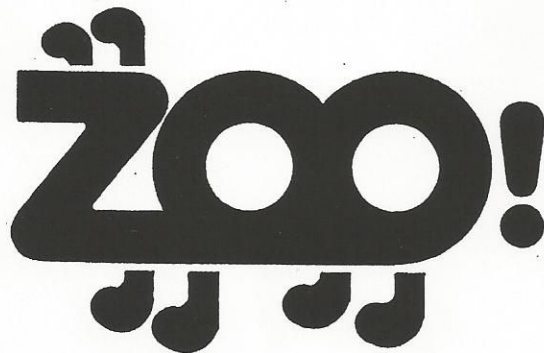


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**THE SUCCESSFUL TREATMENT OF A CHRONIC STEREOTYPE IN
ONE POLAR BEAR (*URSUS MARITIMUS*) USING ENRICHMENT
PROGRAMMING, ENCLOSURE REDESIGN, AND MEDICAL THERAPY**

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INTRODUCTION

Stereotypes are defined as the excessive, invariant, and repeated production of one type of motor act in which no obvious goal or function is apparent (Mason, G.J., 1991; Ridley, R.M., 1994).

Stereotyping is not just a zoo phenomenon. It commonly occurs in humans (Rapoport, J., 1990; Ridley, R.M., 1994) and in a wide variety of domestic (Dodman et al, 1987 and 1993; Luescher et al, 1991), and non-domestic captive (Nelson, W.B., 1967; Meyer-Holzapel, M., 1968; Wallach, J.D., 1983) animal species.

It is possible that a great number of stereotypes exhibited in the zoo community are caused by impoverished living environments defined by small enclosures, interrupted visual pathways, scheduled feedings in one predetermined area, and lack of enclosure furniture and/or toys (Van Keulen-Kromhout, G., 1978; Carlstead, K., 1991). Such an environment would inherently lead to constant frustrated appetitive behavior. However, through time and repetition the stereotype is likely divorced from its original stimuli and its performance is driven by internal mechanisms.

Research shows that stereotyping can have causes other than inappropriate environments. Factors such as stress, learned responses, and brain damage have also been implicated (Kiley-Worthington, M., 1977). Judith Rapoport, a psychiatrist at the U.S. National Institute of Mental Health has been researching human obsessive-compulsive disorder (OCD) and the serotonin connection. She found that in rare cases, during a strep infection the body's immune system will produce antibodies that target brain cells in the basal ganglia, as well as the strep bacteria. The existence of abnormal cells in the basal ganglia has often been associated with people who are diagnosed with OCD (Dolnick, E., 1995).

There is evidence that the stereotyping observed in captive polar bears shows some similarities to the symptoms of human OCD sufferers. First, researchers have observed a sense of compulsivity about the stereotype (Ames, A., 1990; Wechsler, B., 1991 and 1992). Perhaps the best example of this is a phenomenon commonly

observed throughout the zoo community. An animal with a chronic stereotype tends to take its 'stereotypic baggage' with it when moved from a small pit-enclosure to a naturalistic habitat.

Second, in testing the extent to which enrichment will curb a stereotype some researchers have found that there seems to be a ceiling on the number of events that the animal is able to take part in before returning to its stereotype. Thus, if the stereotype is no more than an expression of on-going thwarted appetitive behavior then keeping that animal stimulated all day with enrichment should eradicate the stereotype. Research has shown that this is not what is happening. Some animals appear to show a 'ceiling effect' (Forthman, D., 1992; Poulsen, E.M.B., 1992).

It is now commonly accepted that enrichment alone cannot eradicate a chronic, long-term stereotype, although such programming may have desirable short term effects (Poulsen, E.M.B., 1992).

The fourth piece of evidence that suggests commonality with human OCD is the presence of frequently observed behaviors associated with the polar bears' stereotype such as jaw snapping, chuffing, tongue flicking, and yawning (Wechsler, B., 1991; Poulsen, E.M.B., 1992). These behaviors have been previously described as displacement behaviors. However, their association with a chronic stereotype makes their presence suspect and some if not many are likely better described as facial tics. Twenty percent of human OCD sufferers also have motor tics (Rapoport, J., 1989). These are expressed as involuntary movements of the facial area.

Obsessive-compulsive disorder is a complicated, chronic psychiatric problem that afflicts an estimated 2% of the North American population (Rapoport, J., 1989). The disorder does not respond to psychotherapy, family counseling, and most anti-anxiety, antidepressant drugs. The obsession refers to the thought that is persistently repeated in the patient's brain. The compulsion is the behavior expressed in response to the thought. Thus a sufferer may wash his/her hands in response to the thought that the hands are dirty when in fact they are not. However, the sufferer is fully cognizant of the facts that; i/ the hands were already clean, ii) washing their hands under the circumstances is inappropriate, and iii) they are washing their hands to alleviate the stress of the repeated message, and/or they are attempting to shut down the message.

Behaviors expressed in OCD are based in innate behaviors which link humans to the rest of the mammalian world, such as grooming, travel, and territoriality (Rapoport, J., 1989). Some patients show other neurological disorders such as epilepsy, postencephalitic Parkinson's disease, and facial tics (chorea). The majority are otherwise healthy.

Many OCD patients have responded to a series of antidepressant that are serotonin-uptake inhibitors (Winslow et al, 1990). These currently include clomipramine, fluvoxamine, and fluoxetine.

The similarities noted between polar bear stereotyping and OCD (a disorder possibly linked to the serotonergic system) lead us to test the effects of fluoxetine on one, captive female polar bear.

The study subject was Snowball, a 26 year old, captive female polar bear housed at the Calgary Zoo. She was born on November 20, 1969 to a 13 year old female (Candy) in an old-style barred enclosure at the zoo.

At three years of age she was temporarily moved to another caged exhibit due to an aggressive male bear housed with her mother. According to sketchy written reports, it was then that Snowball was first observed to pace. To combat the pacing she was given an unidentified antidepressant which did not eradicate the pacing. Snowball stopped pacing when she was moved back in with her mother and the aggressive male. At the age of four, Snowball and her cage-mates were moved to the

enclosure that she lives in now; a large, old-style pit enclosure. Snowball was six years old when she gave birth to one young whom she subsequently ate four days later. At the time, she was sharing the 836 m² enclosure with three other adult bears.

Snowball lived with her mother (Candy) for 21 years, and with another female polar bear named Misty for 19 of those years. Zoo staff estimate that Snowball's chronic pacing has been on-going for approximately 20 years. Misty paces seasonally in the winter months.

Snowball weighs between 260-280 kg., and veterinary staff believe her to be in overall good health. She was diagnosed with an arthritic condition in her hindquarters and chronic alopecia prior to the onset of the study.

METHOD

We investigated the effects of fluoxetine administration on the stereotypic and typical behaviors of Snowball. The study consisted of three consecutive phases; the pretrial (32 days), the trial (105 days), and the post-trial (163 days). Observations were taped for nine daylight hours every third day during all phases of the study. The recorded behaviors were scored by placing them into one of five categories (Figure 1).

CATEGORY	BEHAVIOR
1. STEREOTYPE	pace
2. MOBILITY	swim, walk, run, eat, groom, rub
3. AWAKE IMMOBILITY	stand, sit, hold on to edge of pool, lie down with head up
4. SLEEPING	lie down with head down
5. OFF	out of video range, off exhibit

Figure 1. Five behavior categories

Pacing was easily discriminated from other behaviors, and was defined as the constant repetition of one motor act; walking. Mobility was defined as any gross locomotor behavior that was either not repeated, or when repeated showed flexibility in its expression. The absence of any gross locomotor behaviors in an otherwise awake animal was categorized as awake immobility. Sleeping was described when the bear was lying down with its head down. It was often impossible to discern whether the eyes were closed or open. The amount of time that the bear spent off camera was scored in the off category.

The duration of about (ie. continuous time spent in a behavior category), and the number of bouts (ie. the number of times a bout was observed within a nine hour recording session) were calculated. The total time spent within a category per nine hour observation period was calculated, and converted to a percentage.

The drug fluoxetine was administered to Snowball on a daily basis. The capsules of drug (containing 20 mg./capsule) were stuffed into the gill slits of her daily herring. Both Snowball and Misty were hand fed fish in the morning, and keeper observation indicated that Snowball was consuming the drug. To maintain

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consistency throughout the study, the polar bears were hand fed 4 or 5 herring every morning during all three phases.

The fluoxetine was administered in three different dosages (Figure 2).

DATE	STUDY PERIOD (DAY)	DOSE (mg./day)
JUL 07 - AUG 08	01-32	0
AUG 09 - AUG 15	33-40	340
AUG 16 - OCT 30	41-116	160
OCT 31 - NOV 20	117-138	260
NOV 21 - MAY 01	139-300	0

Figure 2. Fluoxetine administration and dosage.

The initial dosage was an empirical dose of 340 mg./day (day 33-40) based on Snowball's estimated body weight. After further consideration of the potential metabolic characteristics of fluoxetine the dose was scaled down to 160 mg./day (day 41-116). Later in the trial phase (day 117-138) the dose was increased to facilitate total stereotype eradication.

On study days number 83 (160 mg./day), 140 (post-trial), and 178 (post-trial) the bear was immobilized and blood serum was collected, frozen, and stored for later metabolite assays of fluoxetine, norfluoxetine, and trifluromethylphenol.

Throughout the duration of the study all normal husbandry practices were maintained. Enrichment programming was neither increased nor decreased. The bears were given their normal diet of Ralston Purina omnivore chow to which they had access all day. Menhaden fish oil was poured over foods. The polar bears were given daily feedings of smelt, herring, chicken heads, and/or horse tails. Fruits, vegetables, invertebrates, and insects were all used for enrichment events.

RESULTS

Snowball's pacing pattern fit that commonly recognized as a stereotype. She placed the same paws in the same temporal sequence each cycle. Snowball had four pacing pathways and showed a preference for one. She did seem to move from one path to the next following the appearance of shade, and the greater portion of her pacing was done in the morning.

Throughout the study we observed that a bout of pacing was frequently followed by a swim, which then lead to another bout of pacing. The pace-swim-pace pattern could be disrupted for extended periods of time by introducing food or a novel object into the enclosure. Snowball did not exhibit any clearly definable stereotypic swimming behavior.

During the pretrial phase Snowball paced for a mean of 68.6 %/day. In an average day there were 22 bouts at 16.84 minutes each. There was great variability in the duration of a bout, from one minute to 150 minutes. One mean bout had 78 cycles, and one cycle took 13 seconds to perform. There was little variability in the duration of a cycle throughout the entire study.

In the first six weeks of the trial phase, Snowball's pacing behavior was identical to that of the baseline observations.

After six weeks in the trial phase, the total number of bouts per day began to drop, and each bout was shorter in duration. The average number of cycles dropped from 78 to 42, but still took 13 seconds each to complete. At this stage of the study we observed what may have been an improvement in Snowball's ability to take part in enrichment programming. It appeared that on days when the keeper increased the number of enrichment events the amount of pacing that Snowball did could drop from 68.6% to approximately 50%. We could not put this perceived phenomenon to a statistical test.

As time progressed the pacing cycle deteriorated, and there were frequent interruptions in the pattern. At 11 weeks we increased the dose of fluoxetine to 260 mg. and the pacing ceased. For statistical purposes we stayed at this dosage for three weeks and observed no pacing. At this time her facial tic, and chuffing disappeared, and her chronic hair loss problem also disappeared. Snowball's patchy baldness appeared to grow in for the duration of the study.

In the post-trial phase, pacing was first observed 14 days after fluoxetine treatment was stopped. Snowball's pacing pattern came back to her in bits and pieces. For instance, she would take one or two pacing steps and then move off the path to perform another behavior. For the first time throughout the duration of the study we observed her facial tic expressed outside the framework of her pacing pattern.

The amount of time spent in mobile activity remained relatively constant throughout all phases of the study. However, the types of locomotory behaviors expressed changed. In the high pacing periods, Snowball also took part in swimming, and feeding. During the trial phase when pacing had been eradicated, she was observed to be spending more time walking about the enclosure, watching activity outside of the enclosure, and manipulating objects.

The fluoxetine metabolite analysis showed that at the lower dosage of 160 mg/day the fluoxetine and norfluoxetine were comparable. At the higher dosage of 260 mg/day the norfluoxetine levels were much greater than the fluoxetine. The clearance of all metabolites was confirmed four weeks after the cessation of treatment.

DISCUSSION

The most significant finding in this study was the dramatic reduction and eventual elimination of a chronic stereotypic behavior in one captive polar bear. The animal appeared to suffer no ill effects from the drug treatment. Snowball exhibited typical polar bear behaviors during the later part of drug treatment and for the first 14 days following cessation of the drug treatment. The response of the bear to fluoxetine treatment suggests the involvement of the serotonergic system in chronic stereotyping.

Pathological repetition can occur at different functional levels (Ridley, R.M., 1994). Snowball expressed repetitive behaviors at the motor level (ie. facial tic, chuffing), the motor program level (ie. pacing), and perhaps to some degree at the planning level (ie. pace-swim-pace pattern). When repetitive behaviors occur at more than one of these levels, a failure in the control system is thought to have occurred (Ridley, R.M., 1994). The data from this study indicates that a serotonin-uptake inhibitor was effective at all functional levels in this polar bear, further supporting the involvement of the serotonergic system in stereotypic behaviors.

The most unexpected result from this study is the absence of the recurring alopecia that has plagued Snowball for years. We are in the process of studying this phenomenon further.

The serum metabolic levels were within those reported as therapeutic for humans at both dose levels (Altamura et al, 1994). The predominant metabolite changed from fluoxetine at the low dose to norfluoxetine at the high dose (Poulsen et

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al, 1995). These metabolite profiles are similar to the concentration response levels and therapeutic ranges found in human studies (Altamura et al, 1994). This suggests that, as in humans, fluoxetine itself may not substantially contribute to the therapeutic response and that the active pharmacological agent may be its metabolite norfluoxetine.

Successful animal husbandry is determined by the sum total of the animals' environment. Therefore we advocate that pharmacological treatment of a stereotype always be done in conjunction with environmental enrichment programming and naturalistic enclosure design/redesign.

Since 1992 Snowball and Misty have been subject to enrichment programming. Initially the Calgary Zoo undertook a study to assess what effects, if any, that enrichment would have on stereotypic behaviors. Twelve enrichment events were identified and tested over a ten week period, and *ad libitum* observations were made (Poulsen, E.M.B., 1992). It was found that Snowball showed a tendency toward problem-solving events, and Misty tended towards hunting-type events. Snowball stopped pacing for the duration of the event, and it is not likely that these events reduced Snowball's daily pacing rate (Poulsen, E.M.B., 1992). Food was used as incentive to take part in the events. Thus, the suspected desirability of the food item often determined the initiative expressed by the bears.

The enclosure that Snowball is currently housed in was built in 1973. It is an old-style pit enclosure made of cement with a large, square swimming pool (4m. deep). Ten percent of the total area is the indoor 'holding' facility. The outdoor display area takes up 76% of the total area and it is made of concrete partially covered with boulders, pebbles, woodchips, and tree trunks. Fourteen percent of area is the deep pool that holds approximately 170,000 l. of City of Calgary processed water. Originally the east wall of the exhibit was a waterfall.

The Calgary Zoo plans to build a natural habitat exhibit for polar bears as part of their Canadian Wilds project. The existing enclosure is currently being renovated to improve the lifestyle of the polar bears while they await their new facilities.

Four activity areas within the enclosure are being developed to accommodate enrichment events. First, large boulders have been piled on the bottom of half of the pool to create interesting nooks and crannies into which food will fall for the bears to hunt. The placement of these boulders also creates alternative water depths. Half of the pool will remain 4 m. deep for the bears to dive in. In addition to this, we have built a raft of logs that can be anchored at various points around the pool. The motion of the raft might mimic that of an ice floe. The bears have shown interest in the raft.

The second activity area is the renovated shallow pool that contained boulders. We have replaced the boulders with pebbles and rocks that make good hiding places for small to medium live fish. The bears can also hunt around these rocks for other foods.

The third activity area was made by placing boulders (from the shallow pool) in a group near the west public viewing bays. Food can be thrown into the pile from the upper deck. The bears then reach into the boulder crevices to fish it out. Misty has been observed to move entire boulders to reach items as small as a smelt.

The woodchip bed is the fourth activity area. It was created by building a one half meter high wall that runs from the west end to the east end of the enclosure. The wall acts as a retainer for the woodchips to protect the drainage system. The woodchip bed is the most popular of the activity areas. The bears dig day and night beds in the woodchips; they roll in it, they dig in it to find buried food, and they spend a great deal of time sniffing it.

The waterfalls served an esthetic purpose. However, the 'white' noise that the falls made drowned out the human noises of zoo visitors viewing the bears from the top deck. The waterfalls were turned off permanently as a cost-saving measure. The upper viewing deck was closed to the public for safety reasons, and to cut down on the presumed stress that pit-enclosures cause animals.

Taking a holistic approach to solve the problem of stereotyping in captive animals by using medical therapy, environmental enrichment programming, and enclosure design/redesign will greatly benefit afflicted animals.

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