FIXED-TIME FOOD SCHEDULES AND THEIR EFFECTS ON ACTIVITY PATTERNS IN TWO ADULT POLAR BEARS (*Ursus maritimus*).

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Stereotypies have been defined as repetitive, invariant behavior patterns with no obvious goal or function (Mason, 1991; Ödberg, 1978). While this may seem an appropriate definition, the last characteristic may be misleading: Even if an immediate goal is not obvious, repeated behavior often appears to reflect natural selection relevant to a goal and potential local function.

A number of persons have described stereotypic behavior as being caused by “boredom”. However, several problems exist with this supposed cause. First, it’s anthropomorphistic. You’re assuming what would make a human bored would make another species or individual animal bored. Second, it’s circular: If the animal paces because it’s bored, how do you know it’s bored? Because it’s pacing. Finally, the resultant sense of understanding can decrease the impetus to track down environmental and physiological causes.

Others have described stereotypic activity as a “coping” response. However, this entails a number of difficulties as well. In many instances, this analysis is in the least incomplete. Saying that an animal paces to “cope” with its environment says little, if anything, about why the behaviors occur to begin with. Presumably, the animal “copes” to deal with some lack of stimulation, or stressful environment. However, without knowing what those variables are, a coping explanation becomes as circular as the previous “boredom” hypothesis. The simple point is that even if stereotypies reflect coping, we need to understand why this action results in coping, and what would lead to a particular form emerging to begin with.

One factor directly correlated with the onset of stereotypic activity is how and when animals are fed. For instance, feeding several times a day, as opposed to once a day, can reduce stereotypic patterns in small cats, (Shepherdson et. al, 1993), stereotypic behaviors in ocelots are highest in the hours before being fed, (Weller & Bennett, 2001), stereotypic patterns are disrupted in polar bears by placing scents in the area where the patterns occur, (Wechsler, 1992), stereotypic behaviors have been reduced by feeding enrichment programs, where part of numerous species of bears’ diets were spread around their enclosure, (Carlstead, Seidensticker, & Baldwin, 1991; Forthman et. al, 1992), and a feeding enrichment program had more effect outside of the breeding season, while various animal scents had more of an effect during the breeding season, for a male black bear, (Carlstead & Seidensticker, 1991).
Therefore, many stereotypic patterns appear to be related to “naturally occurring” foraging patterns and trained food-getting responses. If so, we should be able to alter them with systematically controlled food schedules. In the process, we should be able to learn about the organization of foraging patterns in captive polar bears.

Method

Subjects and materials

Subjects included Pasha, a 17-year-old male polar bear weighing 1100 lbs and Tundra, a 16-year-old female polar bear weighing 750 lbs. Data collection materials included data sheets and palm pilots used to collect ethogram data, repeatable countdown watches used to time coding intervals, and capelin, a small fish, thrown during the various food schedules.

Procedures

An ethogram was developed to code 21 possible behaviors across 7 different classes of responses. The polar bear enclosure was also split into 5 possible areas a bear could be coded in. 3 times were measured: .5 hour before, during, and after food (1.5 hour total measured). Instantaneous time samples were taken for both bears every 15s (120 per .5 hour period). 4 conditions were measured: Baseline (BL), where no food was thrown during the food period, and one of 3 fixed-time (FT) food schedules, where food was thrown either every 10 minutes (FT-10’), every 5 minutes (FT-5’), or every 1 minute (FT-1’) during the middle food period. Reversals were run throughout study to deal with time/seasonal effects (see the following table for condition dates, order, and # of days run for):
The following two pages show the ethogram used to code all behaviors, and the enclosure and area designations used to code where a polar bear was when coded. Note that not all of the classes of behaviors are mutually exclusive, such as grooming responses, which must occur with one of the first 4 classes of behavior:

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>REPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL</td>
<td>2/17/2003 - 4/7/2003 (9 days)</td>
</tr>
<tr>
<td>FT-1'</td>
<td>5/2/03 - 7/2/03 (6 days)</td>
</tr>
<tr>
<td>FT-5'</td>
<td>4/18/03 - 4/28/03 (6 days)</td>
</tr>
<tr>
<td>FT-10'</td>
<td>9/12/03 - 9/24/03* (6 days)</td>
</tr>
<tr>
<td>ORDER CONDITIONS WERE RUN</td>
<td>BL - 5' - 1' - BL - 1' - 10' - BL - 5' - 10'</td>
</tr>
</tbody>
</table>

Conditions where Tundra was the only bear run are marked with a *.
BEHAVIORAL DEFINITIONS

NOTE: Responses with a * must occur in conjunction with a stereotypic, inactive, or active response.

Listed as Classes/Categories (I – VII), and then behaviors under each Class.

I. STEREOTYPY
   Pacing (P) – Repetitive moving pattern on land. Must occur 2 or more times (i.e., one full back-forth repetition), w/o more than a 2s pause in between.
   Circle Swimming (CS) – Repetitive swimming pattern. Must be at least one lap around rock.
   Pace Swimming (PS) – Repetitive swimming pattern. Same definition as pacing, but in water.

II. INACTIVE
   Sitting (Si) – Butt and back hind legs on floor while maintaining an upright position.
   Lying Down (LD) – At least part of back on ground (any down position that doesn’t meet sitting definition).

III. PAUSE
   Standing (ST) – Non-movement standing (3 of 4 paws on ground with no locomotion).
   Rearing (R) – Rearing up on back two legs.

IV. ACTIVE
   Locomotion (L) – Directional, non-repetitive movement.
   Nonpatterned Swimming (NP) – Swimming that doesn’t meet a stereotypy definition.
   This also includes standing or floating when completely submerged in water.
   Manipulating Object (MO) – Any body contact with a moveable, non-edible object.
   Interacting w/ Other Bear (IOB) – Oriented towards the other bear w/o vocalization.
   Vocalization (V) – Any vocal sound produced by a bear while oriented towards the other bear (this is basically IOB w/ vocalization).
   Mating (M) – Pasha mounting Tundra.

V. *FOOD ORIENTED
   *Eating (E) – Mouth contact with any edible item (including drinking).
   *Licking Air (LA) – Sticking tongue out without contact to an object.
   *Sniffing (Sn) – Nose/bridge of nose breaking horizontal plane. Cannot have back oriented towards the ground (I.e., swimming on back) for this to occur.

VI. *GROOMING
   *Licking Paws/Body (LP) – Licking, usually at paws, but on any part of body.
   *Scratching Body (SB) – Contact with a paw or mouth (w/o licking) to body, or rubbing body against an object.

VII. OTHER
   Urinating/Defecating (UD) - #1 or #2!
   Out of Sight (OS) – Can’t be seen.
   Other (O) – Something that doesn’t meet one of the definitions above.
Results

Below are results for the food schedules across the first 4 classes of behavior for both bears (Tundra left, Pasha right). The y-axis shows the percentage of occurrence across the particular condition, and the x-axis shows the pre-, food, and post-food periods. As can be seen, all food schedules showed decreases in the percentage of stereotypic activity during the pre-food and food periods, compared to baseline. Pasha showed an additional decrease in stereotypic activity during the food schedules in the post-food period, although this was replaced with inactive behaviors. Inactive behaviors decreased away from baseline for all food schedules for Tundra during all food periods. Inactive behaviors only showed a decrease from baseline for the FT-5’ schedule during the pre-food period, and for the FT-1’ schedule during the food period, whereas all other changes in activity were increases away from the baseline levels, as in the post-food period observations noted above. Both bears showed greater pause and active behaviors for all of the food schedules in the pre-food and food periods compared to baseline, although this increase was not significant for some of the food schedules.
The following graph shows the results for the last 3 classes of behaviors for both bears. The y- and x-axis are the same for the previous graph (although the y-axis only runs to 30% for these graphs). Both bears showed an increase in food oriented behaviors during the food period for all food schedules compared to baseline. Pasha additionally showed increases in food oriented behaviors for both food schedules in the pre-food period, and for the FT-1’ schedule during the post-food period. Tundra showed increases in grooming behaviors for all food schedules during the pre-food and food periods compared to baseline. Pasha showed increases in grooming behaviors for both food schedules in the pre-food period, and for the FT-1’ schedule during the food and post-food periods, compared to baseline. Few differences were observed for the other class of behaviors, since the behaviors in this class were rarely observed.
The following graph shows histograms of the total area use for each bear across all 3 food periods. The y-axis shows the % of area use for each area, while the x-axis shows the results across each possible condition. The dotted bar running across each graph shows where each bar would be if area use was equally distributed across all five areas (the bear used all of its enclosure equally). During the pre-food and food period, Tundra showed an increase in total area use for the FT-5’ and 10’ schedules, and a decrease in total area use during the FT-1’ schedule, when compared to baseline. During the pre-food and food period, Pasha showed an increase in total area use for the FT-1’ and 5’ schedules when compared to baseline. During the post-food period, Tundra showed few differences in total area use for any of the food schedules when compared to baseline. During the post-food period, Pasha showed an increase in total area use for the FT-1’ schedule and a decrease in total area use for the FT-5’ schedule when compared to baseline.
The following graphs shows stereotypic and inactive classes of behavior combined, as well as active and pause behaviors combined. This combination could be considered undesired and desired responses, respectively, based on most zoos’ desires to display active animals engaging in natural behaviors. The y- and x-axis are similar to those from the first 2 graphs (although the y-axis goes to 100%). For both bears, a significant decrease in stereotypic + inactive (“undesired”) behaviors, and thus, a significant increase in active + pause (“desired”) behaviors, were observed in the pre-food and post-food periods compared to baseline. The largest difference was observed with the FT-1’ schedule during the food period for both bears, where desired responses increased from approximately 20% to approximately 80% for Tundra, and from approximately 15% to approximately 65% for Pasha. Few effects were seen in the post-food period, although Pasha showed a slight increase in “undesired” response (and hence, a slight increase in “desired” responses) for the FT-5’ schedule compared to baseline.
Discussion

All schedules had significant effects on the periods before and during the food period for both bears. Little effect was seen in the .5 hour following food. In one bear (Pasha), there’s a significant decrease in stereotypies during the post-food period, but an increase in inactivity. Tundra showed some increases in stereotypic activity in the post-food period for at least two of the food schedules (FT-5’ and 10’). The FT-1’ schedule was more effective at increasing active and pausing behaviors in the pre-food and food periods. Area use appears to be more variable under the FT-5’ and 10’, but is similar to baseline levels during the FT-1’ condition. This may be because delivering food once a minute made staying in the same part of the enclosure more advantageous.

In the case of both our bears, the food schedules were effective in eliciting natural foraging patterns. The bears generally spent more time pausing, engaging in food oriented responses, and moving around their enclosure when the food schedules were in effect.

Based on the following data, locomotion-based stereotypic activity can be interpreted as a foraging loop, where few stimuli are presented that allow movement to the next mode (focal search). Pre-food conditions presented focal stimuli in the form of food scent (from buckets) and the presence of persons paired with food (researchers), and hence the reduction of stereotypic activity during the pre-food period. Natural foraging behaviors increased and stereotypies decreased during the food conditions because of the delivery of food, which would interrupt a foraging loop. The short intervals food was delivered on under the FT-1’ schedule may have produced more focal search behaviors, and hence, the decreased area use under this condition.

Future Directions

Several other experiments have already been conducted. In experiment 2, we ran the same amount of food as controls for these schedules, where food was delivered in the same amount, but only once. This led to less of a reduction in the stereotypic activity, suggesting that delivery of food during these particular intervals, rather than just the amount of food itself, were responsible for our results. In experiment 3, we examined the effects of variable-time (VT) schedules. VT schedules produced similar results to that of the FT schedules, although less of an effect in the pre-food period.

Future studies could compare fixed food placement to variable food placement, and examine effects of food schedules maintained for lengthier periods of time, (1-hour, 2-hours, 4-hours, etc.) In the near future, we hope to test the above with automated food delivery devices, which would require little researcher/keeper intervention to provide an effective intervention based on timed food schedules. In essence, the automatic feeder could create a long-lasting, simple-to-use intervention that requires little time on the part of the keepers or other staff.
The following is a blueprint of the device our apparatus designers at Indiana University plan to build. They would allow food to be dispensed throughout 6-8 hours after 2 trays of food were placed within one feeder at the beginning of the day:

**Notes:**
Dimensions may change after tests of catapult with food items, addition of insulation, size of motors to achieve necessary power and other factors. A control interface box will be added under the disc.

**Operation:**
Cover removable. Catapult disc lifts out for loading 36 food items onto catapult bins. Disc is placed in feeder indexed to support plate. Cover replaced. Computer rotates disc to aligned desired bin with gate. Computer opens gate and solenoid is energised at appropriate power to cast food item desired distance. Gate closes. Sequence repeated up to 35 times.

**Materials:** Aluminum, Stainless Steel, Wood, Foam Insulation

**Estimated Cost:** $2000 each for two units
$1000 each for two additional discs
Many thanks to my research assistants, who helped make this project possible:

From top left to bottom right: Susie Moller, Nick Helfrich, Keelyn Walsh, Rachel Lehnus, and Kate Rogerson, and Eduardo J. Fernandez (Principal Investigator).
Thank you!
References


