JOURNAL OF APPLIED ANIMAL WELFARE SCIENCE, *3*(4), 293–304

Determining the Value of Social Companionship to Captive Tufted Capuchin Monkeys (*Cebus apella*)

Elizabeth Dettmer and Dorothy Fragaszy
Department of Psychology
University of Georgia

This study used a method similar to one introduced by Dawkins in 1990 to assess the magnitude of the psychological need for social companionship in pair-housed tufted capuchin monkeys (*Cebus apella*). This method permits classification of commodities as necessities or luxuries. The study directly compared the commodity of social companionship to the commodity of food, a known physiological necessity, in a series of preference tests following commodity deprivations. The majority of subjects chose their social companion over food at baseline and persisted in this preference even after several hours of food deprivation. In addition, subjects' preferences shifted from 1 commodity to the other with manipulation of social and food deprivation levels. Capuchin monkeys perceived social companionship as a necessity at a level similar to that of food.

Recent animal use legislation (Animal Welfare Act, 1985, 1991) in the United States requires that those responsible for the care of captive nonhuman primates provide for their psychological well-being, including provisions to meet social needs. Whereas physical well-being can be assessed as the absence of pathology and on the basis of physical condition or physiological measures, the definition of psychological well-being is more problematic. Although many parameters for enrichment have been stipulated in regulations, no consensus on how to measure psychological well-being presently exists (Committee on the Well-Being of Nonhuman Primates, 1998; Dawkins, 1990; Novak & Suomi, 1988; Poole, 1992). Identification of basic needs might be a less elusive research goal than identification of psychological well-being. If we can determine how to meet

Requests for reprints should be sent to Elizabeth Dettmer, Boston VAMC (116B), 150 South Huntington Avenue, Boston, MA 02130. E-mail: dettmer.elizabeth@boston.va.gov

needs, doing so will support physical and psychological well-being. We suggest that a shift from the identification of psychological well-being to the identification of basic needs might bring us closer to current welfare goals.

How does one define basic needs? Maslow (1968) introduced a theory of basic needs for *Homo sapiens*. He placed physiological needs such as hunger, thirst, sleep, rest, exercise, and elimination at the base of the hierarchy. Individuals, he postulated, must first meet these physiological needs before attending to needs of safety, the next step in the hierarchy, or social needs, still another step higher. Maslow's hierarchy continues to levels of introspection that include self-esteem needs and self-actualization and asserts that well individuals can fulfill all of these needs—from nourishment to self-actualization: "If the essential core of the person is denied or suppressed, he gets sick, sometimes in obvious ways, sometimes in subtle ways, sometimes immediately, sometimes later" (p. 4). In free choice situations, the need-deprived person gives basic needs priority over other satisfactions (Maslow, 1968). This theory supports the use of choice tests to evaluate whether a particular commodity fulfills a need.

Animal researchers have employed preference tests similar in theory to that which Maslow (1968) termed *choice situations*. However, many of these tests have been too simplistic in nature. An assumption, originating with Spencer (1880), was made that animals experience subjective feelings of pleasure when given access to reward or positive reinforcers. Therefore, many researchers have presented subjects with a choice between two different environments, assuming the animals would spend more time in the particular environments that they found more reinforcing. Dawkins (1981) used such a method to demonstrate that battery-kept hens prefer larger cages to smaller ones and litter floors to wire floors. When the two commodities were pitted against one another (the animal had to enter a smaller cage to gain access to litter or a wire cage to gain the larger area), litter was given higher priority. According to Dawkins, battery hens "preferred the smaller cage when this had a litter floor to the one four times larger with a wire floor" (p. 255).

Duncan (1978) criticized such preference experiments for providing only relative conclusions: "The fact that A is always chosen in preference to B tells us nothing of the absolute properties of A and B" (p. 198). In addition, many choice experiments are based on the assumption that

> in the natural environment, proximate and ultimate needs will generally go hand in hand. For example, animals that experience a proximate need for food and start searching for it when their reserves are low will be fulfilling the ultimate need of avoiding death by starvation. (Dawkins, 1983, p. 1197).

Duncan argued that animals in laboratory settings often choose according to short-term gains that do not correspond to long term gains. In view of such criti-

cisms, Dawkins (1990) suggested an operant training technique that provides an objective way for determining what animals are experiencing. The paradigm requires subjects to demonstrate motivation to obtain certain rewards through operant tasks for different commodities. An animal's willingness to work for each commodity is compared. Willingness to work for food is used to anchor the relative measurement allowing assignment of qualitative worth. If animals show that they regard being without some commodity as aversive as being without food (a known basic need), then one could argue that the animals suffer (as they surely would suffer without food) without that commodity. In other words, the need for food is used as a yardstick against which other less recognized needs are measured.

Demonstration of such commodity demand curves (demonstration of how hard an animal will work for a commodity) requires a great deal of time. Researchers have voiced concern about the large number of experiments that would need to be done to plot demand functions of different animals, conditions, sexes, times of year, and so on (Dawkins, 1990). In addition, the implementation of such a plan is somewhat problematic in that operant responses such as pressing a lever are associated preferentially with different stimuli. Animals seem to be prepared to make certain associations and less prepared to make others. For example, Garcia and Koelling (1966) showed long ago that rats readily associate an auditory–visual stimulus with shock punishment but do not associate a taste stimulus with shock. Such differential preparedness can alter performance and therefore complicate the comparison of an animal's motivation for different commodities with the use of the same operant task.

This design, a simplification of Dawkins's (1983, 1990) method, investigated whether social companionship is a basic need for capuchin monkeys (*Cebus apella*). Instead of comparing commodity demand curves, we directly compared individuals' needs for social companionship with the need for food.

METHODS

Design

Figure 1 illustrates the experimental design. Subjects were tested in a baseline condition and two test phases. Baseline trials required subjects to choose between food and social companionship without prior deprivation. Following determination of baseline preferences, subjects next were exposed to food deprivation trials (Phase 1, right arm of Figure 1). None of our subjects exhibited a preference for food in baseline testing; therefore, the left side of Figure 1 was not implemented in this study.

Phase 1 determined the duration of food deprivation required to produce a preference for food. If the subject failed to choose food in at least 9 of 11 trials, the du-

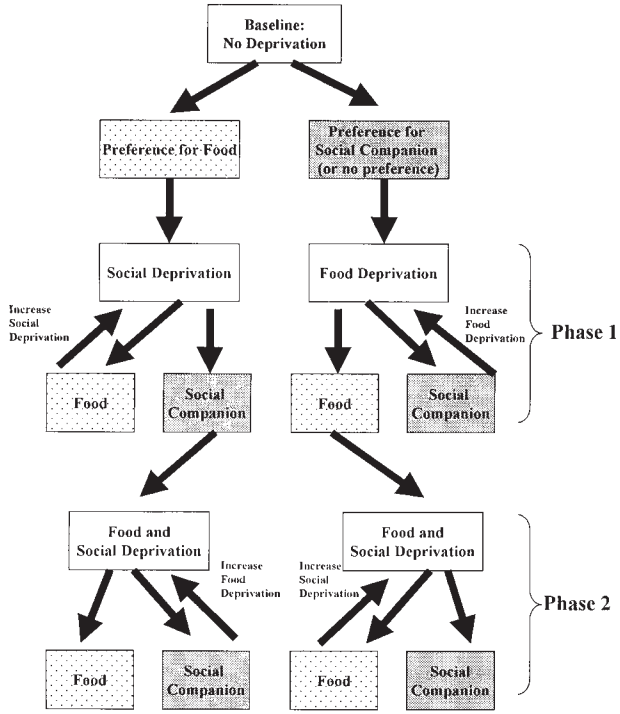

FIGURE 1 The design of the experiment. Subjects were assigned to the left or the right path of testing after we evaluated their preference for food or the pairmate in a choice setting, under normal conditions. In Phase 1, subjects experienced deprivation of the commodity they had expressed preference for in the baseline condition. Testing in this phase was repeated with increasing levels of deprivation until the subject switched its preference to the initially less preferred commodity. Once its preference had shifted, the subject entered Phase 2. In this phase of testing, the subject experienced deprivation of both commodities. The duration of deprivation of the initially preferred commodity was increased until the subject reverted to its original preference. As no subject expressed a preference for food over the social partner in the baseline condition, all subjects followed the path outlined on the right side of the figure.

ration of food deprivation was increased and a new set of choice trials presented to the subject. Once subjects switched to a food preference or reached 22 hr of food deprivation, they moved to Phase 2. On advisement of the attending veterinarian, no animal experienced more than 22 hr of food deprivation.

Phase 2 assessed the subjects' need for social companionship in relation to their need for food. Subjects were deprived of food for the duration determined in Phase 1 to produce a preference for food. Concurrently, they also were deprived of social companionship. The duration of social deprivation was increased until the subject expressed a preference (9 of 11 trials) for the social companion or until 24 hr of social deprivation was implemented.

Subjects

Seven capuchin monkeys, six males and one female, served as subjects. At the onset of the procedures, these animals ranged in age from 19 to 88 months. The subjects had lived as pairs in indoor pens (1.99 m × 1.07 m × 1.19 m) for at least 2 months prior to testing. All subjects but one were reared for at least 2 years in species-typical groups. The only female subject, age 33 months, was paired with the youngest male, 21 months. Both subjects were well below the age of sexual maturity, estimated as 48 months (Fragaszy & Adams-Curtis, 1998). The animals were maintained on Purina Monkey Chow 5045 (Richmond, IN) and daily rations of fruit and vitamin supplements. Food was available ad libitum except during testing periods. The light–dark cycle was set at 13:11 hr, with onset of light at 6:30 a.m.

Materials

The testing apparatus was composed of three adjoining metal mesh chambers, each 45.7 cm × 40.6 cm × 61.0 cm. The chambers were suspended 1.31 m from the ground via a frame. Transparent doors provided access from the middle cage

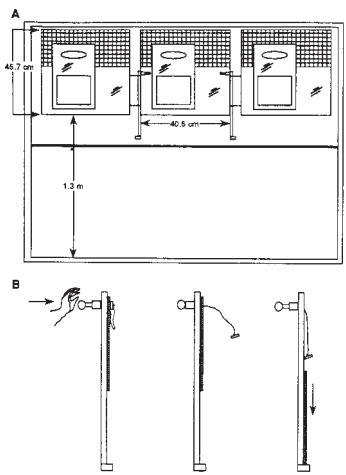

FIGURE 2 The testing apparatus. (a) The subject sat in the center compartment of the three-compartment apparatus. Transparent siding and doors allowed the subject to view but not touch items in the outer two cages. (b) The monkey gained access to one of the adjoining cages by pressing the appropriate knob, which caused displacement of a peg and allowed the separating door to drop. The experimenter then closed the door to the middle compartment, effectively permitting the subject a single choice.

to each of the outer cages (see Figure 2a). Each door was opened by a black knob located in the middle cage to the right of the door. Pushing with a pressure equivalent to 5 lb (2.3 kg) on either knob caused the corresponding door to drop (see Figure 2b). Exertion of 5 lb of pressure was effortful but not difficult for the subject to achieve.

Procedure

Training. Subjects were placed individually into the testing apparatus for 15–30 min each session and hand fed. Agitation (vocalizations and intense watching behavior) dropped rapidly after approximately 11 days. Through a series of successive approximations, the subjects were trained to operate the choice doors by pushing on the appropriate knob. Subjects required from 7 to 17 (average = 12) training sessions to master control of the doors.

The subjects then were presented with two types of choice trials. In the first (Type A), more of one food item (fruits, nuts, and yogurt) was placed on one side of the testing apparatus and less of the same item on the other. Side of placement of the larger amount of food was randomized. Access doors were locked. Subjects were released into the middle compartment where they could view the choices in each adjoining compartment through Plexiglas doors. After 20 sec, a beeper signaled the experimenter to unlock both choice doors and say the word "okay." This signaled the subject to make a choice. Pushing the knob to open a door provided access to the corresponding compartment and any food item contained in it. The experimenter immediately locked the opposite compartment. The subject was required to remain with the choice for 5 min, at which time the subject was removed via a transfer box. The animal remained in the box as the testing apparatus was prepared for the next trial. Subjects underwent four trials of this type per training session. Subjects were assumed to have gained an understanding of the choice situation when in 100% of trials in two concurrent testing sessions (a total of 8 trials) they chose the larger over the smaller amounts of food in Type A trials.

In one trial per session, the subjects were presented with the second type of choice trial (Type B), a choice between two different food items instead of different amounts of the same food item. This procedure was implemented to give the animals experience with the consequence of choice when choosing between two different items.

Testing. The first two trials of each testing session were designed to confirm that subjects were willing to go to either side of the apparatus. The subject was presented with a choice between 1 tsp of flavored sugar water and nothing. The placement of the flavored sugar water was alternated from side to side. Animals continued with testing if on each of these trials they chose the side containing the sugar water over the empty side. Only once did a subject refuse to choose both doors.

The two sugar water trials were followed by one test trial in which the subjects were presented with a choice between the home-cage partner and two Purina Monkey Chow biscuits (the basis of their normal diet). The side placement of these stimuli was systematically varied using the Fellows (1967) testing sequence. The subjects' choice was followed by a 5-min waiting period where they remained in the testing apparatus with the chosen object, the biscuits or social companion. If the subject chose the social companion, the biscuits immediately were removed from the room. If the subject chose the biscuits, the social companion was removed from the testing apparatus and placed on the floor in the same room. After 5 min, the subjects were transferred to the home cage, where they had access only to the chosen stimulus. If the subject chose food in the test trial, the home cage was supplied with food biscuits but the social partner remained outside the cage (although still in view) for 5 min. If, instead, the subject chose the social partner during the test trial, both subject and social partner were returned to the home cage together but waited 5 min for access to food.

Test sessions were conducted in baseline, Phase 1, and Phase 2 conditions. In the baseline, subjects were tested in the choice apparatus with no prior deprivation of food or social companionship for 11 trials (one per day). In Phase 1, the animals were deprived of food initially for 3 hr before each trial. If the subject chose the social companion 3 times at that level of deprivation over an 11 trial sequence, the subject's next trial would be the first of another session of trials following a longer period of food deprivation. Subjects were exposed to a different sequence of deprivation hours, dependent on their preceding performance. For example, Be began Phase 1 trials following 3 hr of food deprivation. On 3 days, she chose her social companion. She then was deprived of food for 5 hr and tested again until she chose her social companion three times. She was then subjected to yet a higher deprivation level (7 hr). Subjects continued in this manner until they chose food on 9 of 11

TABLE 1
Testing Specifics

Subject	*Baseline Trials*	*Food Deprivation Trials*	*Range of Food Deprivation Hours*	*Food and Social Deprivation Trials*	*Range of Social Deprivation Hours*
Be	11 (11)	38 (24)	3–17 (3–5)	21 (13)	17–24 (22–24)
Ch	11	30	3–13	22	22–23
Jo	11	20	3–15	11	17
Qu	11	27	3–13	32	22–24
Xa	11	61	3–22	11	22
Xe	11	41	3–18	11	22
Wi	11	44	13–19	37	22–24

Note. Be was tested twice. The values in parentheses are from her second testing sequence.

trials or reached 22 hr of food deprivation. See Table 1 for the range of hours of deprivation and the total number of trials each individual completed.

In Phase 2 trials, the level of food deprivation required to reach criterion in Phase 1 was continued. Additionally, subjects were deprived of social companionship for 17–22 hr. If the subjects did not chose their social companion on 9 of 11 trials, following the initial period of social deprivation, it was increased by 1 hr (see Table 1). As soon as a significant preference for the social companion was demonstrated or the animal failed to display a preference after 24 hr of social deprivation, testing was terminated. In Phases 1 and 2, subjects were tested on 5 consecutive days, then given 2 days on their standard feeding schedule and without social separation. Testing occurred over a 15-week period.

Welfare Implications

Subjects in the study were deprived of food for up to 22 hr. The attending veterinarian advised that 22 hr of food deprivation was not life threatening and would have no long-lasting effects on the animals. We monitored the subjects carefully when feeding them after periods of food deprivation to make certain they did not eat too quickly, which could contribute to bloating and stomach problems.

Subjects also were deprived of their social companions for up to 24 hr at a time. Past research has shown that primates subjected to social separations are likely to experience an increase in cortisol (Lyons et al., 1999). This physiological response is a normal reaction of the body that facilitates coping with stress and is expected to occur in any new situation characterized by uncertainty. Short-term stressors, such as separation of juvenile rhesus from their natal social group and resulting increased cortisol have been correlated to decrements in some immune parameters (Gordon et al., 1992). However, it still is not clear if such changes occur in all separations and how such specific changes, especially short-term changes, might affect overall health. Chronic elevations of cortisol have been linked more clearly than short-term elevations with detrimental health effects in past research. The separations for this study were relatively brief (less than 24 hr). All subjects remained in good health and exhibited normal behaviors during and after the study.

RESULTS

Baseline

Five of the seven subjects displayed a significant preference for their social companion in baseline sessions, and all seven chose their social companions more often than food in this phase (binomial probability of .008). Three subjects chose their social companion on all 11 baseline trials (see Table 2).

TABLE 2
Summary Table of the Results of Each Subject

Subject	*Baseline: Social Choices Out of 11 Trials*	*Did Animal Display a Baseline Preference for Social Companion?*	*Hours of Food Deprivation Required to Create Food Preference*	*Did Animal Switch Back to Social Preference With Addition of Social Deprivation?*	*Social Deprivation Hours Required to Shift Preference Back to Social*
Be	11	yes	17 (5)	no	N/A
Ch	11	yes	12	yes	23
Jo	10	yes	15	yes	17
Qu	7	no	12	no	N/A
Xa	9	yes	> 22[a]	yes	22
Xe	11	yes	18	yes	22
Wi	8	no	19	no	N/A

[a]Xa failed to reach criterion for food preference even at 22 hr of food deprivation, choosing food on only four trials.

Phase 1

The duration of food deprivation required to produce a preference for food over social companionship was 12–19 hr for six of the seven subjects. The seventh animal (Xa), following 22 hr of food deprivation, still chose his social companion more often than food (7 out of 11 trials). The two animals who failed to demonstrate a statistically significant preference for their social partners at baseline required 19 and 12 hr of food deprivation before they exhibited a preference for food.

Phase 2

Of the five animals who displayed a social preference at baseline, four again displayed a preference for their companion in Phase 2 when they were deprived both of food (12–22 hr) and social companionship (17–23 hr). The fifth animal, Be, never exhibited a significant preference for social companionship in this phase. When 24 hr of social deprivation was added to the 17 hr of food deprivation, she chose randomly between the two commodities. The two subjects who showed no significant preference in baseline chose randomly between the two commodities when 24 hr of social deprivation was coupled with food deprivation.

In sum, four different patterns of response were demonstrated:

1. Three animals displayed a baseline preference for social companionship followed by a food preference after 12, 15, or 18 hr of food deprivation only, then a so-

cial preference following food deprivation of 12, 15, or 18 hr and social deprivation of 23, 17, or 22 hr (social–food–social).

2. One animal showed a baseline preference for social companionship and no preferences after 22 hr of food deprivation. When social deprivation (22 hr) was added to 22 hr of food deprivation, he switched back to his preference for social companionship (social–neutral–social).

3. Two animals showed no baseline preference, a food preference after 12 or 19 hr of food deprivation (but no social deprivation), and no preference when both food and socially deprived (neutral–food–neutral).

4. One animal showed a baseline preference for her social companion, a food preference after 17 hr of food deprivation, but no preference when deprived of both food (17 hr) and social companion (24 hr; social–food–neutral).

DISCUSSION

To measure the need for social companionship, subjects were asked—following a host of commodity deprivations—to choose between two commodities: food and social companionship. The only time subjects showed a food preference was when they were provided with a social companion but deprived of food for at least 12 hr prior to testing trials. None of the subjects showed an initial food preference over social companionship, and four of the seven subjects chose the social partner significantly more often than food, even following lengthy periods (22 hr) of food deprivation.

These results show that social companionship and food are valued similarly by tufted capuchins. This was demonstrated by the manipulation of deprivation levels and the resulting preference shifts that indicate the "need" status of the two commodities as very similar. Because capuchins treat social companionship as if it were at the same need level as food, we propose that these monkeys can be considered psychologically well only if they maintain their access to their companions.

Having said that, we also point out that our results say nothing of the scalar values of the tested commodities (23 hr of social deprivation is not claimed to be equal to 17 hr of food deprivation). No parametric comparison of the amounts of food and social companionship deprivation can be made. Moreover, the extent to which these findings may be generalized across species, ages, sexes, and housing conditions is unknown. For example, these subjects had a history of social housing. It may be that animals housed singly from an early age would perform very differently in this paradigm. As a second example, the quality of the relationship between the subject animal and the social companion may be an important variable. In this study, the subject's familiar cage mate was used as the social companion. It may be that only familiar individuals fulfill the basic need for companionship.

CONCLUSIONS

Despite the caveats arising from our particular sample of subjects and our inability to address the scalar values for different needs, the results are clearly interpretable. Tufted capuchin monkeys value social companionship as they value food: It is a necessity, not a luxury. This paradigm creates a conservative estimate of what animals deem as essential to their well-being as the physiological necessity of food. It avoids time-consuming creation of demand curves and associated problems of equating different operant tasks that must be specific to each commodity. Instead, commodities can be classified in one of two categories: basic needs and luxuries, where no level of deprivation will offset deprivation of a basic need. Future research using this paradigm could investigate relationships or specific inanimate features of the environment such as those often targeted for "enrichment." This method can provide convergent validation for claims that various alterations of housing or handling improve the psychological well-being of animals. It can show that animals regard some object, environment, or event as necessary to their well-being.

REFERENCES

Animal Welfare Act Amendments of 1985, Pub. L. No. 99–198 (1985).

Animal Welfare Act Amendments of 1991, 3.81(a) Fed. Reg. 56, No. 32, p. 6499 (1991).

Committee on the Well-Being of Nonhuman Primates. (1998). *The psychological well-being of nonhuman primates*. Washington, DC: National Academy Press.

Dawkins, M. D. (1981). Priorities in the cage size and flooring preferences of domestic hens. *British Poultry Science, 22,* 255–263.

Dawkins, M. D. (1983). Battery hens name their price: Consumer demand theory and the measurement of ethological "needs." *Animal Behavior, 31,* 1195–1205.

Dawkins, M. D. (1990). From an animal's point of view: Motivation, fitness, and animal welfare. *Behavioral and Brain Sciences, 13,* 1–9.

Duncan, I. J. H. (1978). The interpretation of preference tests in animal behaviour. *Applied Animal Behaviour, 4,* 197–200.

Fellows, B. J. (1967). Chance stimulus sequences for discrimination tasks. *Psychological Bulletin, 67,* 87–92.

Fragaszy, D., & Adams-Curtis, L. (1998). Growth and reproduction in captive tufted capuchins (*Cebus apella*). *American Journal of Primatology, 44,* 197–203.

Garcia, J., & Koelling, R. (1966). Relation of cue to consequence in avoidance learning. *Psychonomic Science, 4,* 123–124.

Gordon, T. P., Gust, D. A., Wilson, M. E., Ahmed-Ansari, A., Brodie, A. R., & McClure, H. M. (1992). Social separation and reunion affect immune system in juvenile rhesus monkeys. *Physiology and Behavior, 51,* 467–472.

Lyons, D. M., Wang, O. J., Lindley, S. E., Levine, S., Kalin, N. H., & Schatzber, A. F. (1999). Separation induced changes in squirrel monkey hypothalamic–pituitary–adrenal physiology resemble aspects of hypercortisolism in humans. *Psychoneuroendocrinology, 24,* 131–142.

Maslow, A. (1968). *Toward a psychology of being* (2nd ed.). New York: Van Nostrand Reinhold.

Novak, M. A., & Suomi, S. J. (1988). Psychological well being of primates in captivity. *American Psychologist, 43,* 765–773.

Poole, T. (1992). Nature and evolution of behavioral needs in mammals. *Animal Welfare, 1,* 203–220.
Spencer, H. (1880). *Principles of psychology* (3rd ed.). London: Longman.