

# OBJECT MANIPULATION IN CAPTIVE POLAR BEARS

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*Abstract:* Data, with special reference to object manipulation, were collected on 14 polar bears (*Ursus maritimus*) held in 8 zoos in the British Isles. More than 1,200 hours of observations were collected from 1989 to 1991. Time scans were made at 5-minute intervals and focal event sampling provided information on object selection, bout length, and behavior on land and in water. Analyses included individual and sex differences in amount, frequency, and complexity of object manipulation. The male bears had higher levels of object manipulation overall, but 24% of the females' manipulative bouts were longer than those of the males. Bout frequencies indicated an organizational difference between the sexes with all but 1 of the females having fewer sessions per hour. Responses to a wide range of objects and food items were recorded and categorized. Findings indicated that the behavioral repertoire of polar bears was more diverse than expected and that bears of all ages and both sexes showed a high level of motivation, ability, and skill toward this kind of activity.

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Polar bears manipulate objects and substrates in their environment (Perry 1966, Jonkel et al. 1972, Kiliaan 1974, Larsen 1985). This type of behavior occurs during hunting, foraging, and the construction of dens and daybeds. Having recently evolved from brown bears (*Ursus arctos*) (Kurten and Anderson 1980), the polar bear has retained the manipulative abilities which have allowed the genus *Ursus* to expand and adapt to a wide variety of habitats. Adaptations for coping with seasonal availability of food have occurred both behaviorally and morphologically. In dietary terms, North American bears have diversified such that a wide variety of foods are exploited. Spatial knowledge of seasonal foods and the physical ability to forage for and process complex food sources have been a key to evolutionary success in a variety of species (Parker and Gibson 1977, Chanin 1985, Schullery 1986, Gurnell 1987, Stirling and Derocher 1991).

The aim of this research is to examine the ability and interest of captive polar bears toward object manipulation. Providing the bears with a variety of objects raised several questions. With no adaptive pressures in captivity will the bears voluntarily perform this type of activity? Are there sexual, individual, or age-related differences in the amount and complexity of object manipulation? Should the provision of objects become a welfare priority for organizations holding bears in captivity?

If curiosity and investigative behavior are innate aspects of the nature of bears, we would predict that captive individuals would respond actively to object provision. If so, bears that are denied such behavioral opportunities may be considered deprived.

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## MATERIALS AND METHODS

Fourteen captive polar bears (8 F, 6 M) were observed over a 2-year period starting in September 1989. The bears were housed in 7 different zoo exhibits located throughout the British Isles. More than 1,300 hours of data were collected using instantaneous sampling techniques (Altmann 1974), at 5-minute intervals. At each data point, the gross state, the posture or locomotion, the activity, and the proximity to other cage mates were recorded for each individual (Table 1).

The past histories of the bears differed widely with some animals being captive born, some wild caught, and in the case of 1 individual, having spent many years in a circus (Table 2). Most of the bears were kept in male-female pairs, but 2 females lost their partners, and a trio is kept in 1 zoo. In addition, the age, and thus reproductive status, varied a great deal among individuals. The youngest bear was 8 and the oldest 31. The 8 enclosures were all very different, yet some aspects of the design were similar. The major feature of all of the enclosures was the use of concrete and rock for construction. In 3 exhibits there was minimal vegetation and in these it was not intentional. None of the enclosures had soil, trees, or any natural substrates.

Sets of observations were collected over a period of at least 10 days to obtain representative data on the animals' activities. The time spent on observations during each of these periods usually totalled 60 hours,

**Table 1. Glossary of behaviors.****GROSS STATE**

**Active:** awake and moving about the enclosure or performing an activity.

**Vigilant:** alert but not active.

**Inactive:** eyes closed and probably asleep.

**POSTURE OR LOCOMOTION**

**Lie:** weight not carried on the feet, can be down on belly, side or back.

**Sit:** head held up and weight resting on front paws and rear.

**Stand:** weight carried on all 4 paws while remaining stationary.

**Walk:** move along on all 4 paws at a moderate rate.

**Run:** move along on all 4 paws at a rapid rate, i.e. gallop.

**Climb:** move up, over, or onto a steep slope.

**Bathe:** in the water with no particular form of locomotion.

**Swim:** moving along in the water.

**Pace:** any locomotor stereotypy which is executed on land.

**Stereotypic swimming:** any locomotor stereotypy which is performed in the water.

**ACTIVITY**

**Look around:** visually scanning the area, inside or outside of the enclosure.

**Watch:** to look at or observe a conspecific.

**Feed****Drink**

**Manipulate:** to handle or use objects.

**Groom:** to clean and keep fur and body clean.

**Scratch:** to scrape with paws or claws, as to relieve itching.

**Rub:** to move body, with pressure, along, over, or against a surface.

**Smell:** olfactory investigation of a conspecific or an inanimate object.

**Scent:** to smell the air.

**Defecate****Urinate****PROXIMITY**

**Contact:** touching each other.

**Arms reach:** within a bear's arm reach of each other.

**Body length:** a bear's body length away.

**Body length plus:** more than a body length apart.

**Out of sight:** out of visual contact.

**Lift mouth:** to raise off the ground by using the mouth.

**Carry mouth:** to transport an object within the mouth.

**Toss:** to project an item through the air from the mouth.

**Lick:** to pass the tongue over.

**Bite:** to sink the teeth into an object.

**Chew:** to work the jaws and teeth in order to grind.

**Nudge nose:** slightly moving an item by pushing along with the nose.

**Carry/wear head:** transport an item on top of the head or around the neck.

**Rub head:** push the head back and forth against an object.

**Hold down:** push an object against the ground with the paws.

**Push against side:** holding against a wall and applying pressure with the paws.

**Lift paws:** raise an object off the ground with paws.

**Carry paws:** transport an item by holding between the paws or between a paw and the body.

**Nudge paw:** slightly move an item by softly pushing it with a paw.

**Bounce on:** to repeatedly jump up and down on something with the paws coming in contact with the object, and the hind legs remaining on the ground.

**Scratch at:** to scrape the surface of an object with the claws.

**Throw:** lift an object with the forepaws and project it into the air.

**Hit:** to strike an object with force.

**Lie on:** to put the body on, over, or across an object.

**Rub against:** to push the body back and forth across an item.

**OBJECT HANDLING—ACTIONS WITH OBJECTS**

**Stack:** to set 1 item on top of another.

**Include:** to put 1 item inside of another.

**Incorporate:** to manipulate more than 1 object at a time.

**Hoard:** to collect a number of items together in 1 area.

**Insert:** to push an object into a hole or gap.

**GAMES**

**Tug-of-war:** two or more individuals pull an object back and forth between each other.

**Stalk:** set an item in position, back off, and then charge it.

**Grapple:** two or more individuals engaging in rough and tumble play.

**Retrieve:** to throw or hit an item away, and then jump on it.

**OBJECT HANDLING—ACTIONS ON OBJECTS**

**Hold mouth:** to have or keep an object between the teeth.

**Table 2. A list of the polar bears held in zoos in the British Isles.**

Identity	Age	Sex	Wild or captive born	Location
Nina	32	F	CB	Bristol
Misha	28	M	W?	Bristol
Bonnie	10	F	CB	Chessington
Clyde	10	M	CB	Chessington
Mandy	16	F	W?	Flamingoland
Marcus	16	M	W?	Flamingoland
Sabrina	24	F	CB	Chester
Sally	29	F	CB?	Glasgow
Winston	28	M	W	Glasgow
Mercedes	11	F	W	Edinburgh
Barney	15	M	CB	Edinburgh
Wash	10	F	CB	Belfast
Tumble	10	F	CB	Belfast
Dudley	12	M	CB	Belfast
Spunky	13	F	W	Dublin
Ootek	13	M	W	Dublin

but less when there was only 1 animal to observe. Data were collected with observations distributed evenly over the hours of 0700-1900 hours, under varying weather conditions and at different times of the week. Observations at each zoo were collected during different seasons to identify seasonal influences upon the animal's behavior. The seasons were defined as summer = June, July, and August; autumn = September, October, and November; winter = December, January, and February; spring = March, April, and May.

Data were analyzed by tabulating data points for selected behaviors. With such a small sample size, repeated measures were collected and the data has been presented as case studies. Data were analyzed using nonparametric tests.

An enrichment program was initiated at all of the zoos, which encompassed a 2-fold strategy with changes in feeding routines (Law et al. 1986) and provision of objects for manipulation and exploration. Guidelines for feeding routines were aimed at making feeds more interesting for the bears. A greater variety and complexity of food items, such as whole crabs or food frozen in blocks of ice, were provided so that bears had to work harder in order to obtain food. Objects were

also provided to stimulate exploratory and manipulative activity. A wide range of objects varying in shape, size, and texture were provided in order to increase the behavioral opportunities available.

The wide geographical separation of the participating zoos, and the need to collect adequate blocks of data on the study animals prior to enrichment, resulted in the program being initiated in a staggered fashion. As a consequence, data were collected and the enrichment program begun at different times of year at each zoo. At some zoos, events or features of current management delayed observations: at 1 zoo the male polar bear was housed with a brown bear while the female reared her cub; at another, the male and female were separated while the female reared her cub in another area; 2 females were dened up during the winter months. One old, male bear died after the initial observations, but before the effects of the intervention could be examined.

Although all the zoos were given the same guidelines and suggestions, quality of enrichment varied at each zoo according to enclosure design, characteristics of individual bears, and timing of the onset of the enrichment program. Some enclosures have filtration systems that provide bears with clean water but limit the type of objects that animals can receive. A glass barrier also resulted in restrictions by limiting objects to those that cannot be used to break glass. Keepers in some zoos had great difficulty in changing the objects in the enclosure because bears preferred not to enter the dens. Antiquated facilities with slides that did not work quickly and easily exacerbated this problem. All of these differences contributed to differences in quality of the enrichment program.

This paper is focused on the ability and interest of captive polar bears to manipulate objects. Prior to the study, captive bears did not receive a supply of moveable objects, and as a result were unable to exhibit manipulative behavior. Following object provision, the animals exhibited a more diverse behavioral repertoire, and it is this increase in behavioral opportunities that will be detailed.

Post-enrichment observations were not carried out immediately. A key goal of the study was to measure the effectiveness of the enrichment program and not the effects of novelty on the bears. Following a 3-month interval, the post-intervention data were collected. The data were examined for seasonal and sex differences in total amount of manipulation. The initiations of object handling sessions were identified and measured when animals first came into physical contact with 1 or more objects. Terminations of sessions were defined by a 5-

minute break in manipulation accompanied by a change in behavior. Breaks of less than 5 minutes were used to identify the termination of object handling bouts. Sessions were comprised of 1 or more manipulative bouts.

Further detailed analyses were conducted in order to identify composition, organization, and intensity of behavior directed toward objects. For measures of session length, frequency of sessions, and body parts used in manipulation, data were limited to observations collected during summer months since males and females appeared equally affected by seasonal variation. During these months both sexes exhibited similar levels of object manipulation. Past research on captive polar bears indicates that seasonal behavior and species management, in regards to reproduction, have marked effect upon various aspects of their behavior (Ames and Redshaw 1990).

## RESULTS

### Total Amount of Manipulation

Levels of manipulation remained fairly constant over the seasons, for the female bears (Wilcoxon test; NS), with a difference of only 1.5% of total observation time between the highest and lowest recordings. The male bears however, showed seasonal variation (Wilcoxon test;  $P < 0.10$ ) with manipulation at a low of 2.1% in the spring and a high of 14.6% of total observation time in the autumn (Fig. 1). In all seasons except the spring, male bears had higher levels of manipulation. It was thought that the age of the bears might have an inverse relationship with levels of object handling but no such relationship was found (Spearman; NS).

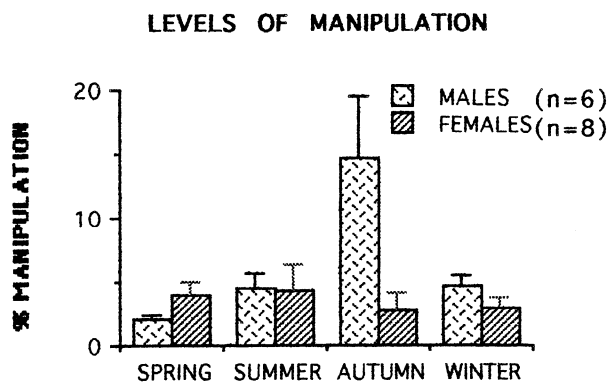


Fig. 1. Proportion of time captive polar bears spent manipulating objects during different seasons.

### Session Parameters

The median session lengths varied from 3 to 12 minutes, while ranges varied from 1 to 96 minutes. The distribution of medians and ranges did not appear to be influenced by sex. However, analysis indicated that there was a difference in the distribution of session lengths. In order to identify male-female differences, session lengths were plotted by frequency, which showed the male's distribution dropping off at sessions  $>15$  minutes (Fig. 2). The female bear's distribution was more prolonged with a further 24% of the sessions having lengths  $>15$  minutes.

The frequency of sessions was examined in order to obtain a comprehensive view of the amount of object manipulation. Session length was shorter for males, while the total amount of manipulation hardly varied between the sexes. It was thus hypothesized that the male bears would have more frequent sessions and this was found to be a significant difference (Mann-Whitney;  $P < 0.05$ ). The frequency of male sessions ranged from 0.2 to 0.8 sessions per hour with a mean score of 0.4 sessions per hour ( $n = 4$ ). Female manipulation ranged from 0.02 to 0.6 sessions per hour with a mean score of 0.2 sessions per hour ( $n = 7$ ). All but 1 of the females had fewer sessions per hour than the male bears.

### Session Composition

Much of the manipulative activity observed had an organized structure involving repeated segments, minor variants, and elaborations (Ames and Redshaw 1990). For example, an animal would knock a barrel with puncture holes into the pool, jump onto it, hold it under the water and when it was full, lift it out, wait until it emptied and then climb out, knock it into the water, jump onto it and so on, repeating the sequence with variations. With a wide range of objects, repeated tossing, dropping, and throwing were common play elements that appeared after visual inspection, olfactory

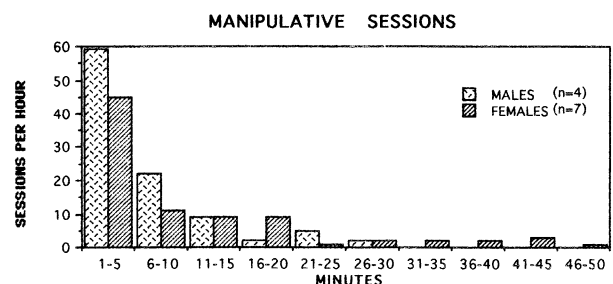


Fig. 2. The distribution of session lengths for the sexes.

and oral exploration, and attempts at destruction.

The use of different body parts was divided up into 3 sections: mouth-muzzle, paws, and body (Fig. 3). Data showed that males and females alike used their paws, 46.7% and 42% respectively, slightly more than their mouth-muzzle, 40.9% and 40.7%, during object manipulation. However, this was not a significant difference (Wilcoxon; NS). Activities with the objects were divided into 4 sections as related to degree of complexity: (1) actions on objects, such as biting or smelling; (2) actions with objects, such as carrying or throwing; (3) actions with objects on self, such as wearing an object or putting the paws or head inside; and (4) actions with objects on other objects, such as stacking objects or putting one inside the other. The scores indicated that although the majority of activity was comprised of actions on objects for both males and females, 44.2% and 43%, female polar bears performed more complex object manipulation. The females were found to perform actions with objects on themselves 10.7% of total manipulation time, while the males were found to do this only 6.2% of their time. Eight percent of the manipulation of females involved actions with objects on other objects. The males exhibited this type of behavior in 6.5% of their manipulative bouts. These differences were not highly significant (Mann-Whitney; NS).

All of the polar bears have been seen manipulating objects. The sex differences were most notable. Manipulation involving more than 1 object, as well as the organization of game structures was observed in 75% of the females and only 33% of the males, while object manipulation involving the individual's surroundings occurred with 62% of the females and 33% of the males. Bears coming together in bouts of

social play with objects occurred in 50% of both male and female bears.

The amount of time spent manipulating objects on the land or in the water indicated the bears' substrate preference. During the summer, both sexes spent the majority of their manipulation time in the water (Wilcoxon;  $P < 0.05$ ). It was found that 80.8% of the females' and 67.7% of the males' object handling was done in the water. Further analysis was done in order to identify the seasonal variation in the pool use (Fig. 4). Lower levels of water-based manipulation were recorded in winter than in summer, however, object handling on land remained at a lower level than that in water, regardless of season (Wilcoxon;  $P < 0.05$ ).

### DISCUSSION

If polar bears have an intrinsic ability and motivation to manipulate objects, 2 results are expected. First, manipulation would occur regardless of season or sex differences. This expectation was realized in every case over a 2-year period of observations. Second, the amount of manipulation might reduce with an increase in age, but levels would still be recorded. Reduction in play behavior with age has been recorded in a number of species (Hediger 1950, Fagen 1981, Poole 1987), but in this sample of polar bears, manipulative ability was independent of age.

Although the median scores for session length were similar for males and females, the distribution of session lengths clearly indicated that differences in the gross organization of object manipulation were occurring. Male polar bears were exhibiting shorter session lengths than females. Total levels of manipulation did not reflect this discrepancy however, with males manipulating objects at mean summer levels of 4.5% and females at 4.3% of the total observation time. Object manipulation appears to be organized in

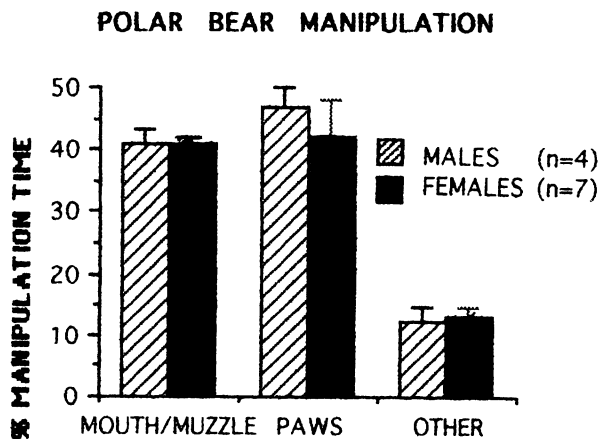


Fig. 3. The different body parts used in manipulative bouts.

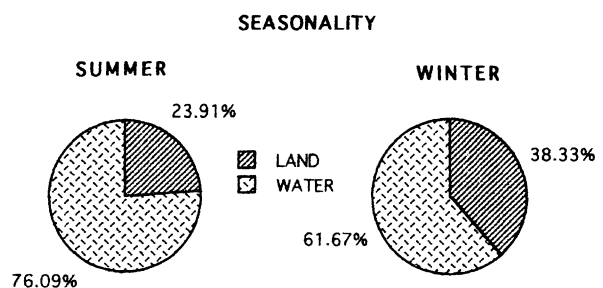


Fig. 4. Results show the bears preference of area for manipulative bouts ( $n = 11$ ).

different ways in the 2 sexes. Male bears spend shorter periods object handling yet manipulative sessions occur more frequently. Female bears perform longer, less frequent sessions.

This differentiation was further identified when activities in object handling sessions were examined. It was hypothesized that if females were having longer session lengths their object handling would become more complex. Male polar bears had a more limited repertoire of activities while females performed a greater number of activities involving multiple objects. Activities involved with putting objects on oneself, i.e., putting the head or a paw inside, involved a greater understanding of an object in relation to the individual. Female bears also performed more of this type of behavior than the male bears.

Although females developed their object handling more than males did, both sexes were found to be capable of delicate, complex manipulation. Data relating the amount of different body parts used in object handling sessions show that even males were still using their paws more than their mouth-muzzle. Captive polar bears do not simply tear objects apart. Mentally and physically, they are capable of deliberate, focused, and agile object manipulation.

Observations and video recordings showed that much of the manipulative activity had an organized structure involving repeated segments (Ames and Redshaw 1990). In many ways these are reminiscent of the play behavior of young primates. Initial investigations of new objects involved visual and oral exploration but as the bears established the properties of an object, they would begin to "handle" and manipulate the item. Some bears were observed to create games for themselves and other individuals. Placing objects in just the right area so that they could be stalked and attacked was a game that was developed on land and in the water. On several occasions, bears were seen to play games of tug-o-war.

## MANAGEMENT IMPLICATIONS

Polar bears are more skilled and dexterous in object manipulation than previously described or expected. In evolutionary terms, such ability is a reflection of intelligence that has allowed all species of bears to adapt to a wide variety of habitats in the wild. Potential for manipulation and object related activity appears to be an indicator of behavioral and psychological needs in captivity (Jordan 1982, Law et al. 1986, Tripp 1985, Carlstead et al. 1991, Pellis 1991). Such requirements can and should be met in

both the short and long term. Day-to-day husbandry routines should be modified in such a way that bears have a steady supply of movable objects. This provisioning should be implemented on a daily basis to provide captive bears with novel objects.

The majority of object manipulation and rough and tumble, social play seen in captive polar bears occurs in the water. This substrate preference is most likely the result of inappropriate enclosure design with the bears having no other soft substrates in which to play. If significant, natural areas, such as sand, soil, or bark litter, were included in captive enclosures, bears would be able to build daybeds, dig dens, and forage as they would in the wild (Ames 1993). Efforts to recreate superficial aspects of the Arctic have left captive polar bears in a traditional concrete pit, allowing only a tiny fragment of their behavioral repertoire to be expressed. Such management can only be considered deprivational. In terms of captive management, polar bears need to be considered primarily as bears, with corresponding behavioral and psychological needs.

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