<td>Female</td>
<td>( \approx 26 )</td>
</tr>
<tr>
<td>Guama</td>
<td>Male</td>
<td>( \approx 25 )</td>
</tr>
</tbody>
</table>

Femke arrived at Asterix Park in June 2008; Baily was pregnant during the study.
### TABLE 2. Pictures and Descriptions of Objects Tested in the Dolphins’ Pool as Enrichment Items

<table>
<thead>
<tr>
<th>No.</th>
<th>Photo</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1.jpg" alt="Photo" /></td>
<td>Water hoses</td>
</tr>
<tr>
<td>2</td>
<td><img src="image2.jpg" alt="Photo" /></td>
<td>Foam mattress (200 × 100 × 8 cm)</td>
</tr>
<tr>
<td>3</td>
<td><img src="image3.jpg" alt="Photo" /></td>
<td>Collection of rubber objects (L = 191 cm)</td>
</tr>
<tr>
<td>4</td>
<td><img src="image4.jpg" alt="Photo" /></td>
<td>Plastic hoop with foam (d = 83 cm)</td>
</tr>
<tr>
<td>5</td>
<td><img src="image5.jpg" alt="Photo" /></td>
<td>Plastic hoops with foam and plastic pieces (d = 93 cm)</td>
</tr>
<tr>
<td>6</td>
<td><img src="image6.jpg" alt="Photo" /></td>
<td>Foam mattress with holes (71.5 × 48 × 8 cm)</td>
</tr>
<tr>
<td>7</td>
<td><img src="image7.jpg" alt="Photo" /></td>
<td>Fish-shaped foam mattress (95 × 48.5 × 9 cm)</td>
</tr>
<tr>
<td>8</td>
<td><img src="image8.jpg" alt="Photo" /></td>
<td>Collection of plastic and rubber objects (L = 100.5 cm)</td>
</tr>
<tr>
<td>No.</td>
<td>Photo</td>
<td>Description</td>
</tr>
<tr>
<td>-----</td>
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</tr>
<tr>
<td>9</td>
<td><img src="image9.png" alt="Image" /></td>
<td>Suspended buoy</td>
</tr>
<tr>
<td>10</td>
<td><img src="image10.png" alt="Image" /></td>
<td>Collection of plastic and rubber objects ($L = 90 \text{ cm}$)</td>
</tr>
<tr>
<td>11</td>
<td><img src="image11.png" alt="Image" /></td>
<td>Buoy and funnel ($L = 115 \text{ cm}$)</td>
</tr>
<tr>
<td>12</td>
<td><img src="image12.png" alt="Image" /></td>
<td>Buoy and jar ($L = 116 \text{ cm}$)</td>
</tr>
<tr>
<td>13</td>
<td><img src="image13.png" alt="Image" /></td>
<td>Plastic plate with rubber pipes ($d = 75 \text{ cm}$, $L = 65 \text{ cm}$)</td>
</tr>
<tr>
<td>14</td>
<td><img src="image14.png" alt="Image" /></td>
<td>Collection of plastic and rubber objects ($L = 144 \text{ cm}$)</td>
</tr>
<tr>
<td>15</td>
<td><img src="image15.png" alt="Image" /></td>
<td>Collection of foam sticks ($94.4 \times 12 \times 11 \text{ cm}$)</td>
</tr>
<tr>
<td>16</td>
<td><img src="image16.png" alt="Image" /></td>
<td>Plastic ball ($d = 32 \text{ cm}$)</td>
</tr>
<tr>
<td>17</td>
<td><img src="image17.png" alt="Image" /></td>
<td>Firemen hoses ($L = 150 \text{ cm}$)</td>
</tr>
</tbody>
</table>
occurrence of interest behavior (both with 0.26). The variables duration and occurrence of interaction contributed to Factor 2, the vertical axe.

Objects on the right of the plot (Fig. 1) presented the highest values for the variables contributing to the horizontal axe, Factor 1, whereas those on the left presented the lowest values. The same reasoning applies for the vertical axe, Factor 2, with objects placed on the top or the bottom of the plot. Thus, objects 7, 8, 4, 1, 2, and 6 elicited sustained manipulative behaviors and objects 7, 8, 17, 4, 1, 2, 5, and 20 elicited sustained interest behaviors (objects are listed in decreasing order of duration of manipulation/interest).

Objects 7, 8, 1, 4, 2, 9, 6, and 20 elicited frequent manipulative behaviors and objects 7, 17, 8, 1, 4, 20, 2, and 5 elicited frequent interest behaviors (objects are listed in decreasing order of frequency of manipulation/interest).

The objects that elicited behavioral responses were: (1) two outdoor water hoses, (2) a square foam mattress, (4) a plastic hoop with a piece of foam attached by tape; (5) a plastic hoop with a piece of foam attached by tape with additional hanging pieces of plastic; (6) a square foam mattress with holes in it; (7) a fish-shaped foam mattress; (8) a collection of several objects; (9) a suspended ball (target used during dolphin shows); (11) a buoy and funnel; (17) pieces of firemen hoses; and (20) a collection of several objects.

TABLE 2. Continued

<table>
<thead>
<tr>
<th>No.</th>
<th>Photo</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td><img src="https://example.com/image18" alt="Image" /></td>
<td>Rubber mattress filled with plastic objects ((80 \times 50 \times 20 \text{ cm}))</td>
</tr>
<tr>
<td>19</td>
<td><img src="https://example.com/image19" alt="Image" /></td>
<td>Collection of four frisbees ((d = 23 \text{ cm}))</td>
</tr>
<tr>
<td>20</td>
<td><img src="https://example.com/image20" alt="Image" /></td>
<td>Collection of plastic and rubber objects ((L = 184 \text{ cm}))</td>
</tr>
<tr>
<td>21</td>
<td><img src="https://example.com/image21" alt="Image" /></td>
<td>Round foam mattress ((d = 95 \text{ cm}))</td>
</tr>
</tbody>
</table>

\(L \times h \times w = L\), length; \(h\), height; \(w\), width; \(d\), diameter.

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Correlation Between Interest and Interaction (Duration in Seconds)

The dolphins were more likely to manipulate objects that elicited their interest than objects that did not elicit interest [Spearman $r = 0.72$, 95% confidence interval (0.40–0.88); two-tailed $P = 0.003$ (extremely significant)] (Fig. 2).

Dolphins' Behaviors

Three female dolphins (Beauty, Aya, and Baily) displayed significantly more interest in the objects than did the fourth female (Femke) (Dunn’s Multiple Comparison Tests with, respectively, mean rank difference: Beauty: 53.62, $P<0.01$;
Effectiveness of Environmental Enrichment for Dolphins

Fig. 3. Interindividual mean duration (sec ± SEM) of interest behaviors (in white) vs. interaction behaviors (in gray). Asterisks indicate significant difference at the 1% level (***\(P<0.001\) and **\(P<0.01\)) and vertical bars depict standard error of mean (SEM).

Aya: 74.21, \(P<0.001\); and Baily: 56.54, \(P<0.01\) and the two males (Balasi and Guama) (Dunn’s Multiple Comparison Tests: Aya vs. Guama: 63.06, \(P<0.001\); Baily vs. Guama: 45.39, \(P<0.05\); Beauty vs. Guama: 42.47, \(P<0.05\); and Femke vs. Balasi: 44.18, \(P<0.05\)). Interindividual variability in interest directed toward the objects was demonstrated (Kruskal–Wallis: \(KW = 39.21, P<0.0001\)).

Interindividual variability in interaction with the object (Kruskal–Wallis not significant) (Fig. 3).

There were no significant differences between dolphins in interaction with the objects; they all interacted equally little with the objects provided.

Intraindividual variation in interest vs. interaction (Kruskal–Wallis extremely significant: \(P<0.0001, KW = 133.52\)).

Four dolphins demonstrated significant intraindividual differences between interest behaviors and interaction behaviors (interest vs. interaction): Aya (Dunn’s Multiple Comparison Tests, mean rank difference: 160.82, \(P<0.001\)), Baily (mean rank difference: 103.90, \(P<0.01\)), Balasi (mean rank difference: 111.73, \(P<0.01\)), and Beauty (mean rank difference: 133.18, \(P<0.001\)). Aya preferred to look at the objects than to interact with them; the preference was statistically significant. In contrast, other dolphins were more active and manipulated the objects. Guama, the older male dolphin, was not interested in the objects and did not manipulate them.

DISCUSSION

In an ethological study conducted on a group of six bottlenose dolphins (\(T. truncatus\)), the animals demonstrated visual interest in the objects introduced into their pools. Furthermore, the dolphins manipulated 50% of the objects. Eleven objects cannot be considered to be visual and/or tactile enrichment devices. The first result demonstrates the importance of scientifically measuring the behavioral effectiveness of enrichment programs. It further highlights the importance of...
questioning the extent to which a stimulus belongs to one of the eight categories of enrichment stimuli [i.e., feeding, tactile, structural, auditory, olfactory, visual, or social enrichment, and human/animal interactions; Hoy et al., 2009]. All the objects provided were hypothesized to constitute primarily tactile enrichment of the habitat [i.e., nonpermanent addition of (novel) objects for manipulation/play; Hoy et al., 2009; Swaisgood and Shepherdson, 2005]. However, the results demonstrated that our hypothesis was only 50% supported; the animals manipulated only half of the objects. The dolphins were visually attracted to some of the objects, and a clear correlation between visual attraction and interactive behaviors was observed; that is, the animals tended to look at and manipulate the same objects. The dolphins predominantly chose to physically interact with the objects rather than simply look at them. This result provides support for the effectiveness of tactile enrichment with this species. However, one female (Aya) demonstrated a primarily visual interest in the objects; for her, enrichment was visual, rather than tactile. The older male dolphin (Guama) did not demonstrate interest or interact with the objects. These two animals’ behavior may have been a function of their age: both are adults and it has been demonstrated that, in many species, young animals tend to play more than the older ones. However, research has also demonstrated that play is a persistent behavior in dolphins [Bekoff and Allen, 1998; Bel’kovitch et al., 1991; Marten et al., 1996; McCowan et al., 2000]. Aya and Guama’s behaviors may be related to acquired habituation (none of the objects provided was new to them) and/or to their social roles in the group [Lusseau, 2007]. In fact, males usually swim in dyads with a partner of the same gender and of a similar age [Connor et al., 2000; Maze-Foley and Würsig, 2002]. At the time of the study, Guama was the only adult male in Asterix Park. As for Aya, she is not related to any of her pool mates and a study of her temperament revealed a tendency to be independent [Estrade et al., 2009]. These variables could explain Aya and Guama’s disinterest or, at least, noninvestment in the objects. Among the interested animals, the oldest female (Beauty) played with the objects the most; she seemed to choose the foam mattress as her favorite “toy”. The tendency to prefer a certain toy was also observed in another female: Femke frequently placed herself beneath a water-jet. As mentioned above, it is widely known that adult dolphins engage in play behaviors. However, because some animals tend to develop preferences among objects, we suggest that the provision of “toys” be carefully planned and monitored. Such organization would prevent the development of competitive or aggressive behaviors, control exploratory behavior, and avoid the establishment of routine. Finally, a focus on the behavior of aging dolphins could improve our ability to anticipate and respond to their needs.

The scientific literature about dolphins abounds with articles describing the importance of vision and touch for these animals [Herman, 1980; Pryor, 1990; Herzing, 2000]. The types of environmental enrichment used at Asterix Park respond to these biological needs and the proposed objects provide general sensory enrichment. Wells [2009] defines sensory stimulation as the use of stimuli designed to trigger one or more of an animal’s senses (vision, sight, etc.). The objects used in this study can be considered to be visual and/or tactile stimuli. However, in our study, these objects did not consistently elicit manipulation behaviors. The findings can be interpreted in the framework of learning theory (novelty, habituation, intrinsic vs. extrinsic reinforcement) [Tarou and Bashaw, 2007]. Indeed, the learning that occurs during animals’ ontogeny impacts their future behavior (e.g., food
preference, mate choice). However, extrinsic reinforcement does not apply in this study, because no food rewards were given and no whistles or vocal encouragement were used. Moreover, because 50% of the objects did not elicit a response, we can conclude that there was no intrinsic reinforcement 50% of the time. None of the objects was new to the animals, and correspondingly, no neophobic behavior was observed (in animals, neophobia refers to the tendency to avoid or retreat from an unfamiliar animal, object, or situation). Our study protocol did not allow us to validate or invalidate the phenomenon of habituation. However, for at least two females (Beauty and Femke), no habituation occurred. On the contrary, these two dolphins demonstrated strong preferences for particular objects. Given the demonstrated limitations of learning theory in this context, we propose an alternative theoretical framework: constructivist ethology. In contrast with classical ethology’s causal approach to animal behavior, constructivist ethology considers the mental processes and the psychological meaning of specific behaviors [Delfour, 2010]. Constructivist ethology maintains that animals ascribe meaning to their environments through their actions and their sensory systems; animals construct subjective environmental perceptual worlds called umwelts [von Uexküll, 1956]. Our results support the hypothesis that dolphins exist via their actions performed at the moment and that actions cannot be separated from the environment. For dolphins, some objects seem to be irrelevant or ignored; in other cases, the subject constructs a strong preference or bond with the object. The animals build individual relationships to their surroundings and ascribe different meanings to elements in their environment. It would be interesting to use the constructivist ethological approach [Delfour, 2010] to analyze the real meaning or representation of certain objects to dolphins (e.g., something to push, chew, throw in the air, etc.), and to determine what makes some objects preferentially attractive. A rapid analysis suggests that dolphins prefer relatively simple stimuli rather than to complex stimuli (e.g., collections of objects); one explanation is the greater transformability of simple stimuli (i.e., they are easy to move, swim with, jump on, push, drag, etc.). We suggest an analysis of bubble production behaviors in cetaceans [Marten et al., 1996; Delfour and Aulagnier, 1997; Pace, 2000] using a constructivist ethological perspective. In this theoretical framework, bubbles can be considered to be self-produced tactile enrichment. Moreover, the action may be more important for the subject than is the product of the action. The action is understood not only as a way to perform a behavior, but also as a method of producing an effect [Delfour, 2010]. Under human care, what actions (i.e., possibilities of creating an effect) are dolphins able to take? Among other things, their caretakers chose the food that the animals eat and decide when and how much they eat. Caretakers determine dolphins’ social partners and may even determine the periods during which they interact with their conspecifics. The opportunities for captive dolphins to engage in action that results in changes in their environment are quite rare. It may be fruitful to implement interactive devices in dolphins’ environments. One such example is the interactive hose device tested with bottlenose dolphins in Sweden [Berglind, 2005]. The author of that study reported a dramatic increase in the sonar activity of the animals in the study (sonar is an infrequently used faculty among dolphins in captivity).

Moreover, the results of our study demonstrate that providing objects to dolphins does not always engender play activity; that is, the provided stimuli were not always perceived as “toys” by the animals. This finding indicates that play was
not necessarily the underlying motivation for the dolphins’ behavioral responses. We agree with Newberry’s [1995] suggestion that researchers avoid the term toy. The motivation for dolphins’ behavioral responses varies according to the type of object and to the ways that it can be used. We conclude this argument by stating that, from a constructivist perspective, animals ascribe subjective meaning to objects in the context of their subjective environment. For example, for respective dolphins, the same object may be something to play with, something to fear, something to take from a conspecific, or something to explore. Moreover, the term toy is anthropomorphic and can lead to misunderstandings on the part of visitors (e.g., captive animals need toys to feel good, plastic balls make fun toys for dolphins, etc.).

Finally, we mention several studies that explored the Asterix Park dolphins’ behavioral profiles and social organization [Estrade et al., 2009; Gutierrez et al., 2010]. The results revealed a social organization within the group of dolphins. The animals did not interact randomly, but rather chose a partner with a compatible personality (similar to their own). The dyadic associations mirrored those observed in the wild [Wells, 1991; Whitehead, 1997; Connor et al., 2000]. These valuable findings can inform efforts to assess the effectiveness of environmental enrichment for these species. For example, a dolphin that does not play may be sick, disinterested, annoyed, anxious, bored, frustrated, or scared. If that dolphin’s behavioral profile indicates that it is introverted, noncurious, and dislikes novelty, the dolphin’s behavior (i.e., not playing) is congruent with its personality and is not a sign of diminished well-being. The dolphins at Asterix Park are social and spend most of their time interacting with each other and/or with a preferred partner. The introduction of objects into the pools did not interrupt this activity. That is, although the dolphins manifested some interest in the objects and interacted with some of them (50%), they seemed to prefer their regular social interactions, a sign of good mental health in social animals. In this case, the limited interest in and use of the objects is not a sign of poor welfare or diminished well-being. On the contrary, the dolphins’ social activity indicates satisfactory health. In sum, when analyzing the effectiveness of enrichment programs in dolphins, it is essential that the results be viewed in the light of the social context of the group and of the individual animals’ behavioral profiles. Only after the investigation of these variables can we arrive at conclusions about possible improvements to the animals’ biological functioning subsequent to modifications to their environment.

CONCLUSION

The results of this study demonstrate that all objects provided to dolphins do not become “toys”. The motivation for and function of the observed behaviors need to be considered, as does the context of each display of behavior. Behavioral changes and investigation of the objects do not necessarily indicate an enriching effect of the objects on the animals. Complexification or diversification of the environment through the use of objects does not necessarily benefit the animals or constitute enrichment. Our study represents an effort to standardize methods and criteria for evaluating enrichment. The results demonstrate the need for further scientific analyses of the effectiveness of environmental enrichment. Such deeper analysis will allow us to identify animals that are bored by or disinterested in the objects owing to habituation; animals that (over)react to novelty with increased attention; animals
that monopolize a particular object, creating the possibility for competition and conflict; and animals that have overinvested in certain objects. Our objective is to highlight the importance of establishing individual behavioral and psychological profiles for each animal. The development of individual profiles will help eliminate misunderstandings that could prove harmful for the animals (e.g., a hesitant animal will be cautious in its exploratory behavior, whereas an inquisitive animal may be more heedless in its exploration; evaluation of their respective well-being must take these variables into account).

In general, environmental enrichment refers to stimuli or techniques that benefit animals and improve their biological functioning [Newberry, 1995]. The effectiveness of the enrichment program described in this study is questionable. However, we believe that animals’ object-directed behaviors can be used as a parameter to evaluate their general capacity to respond to enrichment stimuli.

Finally, in an effort to address some of the limitations in the existing theoretical frameworks, we demonstrated the value of using a constructivist ethological framework to assess the effectiveness of enrichment programs on individual animal well-being.

ACKNOWLEDGMENTS

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