Learning Adaptation in Caged and Enriched Environments: There's Nothing Like a Change of Scenery

Andrew R. Criswell
Hedmark University College
Rena, Norway
Phone: +47 62 43 04 59
Email: andrew.criswell@osir.hihm.no

James L. Fuller
Thai Society for the Conservation of Wild Animals
Bangkok, Thailand
Phone: +1 828-301 1897
Email: jameslfuller@hotmail.com

In May 2004, we initiated a study of learning behavior with captive Asiatic black bears (*Ursus thibetanus*) at a Department of National Parks facility in Thailand's Mae Hong Son province. The results obtained thus far suggest that changing the conditions of confinement from barren concrete cages to naturalistic outdoor enclosures significantly improved the bears' performance on a discriminative learning task. Furthermore, we found no correlation between exhibitions of stereotypy and a bear's performance on the learning task. Not only do these findings have potential implications regarding the welfare of captive bears, but also in the continued debate surrounding the consideration of captive bears for release projects.

Background

Asiatic black bear populations have been in decline throughout their range for decades and, despite widespread protection, the species remains on CITES Appendix I and categorized Vulnerable (VU—A1cd) on the IUCN Red List, 2002.

Figure 1: Female, adult Asiatic black bear solicited for our study

In Thailand, the current wild population of Ursus thibetanus is difficult to estimate as no accurate census has been attempted and cataloguing of protected areas is sporadic at best. While some populations may be stabilizing due to increased enforcement, Thailand's Asiatic black bear population is generally considered disturbingly low.

Ironically, improved enforcement and confiscation of smuggled cubs has resulted in the problem of a growing population of captive bears housed in Thai government facilities. The combination of depleted wild populations and a growing captive population has led to discussion of release programs using captive bears as a way to supplement and reestablish wild populations. Reintroduction, while viewed by some as a last resort, may yet prove a useful conservation tool as bear species continue to face human conflict, an inexorable withdrawal to fragmented habitats, and loss of genetic diversity. The plight of wild bear populations demands a thorough examination of all potential conservation strategies.

Few could reasonably argue that reintroduction of captive bears has proven tremendously successful (Clark et al. 2002). The low success rate can be attributed to any number of factors, as acknowledged by IUCN's reintroduction guidelines and various IBA specialist groups, including the Asiatic Black Bear Expert Team. Low genetic variability, a propensity for homing amongst adults, small founder population size, overly habituated release candidates, and poorly formulated and ill-executed reintroduction protocols may all play a part in the poor success rates of captive bear reintroductions.

More recently, Vickery and Mason (2003) asserted that stereotypy behavior (repetitive, invariant behavior with no obvious function or purpose) in caged bears correlates with persistent abnormal behavior, indicating that there are impediments to learning adaptation intrinsic to captivity. Vickery and Mason (2005: 278) therefore declared categorically that captive bears make poor release candidates. However, Criswell and Galbreath (2005) recently demonstrated that their empirical results are questionable due to a flawed research design and inappropriate methodology. This issue remains open to investigation and formed the initial basis for our study.

Figure 2: Caged environment with learning device

Study Design

Our study examines how changing environmental conditions influences the performance of captive Asiatic black bears on a spatially discriminative learning task. The study further examines whether a correlation exists between the exhibition of stereotypy behavior and task learning.

We framed our experiments around two principle hypotheses: (1) captive bears will perform better on a learning task after having been moved to an enriched, outdoor environment than they will in a barren cage and (2) the level of stereotypy exhibited by a bear will not be correlated to performance on a learning task. We have so far treated ten captive adult Asiatic black bears to a learning task under two distinctly different environmental conditions and recorded bouts of stereotypy behavior throughout the study.

In the first phase of the study, each bear was exposed to a learning task (described below) in its cage after a 72-day caged acclimation period. For the second phase, the five bears in the experimental group were moved to enriched, outdoor enclosures while the five bear control group remained in cages. The same learning task was then re-administered to all bears with a reversal to the reward mechanism.

The cages in the study were identical 3 x 3 x 3 meter structures consisting of a steel-barred ceiling under a corrugated roof, steel or concrete side walls, and a concrete floor and back wall (Figure 2). The 495-meter^2 outdoor enclosures—55 times a cage's area—were grass-covered with intermittent shrubs and trees, and included elevated perches, concrete shelters, and a water source (Figure 3).

The learning task utilized a mechanical device affixed to the front of the cages or implanted outside the enclosures (Figures 2 and 3). This reinforced steel device consisted of two levers, a chute for reward delivery, a bucket containing rewards (dog pellets and peanuts), and a mechanism to record which of the two levers was pressed. The levers were constructed so that depressing one of them ("correct" lever) would release approximately 0.3 liters of reward into the bear's cage or enclosure while depressing the other ("incorrect" lever) would produce no reward. We could switch the levers from "correct" to "incorrect" between learning phases.

For both learning phases, each bear was given the opportunity to interact with the device for a total of 20 interactions (depressing either one of the levers) per day. When the subject had pressed the levers a

Figure 3: Enriched environment, bear interaction with learning device

total of 20 times (either "correct" or "incorrect"), we immediately removed the machine and recorded the percentage of "correct" responses. We pronounced a learning phase "complete" (task learned) for each subject after 3 consecutive days of scoring 90% (18 "correct" lever pressings) or better. After completing the first learning phase, each bear was moved immediately to the second learning phase with the levers reversed, either remaining in cages (control group) or moving to outdoor enclosures (experimental group).

Results

It is important to note that these results are from a small sample and the strength of the stated conclusions should be regarded in that context. Working with behaviorally complex species with extreme individual variation brings a host of challenges. We are continuing this research and intend to include data from a larger sample in our forthcoming report.

Empirical findings for the ten bears thus far studied are summarized in Table 1. Results show that bears in both control and experimental groups learned the task during the first learning phase at the same rate (H_0: P1E = 0; $X^2 = 1.063$; $P = 0.304$). In the second learning phase, bears in the experimental group, after having been moved to the outdoor enclosure, experienced significant improvement in learning the task, both in speed and accuracy, compared to those in the control group that remained in cages (H_0: P2E ≤ P2C; $X^2 = 3.285$; $P = 0.032$). Finally, we found no significant relationship between exhibitions of stereotypy and performance on learning tasks (H_0: STEREO = 0; $X^2 = 0.019$; $P = 0.899$). We estimate that bears in the experimental group reached completion (task learned) for the second learning phase within 14.2 ± 3.2 days (90% CI) while those in the control group achieved learning completion by 19.0 ± 2.8 days.

Discussion

Our results indicate that environmental conditions, more so than stereotypy, exert strong influence on learning adaptation and support a growing literature that improving an individual's environment will typically improve its ability to adapt. This implies that bears need not be precluded as candidates for reintroduction based solely on their having been confined. The notion that captive status a priori disqualifies a bear from being considered for reintroduction diminishes a potentially powerful conservation tool. Given the challenges that face global bear populations, it is important to explore fully all potential conservation strategies—including reintroduction of captive individuals—rather than discounting options based on misperceptions of the effects of captivity on adaptive learning previously reported by Vickery and Mason (2003, 2005).

We acknowledge the challenges of releasing captive bears—especially adults—and do not suggest that improvement in learning based on a changed environment signifies that any individual bear is therefore suitable for release. However, we believe the results of our study show that "strange" behavior in a cage does not make a bear inherently unsuitable for release.

Further study is needed to identify what characteristics would allow

Table 1. Regression estimates

Variable	Coef .	Std. Error	T-value: (H_0: zero)	Prob.
CONSTANT (baseline: phase one, cages)	0.1890	0.4892	0.3864	0.6898
DAY (sessions to completion of tasks)	0.2692	0.0372	7.2438	0.0000
P1E (1 = phase one, enclosures; zero otherwise)	0.7288	0.7068	1.0311	0.3044
P2C (2= phase two, cages; zero otherwise)	-3.0988	0.4451	-6.9618	0.0000
P2E (2 = phase two, enclosures; zero otherwise)	-1.7983	0.7646	-2.3520	0.0202
STEREO (proportion of stereotypy, daily scan samples)	-0.1595	1.1505	-0.1387	0.8999

Dependent variable: daily proportion of correct responses. Estimation method: generalized linear mixed-effects model with logit link, correction for first order autocorrelation within clusters and penalized quasi-likelihood. Model judged best against polynomial functions of DAY, and interactions between covariates and DAY using Bayesian and Akaike information criteria.

researchers to predict an individual bear's potential for release success. We hope that these preliminary results contribute to a better understanding of the effects of captivity and provide important information relevant to selecting candidates for release and designing reintroduction protocols.

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