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Philosophy of Environmental Enrichment: Past, Present, and Future

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The brief tenure of environmental enrichment has been influenced both directly and indirectly by the field of psychology, from the work of B.F. Skinner to that of Hal Markowitz. Research on enrichment supports the supposition that an enriched environment does indeed contribute to a captive animal's well-being. Critical elements of effective environmental enrichment are 1) assessing the animal's natural history, individual history, and exhibit constraints and 2) providing species-appropriate opportunities, i.e., the animal should have some choices within its environment. This paper presents a historic perspective of environmental enrichment, proposes a broader, more holistic approach to the enrichment of animals in captive environments, and describes a framework or process that will ensure a consistent and self-sustaining enrichment program. *Zoo Biol* 20:211–226, 2001. © 2001 Wiley-Liss, Inc.

Key words: animal welfare; husbandry training; history of environmental enrichment; animal well-being

INTRODUCTION

Environmental enrichment and husbandry training have become an integral part of the daily management of animals in captivity. In the past two decades, in particular, both of these tools have been used to enhance the lives of animals in many zoos and aquariums [Mellen and Ellis, 1996]. Training has become not only a useful tool, but is now acknowledged as enriching as well [Hediger, 1950; Shepherdson, 1998]. The concept of environmental enrichment has evolved over its brief history. In answering the question: What is new about the field of environmental enrichment? Shepherdson [1998] stated that “the contemporary study of environmental enrichment differs from its past incarnations in that it is a systematic, scientific approach to

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understanding and providing for the psychological and behavioral needs of captive animals. By drawing on recently derived knowledge, particularly from the fields of ethology, psychology, and animal science, the new discipline of environmental enrichment offers an alternative and exciting way of looking at the environments that we provide for animals” (p 8–9).

The purpose of this paper is to review and to build on the concepts described above by Shepherdson [1998]. Further, we propose here a more holistic approach to the implementation of enrichment in zoo and aquarium facilities. Finally, we propose a framework that we believe will facilitate the integration of enrichment into the daily management regime of zoos and aquariums.

HISTORY OF ENVIRONMENTAL ENRICHMENT

The significance of enrichment was recognized first by Yerkes [1925] and later by Hediger [1950, 1969], who identified the importance of the physical and social environments of animals in captivity as well as the impact of management regimes and diet on the well-being of animals. Historically, zoo keepers and other animal caretakers have provided enrichment to the animals under their care, although it is perhaps only recently that the term *enrichment* has been used to describe the keepers’ role in this phenomenon. Desmond Morris [1960] described a device that released fish into a seal pool at the London Zoo. Zoo designers began to incorporate knowledge of animals’ natural history into exhibit plans in the 1960s [Kortland, 1960; Reynolds and Reynolds, 1965; Freeman and Alcock, 1973]. Maple and Finlay [1989] introduced to the zoo community the concepts of “soft” and “hard” environments in reference to zoo exhibits borrowing from the field of environmental psychology [Sommer, 1974].

Although not its original intent, the psychology literature provided other insights into the environment of captive animals, especially as it related to stereotypies, animal motivation, and species-appropriate behavior. Skinner (who ironically chose to ignore species-specific characteristics of his animal subjects) conducted the now classic studies on operant conditioning and schedules of reinforcement [Ferster and Skinner, 1957]. Among his many findings were the responses observed in animals placed in a small, barren box and fed on a non-contingent, fixed interval schedule of reinforcement (e.g., reinforced every 3 minutes regardless of the behavior performed at the moment of reinforcement). The animal received food independent of its actions. Under this regime, animals learned to predict how long the interval was between feedings and to anticipate the arrival of food. Animals maintained in this schedule of reinforcement developed unique patterns of behavior (generally called adjunctive, stereotypic, or superstitious behaviors). Decades later, Carlstead [1998] noted the similarity between Skinner’s subjects and many zoo animals. “Parceling out food to an animal in a rigidly controlled, highly predictable, stimulus sterile environment can cause it to develop stereotypies. . . . This conclusion is relevant for confined, managed zoo animals because they are also most often on an essentially comparable schedule of non-contingent food delivery. They are out of their natural environment and living in restricted, relatively stimulus-poor surroundings in which they are fed in a highly predictable manner that requires little or no effort to obtain food” [p 175].

Two students of Skinner, Breland and Breland, utilized Skinner’s operant techniques to create commercial entertainment ventures that involved performing ani-

mals. Specifically, they trained pigs to put plastic coins in a piggy bank for a food reward and trained chickens to “play” baseball with a ping pong ball. Each of these animals was successfully trained to perform these behaviors, but after a while their behaviors began to break down. The pigs, instead of placing the coins in a bank, began rooting in the pile of coins. The chickens chose to peck at the ping pong balls instead of batting them. This change in behavior was termed “instinctive drift” by Breland and Breland [1961]. They attributed this break down in behavior to the animals reverting back to their respective natural behaviors. The work of the Brelands reminds us of the importance of understanding the natural history of the animals under our care when developing enrichment programs and husbandry training or when considering other aspects of their captive environment. Another psychologist, Alan Neuringer [1969], demonstrated that when given a choice between “working” for food and having the food provided ad libitum, many animals chose to work for their food. This finding suggests that animals may have a biological need to search for food (among other things) and that denying an animal appetitive opportunities might be a source of frustration or stress [Hughes and Duncan, 1988; Shepherdson et al., 1993; Shepherdson, 1998].

One of the single most influential people in the field of enrichment is Hal Markowitz [Markowitz and Woodworth, 1978; Markowitz, 1982; Markowitz and Aday, 1998]. Markowitz’ major premise has been to provide animals some choices within their environment. He used operant conditioning techniques to “teach” a variety of animals how to procure food. The devices he developed, coupled with systematic data collection, also provided insights into learning styles of these animals [Markowitz, 1982]. For a time, a somewhat artificial debate raged on regarding the “naturalness” of these techniques [Hancocks, 1980; Hutchins et al., 1984], with Hutchins et al. advocating a more “naturalistic” approach. However, as these concepts evolved, they proved not to be mutually exclusive [Forthman-Quick, 1984].

The 1980s saw substantial growth in sharing of environmental enrichment ideas among animal caretakers. Before that time, many excellent examples of enrichment went unreported. Now, publications of the American Association of Zoo Keepers (*Animal Keepers’ Forum*) and the Association of British Wild Animal Keepers (*Ratel*) both feature articles on enrichment and husbandry training. *The Shape of Enrichment*, a newsletter edited by Valerie Hare and Karen Worley, also details ideas and descriptions of enrichment for captive animals. These and other publications have facilitated the sharing of information and ideas about environmental enrichment and husbandry training. However, implementation of these ideas has been, for the most part, opportunistic and reliant on the enthusiasm and persistence of highly motivated keepers. Further, systematic assessment of enrichment and training is the exception, not the rule.

In the past decade, two books were published that addressed the difficulties of defining, measuring, and providing well-being for captive primates [Segal, 1989; Novak and Petto, 1991]; both feature chapters on enrichment. In 1993, the first conference on environmental enrichment began to identify a theoretical framework for enrichment; a book, *Second Nature: Environmental Enrichment for Captive Animals*, was published as an outcome of that meeting [Shepherdson et al., 1998]. Until that point, there had been little to no conceptual evaluation of where the “science” of enrichment could or should go. Toward that end, Shepherdson [1998] described environmental enrichment as an animal behavior principle that seeks to enhance the

quality of captive animal care by identifying and providing the environmental stimuli necessary for optimal psychological and physiological well-being. This is typically accomplished by increasing the variety and range of opportunities or choices to animals in captivity. Research on environmental enrichment has focused on identifying, characterizing, and evaluating the relative importance of different environmental stimuli and finding the most effective ways of providing them [Shepherdson, 1998].

HOLISTIC APPROACH TO ENVIRONMENTAL ENRICHMENT

What, then, is our next step toward advancing these concepts of environmental enrichment? How can we develop programs within each institution and for each animal that build on our knowledge? We propose here that there may be no single definition of enrichment; instead, we suggest that enrichment can be re-defined for each species and perhaps for each individual. We suggest that an enrichment plan be developed based on an animal's natural history, individual history, and its specific exhibit constraints.

We propose that in developing an enrichment plan for a particular animal, its captive environment be assessed in terms of a list of criteria (see Appendix 1 [adapted from Crockett, 1998; Mench, 1998; Seidensticker and Forthman, 1998; K. Carlstead, personal communication]). This more holistic approach would define environmental enrichment in terms of an animal's entire captive milieu. This would include defining the physical and social environment of an animal in captivity, the role of human caretakers (feeding, cleaning, training, other interactions), and diet (type, presentation, variety). This more holistic approach seems more appropriate since there are suggestions that many components of an animal's captive environment may influence its well-being. For example, we know that the occurrence of stereotypical behavior can be influenced by both diet type and level of keeper interaction [Mellen et al., 1998] and that reproductive success can be influenced by social environment and level of keeper interactions [Mellen, 1991]. The principle element comprising a definition of a captive animal's environment is increasing the variety and range of species-appropriate opportunities.

We propose moving beyond trying to simply determine what we can "add to" an animal's existing exhibit that is meant to "enhance" its environment. Instead, we suggest looking at the animal's entire captive environment and, using our knowledge of the animal's natural and individual history, to re-think the way we house, feed, train, and portray them. We see a need to be pro-active, not reactive, and to create specific goals for these animals and develop ways to measure how well we attained these goals. Enrichment needs to be more than a Band-Aid on abnormal behavior or inactivity; it should be a concerted plan of action for captive management with measurable goals and results. Such an approach will require a shift in the philosophy of most zoological institutions.

Operationally Defining Enrichment

Although environmental enrichment is difficult to define, most zoo and aquarium professionals would agree that a beginning point is identifying its intended function. Toward that end, we list some broad goals for environmental enrichment. These goals address why we strive to enrich the lives of captive animals. The list is neither mutually exclusive nor exhaustive. It is expected that more specific goals will be used to

plan for and develop an enrichment program specific to a particular species, a particular exhibit, and a particular group/individual and that these goals may change over time.

1. Animal welfare is our primary goal. Although it is difficult to define and measure scientifically, most animal care professionals would agree that an enriched captive environment enhances the psychological and physiological well-being of animals under our care; therefore, we are assuming that enrichment enhances animal welfare.
2. Successfully reproducing animals that exhibit adequate parental care is a goal of captive management. Animals reared in an enhanced or an enriched environment have a higher likelihood of reproducing successfully and exhibiting adequate parental care (reviewed by Carlstead and Shepherdson [1994]).
3. A goal of enrichment is to identify and reduce potential sources of chronic stress and/or enhance an animal's ability to cope successfully with acute stress. Providing an enriched environment may be less stressful to captive animals; an enriched environment appears to facilitate the animal's ability to cope with aversive situations [Carlstead and Shepherdson, in press].
4. A goal of enrichment is to reduce or eliminate aberrant behaviors and concurrently provide opportunities for species-appropriate behaviors and activity patterns; animals in an enriched environment are more likely to be behaving normally (i.e., show species-appropriate behaviors and activity patterns) and probably are more informative and interesting to our visitors [Hutchins et al., 1984; Kreger et al., 1998].
5. Re-introduction of captive-born animals appears to be more successful when developing animals are reared under conditions that are sufficiently rich to allow the performance and maintenance of species-appropriate behaviors [Shepherdson, 1994; Castro et al., 1998; Miller et al., 1998].

We propose here to begin to operationalize environmental enrichment a priori by identifying goals for specific groups of animals in specific enclosures. Enrichment plans should be based on the animals' natural history, guided by what we know about activity budgets in the wild, contingent on encouraging species-specific behaviors, and mediated by the impact of human caretakers (e.g., husbandry training, veterinary care). Although historically, "the wild" was considered the ultimate guide to assessing the adequacy of a captive environment [Hediger, 1969], both Shepherdson [1998] and Veasy et al. [1996] argue convincingly that "the wild" alone may not be a complete guide for assessing the adequacy of a captive environment. Often, there is not clear information about the behavior and activity patterns of wild populations. Further, we know that behavior in the wild is often highly variable and dependent on local environmental conditions. It could be argued that the captive environment is simply another environment to which an animal has adapted [Shepherdson, 1998]. Behaviors and conditions seen in wild animals, such as predator avoidance, fear of humans, masking signs of illness or injury, and high parasite loads, are typically considered undesirable in captive animals. Thus, although an animal's natural behavior can and should serve as a guide to providing an enriched captive environment, it should not be the sole guiding principle.

These guiding principles can assist in planning and evaluating an animal's physical environment. Exhibits and environments must be functionally "naturalistic" from both the visitors' and the animals' perspective. An exhibit in which a felid attempts to "climb" a tree painted on the wall does not "pass" a naturalistic exhibit test; a gunite pit surrounded by beautiful plants (that the animal is denied access to) is still a gunite pit. Instead, arboreal animals must be provided with a three-dimensional exhibit with usable space. Animals must be able to seek shelter when too cold or too hot, hide when they are confronted with frightening stimuli, and hunt or forage for food in a species-appropriate way when they are hungry. They may need a certain amount of variability/mental stimulation in their lives (e.g., via training or by providing a changing physical and social environment).

FUTURE DIRECTIONS OF ENRICHMENT: FRAMEWORK

Given these concepts, how then do we create, sustain, and assess enrichment programs in zoos and aquariums? We describe a framework or process first presented in 1999 [Sevenich and Mellen, 1999]. We suggest this framework will facilitate the creation of a self-sustaining enrichment program. Components of the framework include goal-setting, planning, implementing, documenting, and re-adjusting components of a plan. [See also Sevenich MacPhee and Mellen, 2000a, b].

1. *Goal setting.* What do we want this enrichment to achieve? Our primary goals are to encourage and provide opportunities or choices for animals to express species-appropriate behaviors [Markowitz, 1982; Seidensticker and Forthman, 1998], to reduce or eliminate undesirable behaviors such as pacing [Carlstead, 1998], and to provide the best possible experience for our visitors.

Appendix 1 contains a series of questions meant to inspire ideas about enrichment for captive animals [adapted from Crockett, 1998; Mench, 1998; Seidensticker and Forthman, 1998; K. Carlstead, personal communication]. We suggest that this list of questions or a similar list can be used as a starting point for institutions to use and modify to create an enrichment plan for each animal/group in that institution's collection. Because of the backgrounds and experiences of the authors, this list is undoubtedly mammal biased and should be changed/augmented to be more taxon appropriate by the user. Further, when reviewing questions in the Appendix, it is important to remember that the term enrichment is used more broadly to define and describe the captive animal's entire captive milieu. The animal's natural history can be used as an initial guide to defining an appropriate captive habitat. An individual's environment includes species-specific needs, an individual's developmental and experiential history as well as its developmental stage (i.e., infant, juvenile, sub-adult, adult).

The concepts presented in Appendix 1 are meant to guide institutions in the development of enrichment plans for individuals/groups at their respective institutions. Specifically, it provides guidance in identifying species-appropriate behaviors to be encouraged and to identify elements and motivators that should be present to facilitate the exhibition of the species-appropriate behaviors. Figure 1 builds on this concept by providing a tool for visualizing temporal aspects of an animal's captive milieu, (i.e., its activity budget). How an animal spends its time differs by location, seasonally, and developmentally (e.g., infant, juvenile, adult). Obviously, "wedges" of each activity pie will differ from species to species [e.g., a giant anteater (*Myrmecophaga tridactyla*) spends its time in a dramatically different way than does

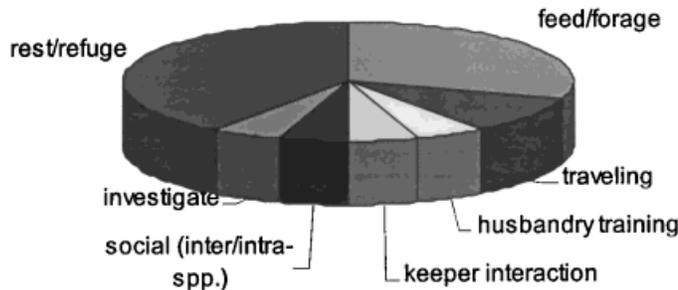


Fig. 1. Enrichment “pie” visual representation of how an animal might spend its time in a captive environment. The relative size of each wedge will differ from species to species.

an African elephant (*Loxodonta africana*)]. Our goal should be to not only encourage species-appropriate behaviors, but also to mimic an animal’s wild counterparts in terms of the amount of time an animal spends in various activities.

2. *Planning/approval*. Given the above potential enrichment ideas, how do we decide which initiatives should be implemented? Who should review/approve enrichment initiatives? How will animal care staff insure that enrichment is routinely provided?

Table 1 [from Sevenich MacPhee and Mellen, 2000b] details how information collected using the questions in Appendix 1 can be synthesized and prioritized. Basically, information on natural history, individual history, and exhibit constraints (Appendix 1 content) is reviewed; behaviors to be encouraged are listed; and techniques to encourage these behaviors are discussed and designed. This list of potential enrichment initiatives is then prioritized based on the relative “importance” to the animal (admittedly a subjective assessment) and feasibility (in terms of cost or exhibit constraints). We also suggest that reduction in the occurrence of abnormal behavior and fearful or aggressive behavior toward human caretakers be first priorities. Mench [1998] suggests that preference should be given to satisfaction of higher priority behaviors that are strongly motivated (e.g., food acquisition, seeking a mate or social partner) and secondarily information gathering (e.g., exploration of novel objects/situations). In other words, she suggests that a hungry animal is not likely to seek out novelty, but instead will first seek to satisfy more primary needs. Table 2 facilitates the actual planning of specific enrichment initiatives. Examples of this review process can be found in a web site developed at Disney’s Animal Kingdom (www.csew.com/enrich/).

Who should review/approve enrichment initiatives? Each institution will need to create an approval process for enrichment initiatives. At the authors’ home institution (Disney’s Animal Kingdom), keepers can propose an enrichment initiative by completing an enrichment approval form. Zoological managers (immediate supervisors of animal keepers) can approve most enrichment items. If questions arise about a particular initiative’s safety, the completed form is forwarded to the area curator, the curator of behavioral husbandry (person who coordinates enrichment efforts), and the veterinary staff. A copy of Disney’s Animal Kingdom approval form can be found at the web site (www.csew.com/enrich/).

How will animal care staff ensure that enrichment is routinely provided? Again, each institution will need to clearly identify all staff roles with regard to enrichment

TABLE 1. Enrichment goal development tool to assist in identifying what enrichment and training should be provided

Species	What behaviors do we want to encourage?		How do we want to encourage behaviors?	Prioritizing behaviors to be encouraged		
	Behavior based on natural history and/or husbandry need	Do they exhibit the behavior now?	Describe enrichment and/or training techniques that would provide, or are currently providing, the opportunity and motivation for behavior	1. Behavioral need (low, medium, high) ^a	2. Feasibility (low, medium, high) ^b	3. Does it fit with educational objectives?
Golden-breasted starling	Ground foraging and investigating ground area	Yes, but would like to see more	Enrichment techniques: tossing insects on ground, bug feeders, novel objects on ground, bury objects/food in leaf litter, add recorded sounds of insects	1. High	2. High	3. Yes
	Mobbing behavior	Yes, but rarely (to snakes)	Enrichment techniques: rubber snake, use dummy bird on string; training techniques: getting mobbing behavior on cue	1. Low	2. High	3. Yes
	Shower bathing	Yes, but out of guest view	Enrichment techniques: provide shower in new location	1. High	2. High	3. Yes
	Follow the keeper	Yes, but want to extend to following other staff	Training techniques: provide branches (perching) in better guest viewing areas and closer to where staff can stand; reinforce following behavior	1. Low	2. Medium	3. Yes
	Nesting behavior	Yes, but not very visible to guests	Enrichment techniques: provide a variety of nest boxes (log cavity, natural hollows, Plexiglas see-in nest box), nesting materials, open up canopy to allow sun in lower parts of exhibit, change sex ratio (since they are cooperative breeders), investigate additional possible triggers such as bathing opportunities and food supply	1. High	2. High	3. Yes
	Nectar feeding	No	Enrichment techniques: provide hummingbird feeder and flowers (rotate potted plants in/out of exhibit)	1. High	2. High	3. Yes

^aBehavioral needs = subjective assessment of how “important” it is for the bird to be able to exhibit/perform this behavior.

^bFeasibility = assessment of current/potential resources or management constraints that may limit ability to implement.

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TABLE 2. Enrichment planning tool to assist in identifying how enrichment and training should be provided: planning tool for golden-breasted starlings

Goal	Constraints	Support		Changes
Species and selected behaviors	Constraints on behavior (seasonal, temperature, etc.)	Facility (exhibit elements, holding spaces, etc.)	Staff (time, skill development, etc.)	1. Collection plan ^a 2. Interpretive plan ^b
Ground foraging	None anticipated	Construct bug feeders, acquire novel objects, acquire leaf litter, acquire insect sounds	Need time to order items and construct them	1. None 2. None
Enhance nesting behaviors	Seasonal	Acquire a variety of nesting materials, design and/or acquire a variety of nest boxes (plexi, logs, hollows, natural cavities); need to trim vegetation and open up canopy	Need time to design and construct boxes	1. Need to change sex ratio of the birds 2. Work with horticulture regarding trimming vegetation
Nectar feeding	None anticipated	Acquire a variety of feeders including a hummingbird feeder; contact horticulture about providing live, potted flower plants that can be rotated into exhibit	Need time to design and construct feeders	1. None 2. Work with horticulture regarding trimming vegetation and providing flowers

^aCollection Plan = Institutional collection plans may indicate that a species' intended purpose is breeding, exhibit, or both; enrichment/training plan may be influenced by collection plan.

^bInterpretive Plan = Educational goals may be impacted by enrichment/training plans; for example, enrichment devices may need to look naturalistic.

as well as the specific process to insure that enrichment is provided as planned. At Disney's Animal Kingdom, a calendar is used to plan the schedule of delivery. A copy of that calendar is delivered to the forage warehouse to facilitate delivery of food items per the plan. Additionally, these enrichment calendars identify which keeper is responsible for the provision of which enrichment component; this creates a situation in which all members of the team are equally responsible. Again, samples of the calendars used at Disney's Animal Kingdom can be found at the web site.

3. *Implementation.* Who will implement the enrichment? By almost anyone's estimation, implementation is enriching to the staff as well as to the animals. It is fun to provide new and interesting environments to the animals under our care. It is the part in the whole process for which it is the least difficult to get staff buy-in. However, if we simply implement haphazard ideas, we will not know what worked (because we would not have even established which behaviors we are trying to encourage), we will not necessarily have buy-in from the entire staff (enrichment may be dependent on only those keepers who are motivated to provide it) nor will we have a mechanism for accountability (if it did not get done). At Disney's Animal Kingdom, we use the same calendar to facilitate implementation. Keepers simply place their initials next to the item on the calendar once it has been provided.

We suggest that the keeper staff needs support from the entire zoo (e.g., directors, curators, managers) to get to this stage and that the management staff needs to provide the resources (materials and staff time) to implement enrichment and to evaluate the animals' responses to that enrichment [Laule, 1997; Sevenich MacPhee and Mellen, 2000a].

4. *Documentation.* What happened? Did the enrichment work? Subjective assessment (i.e., "I think it worked") is not an appropriate mechanism to determine the success of an enrichment plan. In fact, Morgan et al. [1998] and Crockett [1998] describe how our intuition and sense of what is good for animals may not always be correct. How then, do we assess the success of our enrichment initiatives?

The same calendar system used to plan and implement enrichment can be used to document the animal's response to enrichment. At Disney's Animal Kingdom, all keepers are responsible for documenting enrichment (just as all keepers are responsible for documenting administration of a medication).

We have developed (and agreed on) three levels of documentation. The first, and most commonly used, is simply to record any noteworthy events associated with the enrichment initiative. If the animal responds as predicted, there may be no need to record any response. If, however, the animal's response is atypical, keepers record that information in the daily report system (keeper report). Approximately 90% of all enrichment initiatives at Disney's Animal Kingdom are assessed at this level.

For those enrichment initiatives that are new and/or are of greater interest, keepers use one of three scales to assess enrichment. Specifically, keepers are asked to assess direct evidence (they observed the animal's response to some enrichment) and/or indirect evidence (keepers were unable to directly observe animal's response, but looked for evidence that the animal had interacted with the enrichment provided). Both direct and indirect evidence is scored on a five-point Likert scale.

Direct evidence: At end of keeper's shift, he/she rates the observed animals' interaction with enrichment for that day and assesses animals' level of involvement with enrichment.

- 1 = animal flees from/avoids enrichment
- 2 = animal appears to ignore enrichment
- 3 = animal orients to/looks at but does not physically contact enrichment
- 4 = animal makes brief/cursory contact with enrichment
- 5 = animal makes repeated/sustained contact with enrichment

Indirect evidence: Keeper is unable to observe animals' interaction with enrichment directly, but can assess through indirect evidence (e.g., cardboard box ripped up).

- 1 = no evidence of interaction
- 2 = moderate evidence of interaction
- 3 = significant evidence of interaction

A third scale has been developed to assess whether a particular enrichment initiative has encouraged a particular behavior.

Enrichment initiatives achieve intended behavioral goals:

- 0 = enrichment encourages undesirable/dangerous behavior (e.g., ate substantial amounts of nesting material)
- 1 = no reaction, did not encourage goal behavior
- 2 = animal reacted, but behaviors were unrelated to planned goal: describe (e.g., dragged nesting materials all over holding area)
- 3 = some reaction; some goal behaviors observed (e.g., some partial nests built)
- 4 = moderate reaction, achieved moderate amount of goal behavior (e.g., two nests built overnight)
- 5 = strong reaction, encourage many or substantial amount of goal behavior(s) (e.g., nests built and used by all but Spike)

We suggest that approximately 8% of all enrichment initiatives be documented using these Likert scales. Although this assessment tool has yet to be validated, we believe that it represents an important first step in systematically assessing the impact of enrichment. Future plans include using traditional animal behavior methodologies to validate this cumulative keeper assessment tool. Toward that end, members of the American Zoo and Aquarium Association's Behavior and Husbandry Advisory Group (BHAG) are in the process of validating this "cumulative" or "rapid assessment tool" for measuring/assessing enrichment initiatives. The BHAG group will attempt to validate this cumulative assessment tool by comparing keepers' assessments (using the five-point Likert scale previously described) and results from data collected using traditional animal behavior observational research methodology. Multiple comparisons within and between institutions on a broad spectrum of species will be necessary to truly validate new assessment techniques.

It is important to note that this cumulative assessment tool (even if validated) only assesses enrichment initiatives that are "add on" (e.g., adding boomer balls, insect feeders, or scent trails to the environment). If we take a more holistic approach to enrichment (even if the cumulative assessment tool is validated), we still need to find another measurement tool to assess the entire milieu of an animal's captive environment, not just items we might add to an animal's exhibit.

Finally, we suggest that a small percentage of enrichment initiatives (approximately 2%) is assessed using traditional animal behavior methodologies. This documentation technique is very work intensive and requires a large time commitment. Examples of this technique include those of Baker [1997], Burghardt et al. [1996], Carlstead et al. [1991], Powell [1995], Shepherdson et al. [1993], and van Hoek and King [1997].

5. *Evaluation.* Questions that should be asked every few months include “Did we like what happened?”; “Did the enrichment initiatives achieve the goals we set?” The keepers’ assessment of the enrichment (i.e., the numeric values assigned by the keepers) can be examined for trends. The data can provide information on the animal’s response to an enrichment item over time and thus suggests the frequency of delivery for optimal effectiveness. In short, evaluation allows us to assess the relative success of a particular enrichment initiative.

6. *Re-adjustment.* Finally, we adjust our plan and start the process over again with a new initiative and a modification of the original goals.

CONCLUSIONS

In short, we recommend that the science of environmental enrichment develop in the following directions:

1. A successful enrichment program must be proactive, i.e., managers and keepers must determine a priori the optimal environment for each group of animals in the collection using their knowledge of the animal’s natural history, individual history, and exhibit constraints. Instead of planning to reduce or eliminate stereotypy, a proactive approach would optimize the captive environment to prevent the establishment of a stereotypic pattern.
2. Using this knowledge, we recommend that managers and keepers outline a plan to promote the behaviors and activity patterns that address the animal’s natural and individual history within the constraints of the institution’s resources. Given that, it may be necessary to decide that that institution cannot provide an adequately enriched captive environment for that species and may decide to eliminate it from that collection (e.g., red pandas in warm-climate zoos).
3. Subjective, non-systematic assessments of the relative success of a captive environment (i.e., enrichment) are not appropriate. Our subjective assessments may be incorrect and/or biased. Instead, we need to validate cumulative/rapid assessment methods by using traditional animal behavior data collection techniques and comparing those traditional methods with these new rapid assessment techniques.
4. Accountability is key to the consistent planning, implementation, execution, and documentation of an enrichment program. The success of an enrichment program ultimately lies with the director of each zoo and aquarium. If directors demand accountability (via plans and documentation), the program itself has a much higher probability of success.

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APPENDIX 1. CHECKLIST FOR DEFINING AN ANIMAL'S CAPTIVE ENVIRONMENT

Natural History

1. What is this species' wild habitat (e.g., desert, tropical rainforest, cover, moisture, concealment/camouflage options, temperature ranges, barriers from conspecifics)? (If specific information on a particular species is unknown, provide information on closely related species/genus/family.)
2. How does the animal in the wild behave in response to changes in temperature and weather? What temperature/humidity range does it experience in the wild?
3. What are some self-maintenance/comfort behaviors (e.g., preening, grooming, bathing, dust-bathing, wallowing, sunning, anting)? Is there a seasonal molt/shed?
4. When is it most active (diurnal, nocturnal, crepuscular)? Why (e.g., predator avoidance)? Does the activity pattern change seasonally?
5. Does the species in the wild inhabit primarily arboreal, terrestrial or aquatic environments or does it switch between them at times?
6. What are the main threats to the animal in the wild? What is it likely to be afraid of (e.g., conspecifics, humans)? What different types of predators does it have to look out for in the wild? Are there any anti-predator behaviors (e.g., broken-wing display)? Where and how does the animal seek refuge in the wild from fearful situations (e.g., loud noises like thunder)? What does fearful behaviors look like?
7. What are its primary sensory modalities (e.g., sight, smell, sound) for communicating with conspecifics, detecting predators and for finding food, mates, or other social partners?
8. What is the social structure of this species (e.g., solitary, dyads, "harem," colonial, leks, polyandry)? What is the average/typical group size?
9. What is the average distance between social group members and from neighboring conspecifics?
10. Describe the primary social behaviors of this species (e.g., aggression, courtship, affiliative, play).
11. Does the social structure change seasonally or throughout the animal's life (e.g., juvenile versus adult, bachelor groups)?
12. Does this species defend territories? Does it maintain a home range? What is the size of the home range/territory? Does this species migrate seasonally?
13. How does the animal advertise its home range or territory (e.g., scent marking, song)? How does the animal attract a mate (e.g., displays, scent marks)? Who displays?
14. Where does the animal raise young (nest location/type, den)? What materials does it use to build nests/prepare dens? Are both sexes involved in rearing young? Are the young precocial or altricial? How are the young fed?
15. How does the animal locomote through its habitat?
16. What is the animal's diet type (e.g., omnivore, carnivore, herbivore, nectivore) in the wild? Does diet change seasonally? By age?
17. What does the animal feed on in the wild? What variety of food does it

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need to eat? What behaviors does it use to locate and procure the different types of food it needs? Does it use tools to obtain food? Store/cache food?

18. Where does the animal sleep or rest? Does that change seasonally?

Any other considerations?

Individual History

19. Does this animal have any medical problems (e.g., arthritic, obese, diabetic, missing digits, wing damage, pinioned)?

20. Does this animal have any behavioral problems (e.g., fearful/aggressive to humans, stereotypy, feather plucking)?

Any other considerations (e.g., exhibit at previous institution, hand-raised)?

Current Exhibit

21. What is the size of the animal's enclosure (exhibit and holding area)? What are the containment barriers (e.g., chain link, moat)?

22. Can the animal use all components of its exhibit? Can it hide? For example, how many places could this animal be out of view of its cage mate?

23. How functional is the current exhibit? Does the exhibit facilitate/allow the animal to exhibit natural behaviors? How does the animal interact with exhibit elements?

24. Where and how is the animal's food (normal diet, enrichment, browse) provided? Does the animal have a preference for one feeding site over another?

25. Does the physical environment contain elements of novelty (e.g., weather changes, can furniture be changes easily)?

26. What are the animal's opportunities to feed/forage, breed, socialize in species-appropriate ways? Do/can/should animals interact with other species in exhibit?

27. Can the animal exhibit normal patterns of behavior? Are components of the physical environment available for this to occur?

28. Can the animal make choices about where and how it spends its time? Does the animal have control over acquisition of food? Access to hiding places? Protection from the elements?

29. Are there any hazards in this enclosure?

Any other considerations?

Given these considerations (natural history, individual history, and current exhibit), what behaviors should we attempt to encourage? Discourage?