Control, Choice, and Assessments of the Value of Behavioral Management to Nonhuman Primates in Captivity

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Many people have devoted considerable effort to enhancing the environments of nonhuman primates in captivity. There is substantial motivation to develop experimental, analytical, and interpretational frameworks to enable objective measurements of the value of environmental enrichment/behavioral management efforts. The consumer-demand approach is a framework not frequently implemented in studies of nonhuman primate welfare but profitably used in studies of the welfare of nonhuman animals in agriculture. Preference studies, in which primates can voluntarily choose to socialize or to participate in training, may be the best current examples of a consumer-demand-like approach to assessing the effects of captive management strategies on primate welfare. Additional work in this area would be beneficial; however, there are potential ethical constraints on purposefully subjecting primates to adverse circumstances to measure their demand for a resource. Primate welfare researchers need to design consumer-demand studies with obstacles that will help measure the relative value of resources to captive primates without compromising the welfare they are attempting to evaluate and enhance.

Recently, efforts to enhance the environments of nonhuman primates (NHP) kept in captivity have generated considerable attention (Bloomsmith & Else, 2005; Lutz & Novak, 2005; Nelson & Mandrell, 2005). Such efforts frequently involve behavioral management programs (environmental enrichment, socialization, and/or positive reinforcement training) designed to provide primates with functional
simulations of natural conditions (Schapiro, 2002; Schapiro, Perlman, & Boudreau, 2001). Attempts to simulate natural conditions should be beneficial because they allow nonhuman animals to express naturalistic behavior patterns, usually considered as indicators of “good” animal welfare (Bloomsmith & Else). In research endeavors, good welfare increases the value of the animals as subjects for most investigations (Hau & Schapiro, 2004).

Although enhancing NHP environments generates considerable effort, systematic evaluations of these efforts do not always occur. In some instances, interpretations of enhanced welfare are anthropomorphic rather than empirical. These interpretations may often be correct, but there is substantial motivation to develop experimental, analytical, and interpretational frameworks to enable objective measurements of the value of environmental enrichment/behavioral management efforts. Similar problems exist in analyzing environmental enrichment benefits for animals in agriculture, and several investigators in that field have profitably used consumer-demand approaches for such analyses (Cooper, 2004; Dawkins, 2006; Mason, McFarland, & Garner, 1998). Assessments of the value of particular behavioral management strategies to captive NHP welfare could, and should, profitably employ consumer-demand analyses as well.

The consumer-demand approach to analyses of the welfare of animals in captivity is multifaceted, involving numerous variables; formulas; and functions (Dawkins, 1983; Mason et al., 1998). What follows is an extremely brief, selective, and simplistic treatment of those aspects of the consumer-demand approach that may be most relevant to studies involving NHP. The reader should explore the cited references for detailed and scholarly treatments of the specific issues raised in this article.

**CONSUMER-DEMAND STUDIES**

In assessing the welfare of captive animals, one of the primary goals of the consumer-demand approach is to determine the value an animal places on a specific resource (Dawkins 1983; Mason et al., 1998). On one level, this approach simply assesses how hard subjects will work to attain the resource. The proper implementation of consumer-demand strategies can yield considerable information about the relative value of resources to captive animals (Albentosa & Cooper, 2005; Sherwin, 2004).

On the other hand, investigators must exercise caution when interpreting the results of consumer-demand studies, because animals (including people) do not always make optimal choices regarding their overall welfare (Dawkins, 2006). Animals may show a greater motivation to work for unhealthy resources than for healthy ones, and NHP are perhaps more likely than some other species to behave in this way. One example of such suboptimal behavior involves addictive drug
studies, which demonstrate that monkeys will perform operant tasks to earn drugs, to the exclusion of earning food (Paronis, Gasior, & Bergman, 2002).

In addition, a properly implemented consumer-demand study requires the satisfaction of several conditions (Mason et al., 1998). Although some studies of agricultural animals and mice easily satisfy many of these requirements (Albentosa & Cooper, 2005; Sherwin, 2004), the prospect of satisfying all of the consumer-demand criteria in studies of NHP is more tenuous. A partial list of relevant conditions for application to primate studies includes (a) a closed economy, (b) validity, and (c) adversity.

Consumer-demand studies seem to yield the best data when conducted in a closed economy (Cooper, 2004; Mason et al., 1998); that is, assessing the value of resources works best when the animals can obtain the target resources only under experimental conditions. To determine the value of positive reinforcement training, for example, the animals should have access to their trainers only during the experiment, with no other opportunities for training. On the other hand, an example of an open economy would be a situation in which animals had access to social interactions both during, and outside, the experiment (Mason et al., 1998; Matthews & Ladewig, 1994). With NHP it might be possible to maintain a closed economy for some resources (access to trainers, if the primates receive training only during the experiment) but not for others (access to food reinforcers, if the primates must receive food outside the experiment).

Validity is another concern in consumer-demand studies (Cooper, 2004; Dawkins, 2006; Sherwin, 2004). Typically, these studies can achieve considerable internal validity, but external validity is somewhat more difficult (Cooper, 2004; Sherwin, 2004), especially when assessing welfare implications for animals who live socially but undergo testing individually (Cooper & Appleby, 1997). There is thus substantial motivation to have experimental environments and manipulations functionally simulate the conditions of interest, such as, one should study socially housed chickens (Albentosa & Cooper, 2005) when analyzing conditions in commercial group-living chicken operations. In addition, having chickens squeeze through a gap to assess the value of different cages or perch heights (Albentosa & Cooper, 2005; Cooper & Appleby, 1997) may be a more ecologically relevant “cost” than the more traditional operant response of pecking a key (Cooper, 2005). One must also be careful, in these types of studies, not to interpret an inability to master the operant response as a lack of interest in the resource (Dawkins & Beardsley, 1986), a concern that could be particularly relevant in those NHP studies that require subjects to perform several responses to attain their reward (Paronis et al., 2002).

Finally, in consumer-demand studies using agricultural animals and mice, one can assess the motivation to attain a target resource by exposing subjects to adverse conditions such as a water barrier for mice (Sherwin & Nicol, 1996). The greater the amount of adversity the subjects are willing to experience, the stronger their
desire for that resource (Albentosa & Cooper, 2005; Dawkins, 1983; Sherwin & Nicol, 1996). This approach may be problematic with NHP, as there could be ethical concerns if primates have to experience adversity to demonstrate their preference for a particular resource (squeezing through a narrow gap to access an enrichment cage). The use of narrow gaps, in particular, may also cause practical concerns, because monkeys have an inexplicable propensity for getting stuck in small spaces.

APPROXIMATIONS OF CONSUMER-DEMAND STUDIES OF NHP WELFARE

Early Studies
Several research programs have attempted to assess the value of particular resources to captive NHP, but a systematic use of consumer-demand approaches has historically been absent in this field. The early studies probably suffered from the same open-economy shortcomings that Mason et al. (1998) pointed out in the work of Matthews and Ladewig (1994). Although none of these studies met all of the conditions required for a proper consumer-demand study today (Cooper, 2004; Mason et al., 1998), some of them did address several of the consumer-demand criteria.

In one example, from early studies of motivation, Butler (1960) demonstrated that monkeys would work for the opportunity to observe things through a window. This finding was surprising at the time, providing insight into what motivated captive monkeys. A similar, but perhaps more famous, example involves Harlow’s (1971) studies of contact comfort in infant monkeys, in which young monkeys exercised choice by running for comfort to cloth surrogates—rather than wire surrogates—when confronted by a frightening stimulus. In this scenario, the potential cost was that only the wire surrogate provided nutritional resources, so time spent on the cloth surrogate was time spent away from the food source.

More Recent Studies
Even today, few empirical assessments of captive NHP welfare have used a strict consumer-demand approach or addressed the “real” value to NHP of particular behavioral management strategies. Some relatively recent studies have compared preferences for, and use of, different enrichments (Pruetz & Bloomsmith, 1992; Reinhardt, 1990; Schapiro & Bloomsmith, 1995; Schapiro, Bloomsmith, Suarez, & Porter, 1997); however, such investigations are more appropriately considered preference studies, rather than consumer-demand studies. However, two enrichment approaches described in the literature (grooming-contact cages and positive
reinforcement training) may come closer than most to incorporating some elements of consumer-demand studies.

Grooming-contact Cages

The first relevant approach involves assessments of social activity in NHP housed in grooming-contact cages (Crockett, Bellanca, Bowers, & Bowden, 1997). Grooming-contact cages allow neighboring animals to have protected social contact through a common wall between their enclosures. Depending on the size of the gaps between the bars in the wall, the animals can touch or groom one another, but they cannot achieve full physical contact. This housing arrangement potentially enters the realm of consumer demand because the animals can choose either to engage in social activity at the common panel or to remain isolated from their neighbor; that is, the resource of physical social contact exists in a closed economy. This type of study has considerable external validity for the target population, involving subjects and housing conditions that are typical of NHP research environments.

In such protected-contact situations, behavioral measures of proximity and/or affiliation should provide reasonable estimates of the value of social opportunities to the subjects. Clearly, however, achieving access to the social opportunity involves little work and few adverse consequences (therefore few costs), making assessment of the animals’ level of desire for the resource somewhat problematic. Although Crockett et al. (1997) found that pairs of cynomolgus macaques spent about 23% of their time near the grooming-contact panels and about 12% of their time in contact with their neighbor (virtually all of it in social grooming), recent analyses of similar protected-contact strategies have identified fewer beneficial outcomes (Baker et al., 2005).

Positive Reinforcement Training

Positive reinforcement training (PRT) studies constitute the second approach that may be relevant to consumer-demand-like analyses of captive NHP welfare. PRT encourages primates to perform valuable behaviors on command (Laule, Bloomsmith, & Schapiro, 2003), using the stimulus/response/reinforcement contingencies of fairly simple operant conditioning techniques (Mazur, 2002). The most commonly used positive reinforcer for performance of a target behavior is food. Subjects typically participate in training sessions voluntarily. During these sessions, they must “work” for desired resources (food rewards, human interaction, cognitive challenge, and/or control). In some cases, they may also encounter the additional cost of tolerating an uncomfortable procedure (an injection or venipuncture). Food is usually available outside of training sessions, but animals typically have access to trainers only during the sessions (closed economy for trainer attention and/or control over procedures). Like the grooming-contact work
discussed earlier, PRT studies should have considerable external validity because the target behaviors are useful ones for which training is most effective in conditions that closely approximate “real” situations (Schapiro, Perlman, Thiele, & Lambeth, 2005).

One particularly relevant PRT example is a study of the effects of training rhesus monkeys to change their preferred patterns of proximity to, and affiliation with, other monkeys in their group. Monkeys experience potential costs when they alter their patterns of proximity and affiliation (increased proximity yields increased risk of injury). In this study (Schapiro et al., 2001), low-affiliating adult female rhesus monkeys received reinforcement for affiliating, and high-affiliating adult females received reinforcement for not affiliating. Study results demonstrated that originally low-affiliating monkeys significantly increased the amount of time they spent affiliating, but they did so only during nontraining observations. This suggests they chose to take advantage of their enhanced opportunity/propensity to behave socially—in spite of any costs. Originally high-affiliating monkeys, on the other hand, did not significantly decrease the amount of time they spent affiliating (few costs, but few benefits as well).

A second type of PRT study that may be relevant to consumer-demand analyses involves training chimpanzees to allow voluntary intramuscular injections, usually of anesthetics (Lambeth, Hau, Perlman, Martino, & Schapiro, 2006). In these studies, chimpanzees had the opportunity to present a thigh voluntarily for an anesthetic injection (a procedure that is uncomfortable, but perhaps not particularly stressful), as opposed to receiving an involuntary injection, typically via a dart gun (a procedure that is both uncomfortable and stressful). Training sessions can use both primary and secondary positive reinforcement (Laule et al., 2003); however, during an actual anesthetic injection, only secondary reinforcement is feasible. Most chimpanzees in our colony (66.1%) will reliably present a thigh (Schapiro et al., 2005). Although the voluntary performance of the target behavior itself suggests that the animals have chosen to participate, the hematological and chemistry data from blood samples obtained after the dose of anesthetic also suggest that training animals to submit voluntarily to injections leads to less stressful animal handling procedures. In this case, the economy is not a closed one, but the animals are choosing to experience adversity to attain the available resources.

One final example of data from NHP studies that are potentially relevant to the consumer-demand approach is the training of chimpanzees to provide voluntary conscious blood samples, using a “blood sleeve” with a bar at the end (Lambeth, Perlman, Thiele, & Schapiro, 2005). Positive reinforcement encourages the chimpanzees to insert an arm into the sleeve and hold onto the bar. This positioning exposes the cephalic vein for venipuncture. Unlike an anesthetic injection, where primary reinforcement is not possible directly after the performance of the most critical trained behavior (presentation for the actual injection), chimpanzees can receive food immediately on completion of blood collection. Trained animals will
reliably perform this behavior. Clearly, voluntary participation in this uncomfortable procedure indicates that the chimpanzees “want” to engage in the behavior to attain the available resources. Also, as with training for injections, significant differences exist between the physiological data from voluntarily collected blood samples and the data from nonvoluntarily collected blood samples (Lambeth et al., 2005).

Cumulatively, these examples suggest that determining the value of target resources should be possible when NHP voluntarily participate in uncomfortable procedures. The degree of discomfort an animal will voluntarily tolerate indicates the value of the resource. However, in many circumstances, isolating and assessing the value of individual target resources may be difficult.

CONCLUSIONS

Preference studies, in which primates can voluntarily choose to socialize or to participate in training, may currently be the best examples of a consumer-demand-like approach to assessing the welfare effects of management strategies for captive primates. It will likely be more difficult to comply with all of the highly desirable criteria (Cooper, 2004; Mason et al., 1998) for proper consumer-demand studies, but such analyses could yield profitable results in primate welfare investigations. Questions of external validity and “selectively” closed economies should be addressable for NHP.

Although it makes sense to encourage additional research in this area, there will be ethical concerns involved in purposefully subjecting captive NHP to adverse circumstances to measure their demand for a resource. The use of water barriers in studies of mice has proved to be acceptable (Sherwin & Nicol, 1996), but similar manipulations may not be justifiable in studies of primates. Problems could also result from something as seemingly simple—and potentially relevant—as making NHP squeeze through a small opening to gain access to a resource, given the relatively high probability that they will become stuck or injured. It will be up to primate welfare researchers to design studies and/or obstacles that will help measure the relative value of resources to captive primates without compromising the welfare they are attempting to evaluate and enhance.

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