Aquatic Mammals 2002, **28.2,** 113–120

The effect of a simple feeding enrichment strategy on the behaviour of two Asian small-clawed otters (*Aonyx cinerea*)

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Abstract

The behaviour patterns of two Asian small-clawed otters (*Aonyx cinerea*) were investigated to determine the effects of a simple feeding enrichment technique on a number of undesirable behaviours. Two of the three daily meals were inserted into grapevine balls and delivered to the otters in the exhibit pool. Rates of social hair-plucking, auto hair-plucking and door manipulations significantly decreased even after the effects of novelty were minimized. These behavioural effects also generalized to times outside the use of the intervention. Although only two subjects were involved, this study provides preliminary evidence for the effectiveness of this intervention in reducing atypical behaviours in Asian small-clawed otters.

Key words: otters, *Aonyx cinerea*, enrichment, welfare, well-being, zoos, hair-plucking, feeding

Introduction

Carnivores seem to be particularly susceptible to abnormal behaviour patterns in captive environments and often these stereotypies seem tied to deficiencies in the method and frequency of feeding (Carlstead, 1998). However, there have been some successes with feeding enrichment with a variety of captive carnivore species in zoological parks (recent examples for mustelids, felids, canids, and ursids include Hawke *et al*., 2000; Shepherdson *et al*., 1993; Carlstead, 1991; Carlstead & Seidensticker, 1991, respectively). There seem to be three primary strategies of carnivore feeding enrichment. The first is to increase the number of daily feeding sessions (i.e., Shepherdson *et al*., 1993) to represent a natural behaviour pattern in which animals often spend a high proportion of their activity budget engaged in feeding-related behaviours. The second is to make the feeding schedule more unpredictable (i.e., Hawke *et al*., 2000) to more closely mimic a free-ranging situation where the timing of meals is much more variable. The third strategy is to make the food items more difficult to obtain, either by hiding them (Fischbacher & Schmid, 1999) or by adding a level of complexity to the food manipulation process, such as providing live prey (i.e., Shepherdson *et al*., 1993; Carlstead, 1991) or full carcass meals (Hutchins *et al*., 1984; Bond & Lindburg, 1990). As in the wild, where food items often are protected by thorns, husks, exoskeletons and shells, artificial feeding interventions create a level of complexity to the feeding process. A more natural behavioural repertoire can have several positive effects including, but not limited to, increasing the welfare of the animal (Mellen & MacPhee, 2001) and making natural history interpretation simpler for the zoological institutions (Hutchins *et al*.,1984).

Free-ranging Asian small-clawed otters (*Aonyx cinerea*) inhabit complex aquatic environments throughout Southeast Asia, comprised mostly of small rivers and streams (Sivasothi & Nor, 1994). Their diet is a variety of mollusks, crustaceans, amphibians, and fish species (Nor, 1989) and like most wild animals, the process of obtaining nutrition is a multi-step procedure involving detection, capture, processing, and ingestion. The ability to process difficult food items, such as shellfish, has been facilitated by the evolution of reduced claws and webbing on the digits. Otters often use their dexterous paws to remove prey species from sand and mud, before removing outer shells and consuming the meat within. Conversely, diets provided to otters in captivity often involve the provision of pre-processed food items, such as manufactured Feline Diet (Lombardi & O'Connor, 1998), which require little pre-ingestion manipulation and are quickly consumed. Lack of feeding complexity can have negative behavioural effects in other captive mammals (Lindburg, 1998) and there is some evidence that this may be the case with captive otters.

The purpose of the present study was to determine the effectiveness of a simple and inexpensive form of feeding enrichment designed to increase the complexity of foraging bouts of two captive Asian small-clawed otters. The impetus for the study was

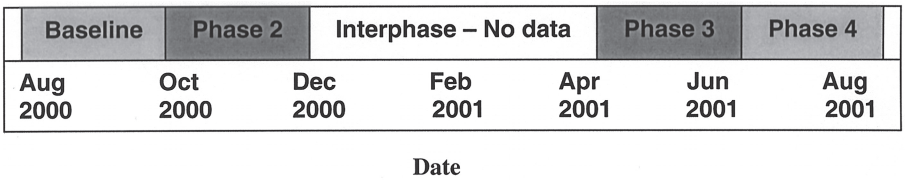

Figure 1. Timeline of experimental protocol.

the perceived high levels of undesirable behaviour shown primarily by the male otter at Lincoln Park Zoo in Chicago, Illinois. He was reported to engage in high levels of social hair-plucking (social-plucking), auto hair-plucking (auto-plucking), and aggression, as well as spending inordinate amounts shaking the metal door to a holding area, which was considered to be a food anticipatory behaviour. By increasing the time required to obtain food, I hoped to alter the behaviour of otters in a species-typical direction and show reductions in undesirable behaviours both in the short and longterm. Otter meals were stuffed inside grapevine balls to force the otters to perform some manipulations to access food items and observations were made to quantify the behavioural effect of this intervention. In addition to measuring the proximate effects of this feeding method, I sought to understand this intervention. Many behavioural studies of enrichment are limited to time frames in which novelty could be a major factor in the effectiveness of the intervention. This study examined not only the immediate effect of the enrichment, but also whether behavioural changes persist over time and even whether any effect of this new feeding method is generalized to times after the grapevine balls were removed.

Materials and Methods

The subjects were 1.1 full-sibling, adult Asian small-clawed otters (*Aonyx cinerea*) housed at the Regenstein Small Mammal-Reptile House at Lincoln Park Zoo in Chicago, Illinois. The otters were aged 10 and 11 years and had lived together since birth. They had varying access to three primary areas: the exhibit (14.2 m^2), the den area (2.7 m^2), and the holding area (2.4 m^2). The primary exhibit area included a large freshwater pool of approximately 7200 l.

Data were collected between August 2000 and August 2001 (Fig. 1) by 13 trained observers, including keeper staff, interns, and others. All observers passed inter-observer reliability tests with a minimum score of 85%. Group scan-sampling (Altmann, 1974) with a 30-s interval was supplemented by all-occurrence recording of key behaviours. All-occurrence data were used to determine frequencies of relatively rare and short duration behaviours. Data were collected 3–6 times daily during 15-min sessions. Scan-sampling data were grouped into categories for analysis (see ethogram, Table 1). Observations were randomly scheduled between 0800 and 1800 h so as not to bias the data towards feeding times. A total of 313 h of data was recorded over four, 8-week phases of the experiment: baseline, intervention, extended intervention, and a post-intervention period.

The enrichment intervention used was a 20 cm hollow sphere made from grapevine and commercially available at most craft and hobby stores. The otters' regular meal was prepared and stuffed into the ball before being tossed into the exhibit pool at approximately 0800, 1200 and 1630 h. Meals consisted of between 150–200 g of cut fish including mackerel, capelin, smelt, herring and/or trout. Empty grapevine balls were removed from the exhibit after feeding and were regularly replaced as they became damaged by the otters' manipulations.

The otters were studied using an A-B-B′-A′ experimental design, with phases numbered 1–4. Phase 1 represented a baseline phase prior to the exposure to the grapevine balls for feeding; otters were hand-fed three meals daily in the off-exhibit area and one of these meals was structured as a positive-reinforcement training session. Phase 2 represented the grapevine ball treatment phase, and phase 3 represented an identical treatment phase occurring 4 months after phase 2. During these treatment periods, two of three meals were delivered to the otters via the grapevine balls, and the other meal was fed off-exhibit during training. These training sessions helped reinforce trained behaviours that aided husbandry procedures and insured that both otters received proportionate amounts of food and dietary supplements. When grapevine balls were used for meals, the otters were briefly locked in holding as keepers entered the exhibit and tossed the balls into the pool. The otters were then released back into the exhibit area and entered the pool to manipulate the pieces of fish out of the grapevine balls. Phase 4 represents a post-intervention phase in which feeding returned to baseline methods. It is important to emphasize that the intervention itself neither altered the amount of food or the timing of meals provided to the otters,

Table 1. Ethogram of instantaneous sampling categories and all-occurrence behaviours.

Instantaneous sampling categories:	
Aggression	Individual engages in contact aggression, such as biting, clawing, or wrestling, or non-contact aggression such as threat or attempted aggression.
Locomotion	Individual is actively moving by way of walking, running, climbing, or swimming.
Object Manipulation	Individual physically moves or manipulates any object or aspect of the environment with paws or mouth.
Social	Individual contacts conspecific with mouth or paws and removes debris or hair. Includes hair-plucking of another individual.
Solitary	Individual is engaged in a stationary, non-social behaviour. Includes self-grooming, yawning, or feeding.
Inactive	Individual is standing or lying and not engaged in any of the above behaviours.
Not visible	Full view of the individual is obstructed and behaviour cannot be accurately determined.
All-occurrence behaviours:	
Aggression	Individual engages in contact aggression, such as biting, clawing, or wrestling, or non-contact aggression such as threat or attempted aggression.
Manipulate Device	Individual physically moves, manipulates or investigates any enrichment item.
Manipulate Door	Individual manipulates the door separating the exhibit from holding areas. May include scratching, pulling or shaking.
Social-plucking	Individual pulls roughly at hair of conspecific.
Auto-plucking	Individual is using mouth to roughly pull hair from own body.

but instead simply changed the manner in which the food was presented.

We compared the otters' behaviour in the baseline phase to that of the three subsequent phases. We calculated the mean time spent by the male and female in each behavioural category for each phase each week. The results were then compared within each individual using one-way analysis of variance across the four conditions and when significant results emerged, planned, *post-hoc* paired comparisons were conducted to determine differences between baseline and each subsequent phase. Because the male otter was the primary participant in the targeted undesirable behaviours, we limited our analysis of the all-occurrence behavioural data to that individual. An alpha level of 0.05 was used for all statistical tests. All analyses were performed using SYSTAT® 7.0.

Results

Means for each behavioural category collected during group scans are in Table 2. Table 3 shows the all-occurrence behavioural data for the male otter only. For the most part, only significant differences are reported below.

Initial effect of the grapevine ball intervention (Phase 2)

Data were analyzed to determine the effects of the grapevine ball feedings in the first 8 weeks of implementation. Analysis of variance revealed that both the male and the female spent significantly less time engaged in social behaviour (male: $F_{(1,5)}=57.1$, $P<0.001$, female: $F_{(1,5)}=46.5$, $P<0.001$) during the proximate intervention phase 2. This effect was due to decreases in both prosocial (social grooming) and abnormal (social hair-plucking) behaviours. Activity levels also were affected as the male showed higher rates of locomotion ($F_{(1,5)}=16.8$, $P=0.005$) and the female showed decreased levels of inactivity ($F_{(1,5)}=25.2$, $P=0.002$). The male otter, who demonstrated 85% of the instances of hair-plucking, showed significant decreases in both social-plucking ($F_{(1,5)}=36.3$, $P=0.001$) and auto-plucking ($F_{(1,5)}=7.50$, $P=0.029$). Not surprisingly, there also was a significant increase in manipulating enrichment items ($F_{(1,5)}=8.49$, $P=0.023$) when the grapevine ball was introduced.

Extended effects of intervention (Phase 3)

Following a 4-month interim period, during which the use of the grapevine ball continued, the effect of the intervention was re-evaluated. The results of this phase demonstrated the effect of the grapevine ball without the benefit of any 'novelty effects' that may have been present during the first 8–week period. Both otters continued to show decreased time engaged in social behaviours (grooming and plucking) compared to rates in the baseline phase (male: $F_{(1,5)}=31.3$, $P=0.001$; female: $F_{(1,5)}=8.68$, $P=0.022$). Likewise, both otters were engaged in solitary behaviours, such as self-grooming, at a significantly greater rate (male: $F_{(1,5)}=6.08$, $P=0.043$; female: $F_{(1,5)}=11.4$. $P=0.012$) in the intervention phase 3. The male otter now showed

Table 2. Proportion of scans engaged in different behavioural categories.

	Baseline Phase 1	Intervention Phase 2	Extended Intervention Phase 3	Return to Baseline Phase 4
Male				
Aggression	0.19	0.10	0.16	0.09
Inactivity	40.97	35.99	47.27*	55.45*
Locomotion	8.99	12.76*	9.08	6.94*
Manipulate Object	11.50	11.12	5.37*	9.48
Social	1.87	0.58*	0.94*	1.15*
Solitary	9.21	11.05	12.29*	9.46
Not Visible	23.07	23.16	22.14	17.43
Female				
Aggression	0.19	0.09	0.16	0.09
Inactivity	47.19	41.24*	50.40	59.54*
Locomotion	16.89	19.51	14.90	13.19*
Manipulate Object	2.51	3.25	1.95	0.82*
Social	1.56	0.61*	0.96*	1.07
Solitary	9.55	10.44	14.29*	8.64
Not Visible	21.99	24.32	16.78	16.74

*Significant difference when compared to baseline rates ($P<0.05$).

Table 3. All-occurrence of behaviour by male otter. Data are shown as hourly rates.

	Baseline Phase 1	Intervention Phase 2	Extended Intervention Phase 3	Return to Baseline Phase 4
Aggression	0.92	0.80	0.72	0.36*
Manipulate Enrichment	0.08	0.80*	1.40*	0.08
Manipulate Door	8.28	9.24	3.60*	4.28*
Social-plucking	1.64	0.68*	0.52*	0.76*
Auto-plucking	2.08	1.24*	1.72	2.48*

*Significant difference when compared to baseline rates, $P<0.05$.

an increase in inactive behaviour ($F_{(1,5)}=5.96$, $P=0.045$), reversing the effect seen in the proximate intervention phase 2. All-occurrence data revealed that the male continued to engage in less social-plucking ($F_{(1,5)}=28.8$, $P<0.001$) and less door manipulation ($F_{(1,5)}=28.3$, $P<0.001$) during phase 3 compared to baseline.

Generalized effects of intervention: post-intervention phase (Phase 4)

The fourth phase of the study involved a return to baseline feeding methods. We were interested in examining whether any of the effects of the intervention would be generalized to a period when the intervention was no longer present. The male continued to show a decreased proportion of time engaged in social behaviours ($F_{(1,5)}=7.375$, $P=0.042$), but the difference for the female was no longer statistically significant. Both individuals showed levels of locomotory behaviour that were less than baseline levels (male: $F_{(1,5)}=14.8$, $P=0.012$; female: $F_{(1,5)}=7.66$, $P=0.039$) coupled with increased levels of inactivity (male: $F_{(1,5)}=106.6$, $P<0.001$; female: $F_{(1,5)}=185.7$, $P<0.001$). Significant decreases in all four targeted behavioural problems were found in the all-occurrence data for the male: aggression ($F_{(1,5)}=11.475$, $P=0.02$), door manipulation ($F_{(1,5)}=70.619$, $P<0.001$), social-plucking ($F_{(1,5)}=95.902$, $P<0.001$) and auto-plucking ($F_{(1,5)}=13.15$, $P=0.015$).

Temporal effects

Because the male was the primary initiator of the key undesirable behaviours, I limited the investigation of temporal patterns to him. Figures 2 through 4 show how rates of social-plucking, auto-plucking, and door manipulation changed over the course of the day and between phases of the study.

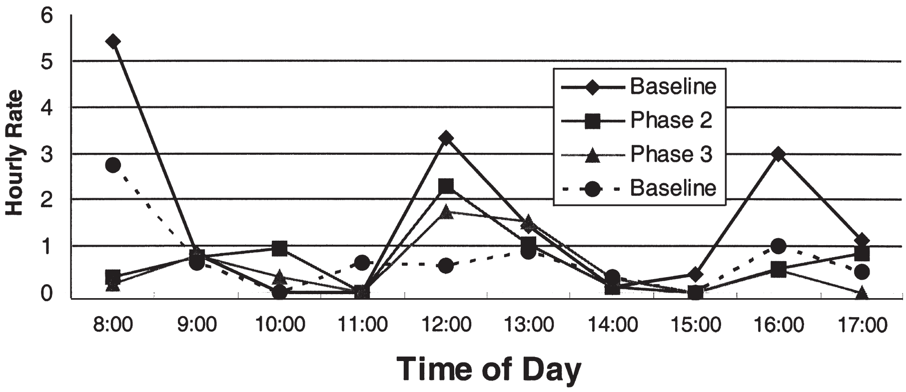

Figure 2. Rate of male otter social-plucking across time of day.

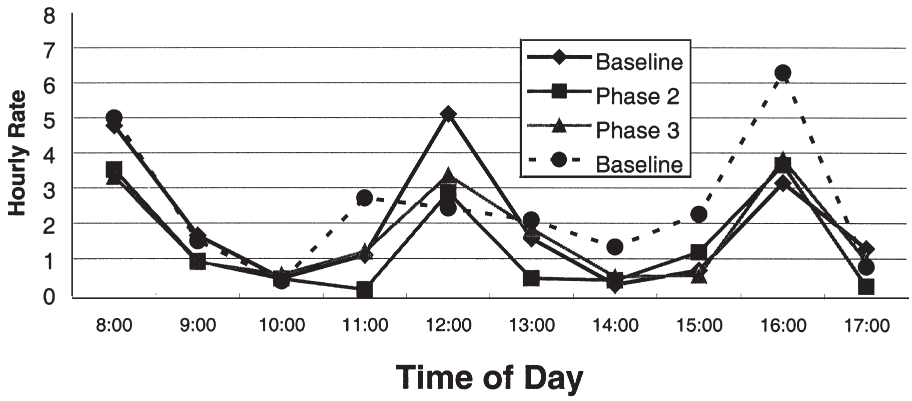

Figure 3. Rate of male otter auto-plucking across time of day.

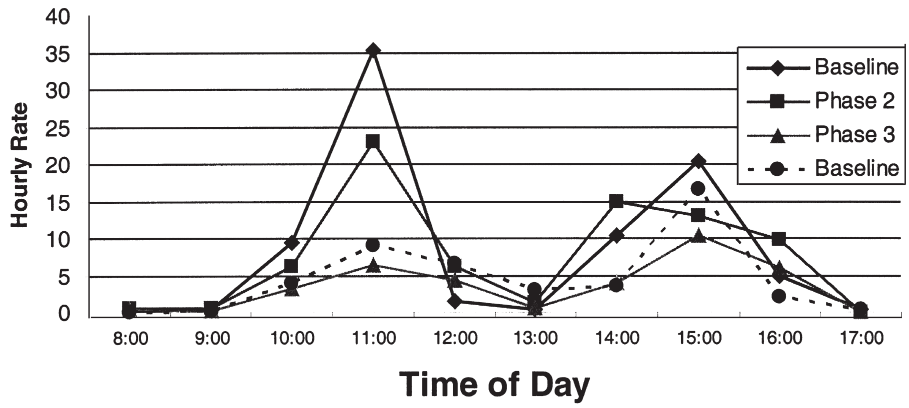

Figure 4. Rate of male otter door manipulation across time of day.

Discussion

Our results showed that the provision of an alternative feeding method had significant effects on the behaviour of a pair of Asian small-clawed otters. The primary hypothesis of this study was that the intervention would extend the foraging time and in turn replace time spent in undesirable behaviours with time engaged with the enrichment. Carlstead (1998) emphasized that animals living in situations where little or no effort is required to obtain their daily nutrition often are prone to developing stereotypies. In one example of effectively lengthening the foraging time, Casson (1990) froze otter meals inside ice blocks, forcing the otters to work for their food and as a result, rates of stereotyped behaviour decreased. Although there are not systematic measurements of time engaged in feeding behaviour in this study, *ad libitum* observations suggested that the length of time spent receiving food in the holding area (baseline condition) was approximately equal to the time spent retrieving the food from the grapevine balls; approximately 2–3 min per meal. Despite this failure to increase feeding time, the use of the intervention had the desired effect. This mirrors results of a study at the Adelaide Zoo (Hawke *et al*., 2000) in which a food catapult was used to distribute food randomly to their Asian small-clawed otters. They also found that stereotyped behaviours were reduced despite a lack of change in foraging time.

Regardless of the issue of foraging bout length, the aim of the study was to reduce a number of undesirable behaviours specifically with the male otter; including social aggression, self-plucking and auto-plucking. The male otter showed significant reductions in the rates of these behaviours, not only when the intervention may have benefited from some novelty effect, but also several months afterward. Additionally, these effects were generalized to the point that there remained significant reductions in these behaviours even after the enrichment was removed. Whether or not these behavioural changes would have continued if the intervention was permanently discontinued remains unknown, but there is at least preliminary evidence for some 'generalized benefit' effect whereby the otters' behaviour were affected outside of the immediate enrichment time. Lindburg (1998) suggested that enrichment interventions with measurable effects after the actual time of stimulation could be more effective in tapping into the motivational states underlying certain behaviours and therefore, may be more effective in increasing measures of well-being. These types of 'generalized' effects also were evident in a study on the effects of providing live fish to captive felids which showed some benefit for more than a week after live-fish were provided (Shepherdson, *et al*., 1993).

I also hoped to reduce the frequency of door manipulation, which was interpreted as a food-anticipatory behaviour similar to those described by Mellowship (1990). The sound of keepers entering the off-exhibit area often prompted the otters to run quickly to the door of the holding area and vehemently dig at the metal door with their paws. This reaction often was generalized to the sounds of keys the keeper staff, custodial staff and even visitors. Since these sounds variably accompanied the opening of the holding area for feeding, the keepers were inadvertently reinforcing the behaviour pattern. By reducing the association of the holding area to feeding bouts by delivering meals to the otters while on exhibit, we hoped to decrease the rate of door manipulations. Interestingly, there was an initial increase in the rate of these door manipulation events by the male when the grapevine ball intervention was first introduced. However, this quickly dropped-off and when the effect of the intervention was examined several months later, there was a significant decrease in these events. Again, this behavioural change was generalized to times when the enrichment was no longer used for feeding.

It is also important to note that these behavioural effects were shown almost exclusively outside the time when the actual enrichment was present. Because feeding bouts were so short in duration, very little (approximately 2%) of the data were collected during times when the grapevine balls were in the exhibit with the otters. Unlike many studies of enrichment, which measure the direct effect of an intervention on the behaviour of an animal, these results are due primarily to indirect effects. Enrichment that provides only direct effects often is difficult to implement because caretakers must constantly replenish the supply of the intervention. The resilience to novelty effects in combination with these indirect effects makes the grapevine-feeding regimen an ideal enrichment approach.

Although not directly targeted, I also was interested in determining the effects of these interventions on activity levels. Activity levels were measured in two ways: rates of locomotion (which included walking, swimming, and climbing) and rates of inactivity. Both otters showed similar patterns across the four phases of the study. There was an increase in activity in the proximate intervention phase 2, demonstrated by increased locomotion by the male or decreased inactivity by the female. However, this pattern reversed after the intervention had been in place for several months, as evidenced by increasing rates of inactivity and decreasing rates of locomotory behaviour. Seasonal effects may account for the reduction in activity in phase two, because otters are reported to be less active in the winter months (Harris, 1968). It is also possible to interpret the overall decrease in activity in terms of a successful intervention effect. If the grapevine balls were successful in lessening levels of food-anticipatory behaviour (and data on door manipulations suggest this is true) then lower levels of activity could be indicative of a more 'relaxed' state. Much of the locomotion observed could have been interpreted as 'fossicking' (searching) behaviour in which the otters repetitively searched around the exhibit. This type of behaviour may be due to the frustration of an arbitrary feeding regimen

(Hawke *et al.*, 2000) and a reduction in these behaviours could be classified as an improvement in the otter's behavioural repertoire. Increased activity levels could be something the public would like to see, but without clear empirical data from the field, it is difficult to justify an appropriate level of activity that could be considered 'species-typical.'

Temporal Patterns

Daily temporal peaks in abnormal behaviour are not uncommon with zoo carnivores (Carlstead, 1998) and because of the high levels of food anticipatory behaviour I expected to see these patterns as well. Figures 2–4 show how the male's rates of social-plucking, auto-plucking, and door manipulation changed over the day and among phases of the study. During the baseline period, social-plucking and auto-plucking peaked at three different times immediately following a meal. Perhaps the short duration of feeding bouts is not providing the appropriate amount of stimulation, and the otters are compensating with this burst of oral abnormal behaviour following a meal. This pattern of behaviour has been demonstrated in other species, such as the regurgitation and reingestion demonstrated by lowland gorillas in captivity (Lukas, 1999). When the grapevine ball intervention is introduced, this pattern is diminished, and in phase 3, when the intervention firmly was established, there was even less of an effect of time of day on social-plucking. Despite the fact that feeding bout length was not increased, the new pattern of behaviour could have been a better substitute for their normal foraging activities because of the greater manipulation challenge.

The temporal pattern of door manipulation differed slightly from that of the plucking. The male otter engaged in high rates of door manipulations just prior to the second and third meals of the day during the baseline period. This confirms my presumption that this behaviour was a result of food anticipation. The proximate effect of the intervention was evident and grew in strength as door manipulations further reduced in phase 3. That there was no early morning peak in door manipulation is more likely explained by the fact that data collection did not commence until 0800 h than by the fact that it was not occurring at all.

Although these results are interesting in light of the significant behavioural changes observed with these two otters, several obvious limitations to this study remain. Foremost is the small sample size. Although we are encouraged by the results of the grapevine ball feeding intervention, I am not suggesting that these benefits would necessarily generalize across a larger population of otters. I do however, encourage other institutions to use these and other methods to provide more stimulating foraging opportunities in the hopes of fostering a more species-typical behavioural repertoire. Further study of a variety of enrichment techniques is needed across multiple institutions to provide a more representative sample across different categories of age, sex, rearing history, and captive environment. Aspects of the experimental design might also prove enlightening. For instance, it would be interesting to separate the effect of the grapevine ball from that of the food, by providing empty grapevine balls to the otters. Additionally, more complex permutations of this and other interventions might prove to have even greater effects. Provision of meals in the grapevine ball while using a random schedule could garner the combined benefits demonstrated by those methodologies separately.

Acknowledgments

This study would not have been possible without the exemplary work of the keeper staff at Lincoln Park Zoo. Special thanks to Diane Mulkerin and John Gramieri for their administrative support and to Kristen Lukas, Steve Thompson, Kathleen Holt, and Megan Reinertsen Ross for their helpful comments on this manuscript.

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