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Factors affecting the quantity of social interactions and aggression in captive group-housed Asiatic black bears *(Ursus thibetanus)*

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Abstract

This study observed a group of Asiatic black bears *(Ursus thibetanus)* in a captive environment that differs greatly to standard zoological institutions. Rather than being housed alone or with one other, as is typical in captivity, two large groups of bears consisting of 24 individuals were observed in two different enclosures. Any instance of social behaviour was noted down, both positive and negative, to determine the extent to which social relationships form and whether these animals have the capacity to live in large groups, regardless of their supposed solitary nature. The results indicated that the duration of social interactions were longer in the smaller group of bears but there was a higher number of instigators in the larger group. Generalised Linear Model analysis showed that interactions, both positive and negative, occurred less in the mornings, particularly during feeding time while an increase in aggression was noted generally prior to afternoon feeding ($P = 0.001$). Female-female aggression was much more prominent than between males or males and females. It appears that despite being defined as solitary, this species benefits greatly from social interaction with others of its kind when housed in captivity.

Keywords: social behaviour; Asiatic black bear; aggression; captivity; interaction

Introduction

The word 'social' could be perceived as being ambiguous as it comprises many diverse connotations (Giraldeau & Caraco, 2000). For example, some restrict the term to organisms exhibiting a certain amount of familial dependence, those bearing elaborate behaviour displays, or those living in demographically structured groups. It has also been described as any animal that spends a good part of its life in groups, even if they are open, unstructured and temporary (Kao et al., 2014). However, in its broadest sense, 'social' can be defined as 'any set of individuals linked by identifiable, mutual relationships' (Giraldeau & Caraco, 2000). In contrast, some groups are seen as mere aggregations instead. 'Social groups' are classified as collections of social animals, the result of genuine attraction between individuals, while 'aggregations' are classified as collections of non-social animals, statistical coincidences of animals often around a common occurrence (Giraldeau & Caraco, 2000). For example, hundreds of insects gathering around a lamp are not social, but has been misconceived as social due to a mutual attraction (Tinbergen, 1964).

Genders, isolation, familiarity, possession of a resource, previous experience and genetic aspects have all been shown to have some influence on mammalian social behaviour, including aggression (Poole, 1985). The most frequent situation in which agonistic behaviour occurs in mammals, involves them defending assets which can be monopolized. These resources include food supply, living space, mates, resting sites and dominant status which allow animals to acquire resources (Poole, 1985). Kleiman & Eisenberg (1973) stated that increased aggression may relate to the level of sociality in some mammalian groups. The classification of social systems in the wild could be helpful for predicting potential aggression in captivity. Hence, in the case of the Asiatic black bear *(Ursus thibetanus),* a predominantly solitary mammal in the wild, it would be predicted that being placed in an environment with fellow conspecifics would be detrimental as it should not be living in a group system.

However, captive animals experience different ecological pressures as opposed to their wild counterparts (Elsbeth McPhee, 2004). Food availability and predation are no longer concerns, although they still face competition for mates and are incapable of making the social adjustments necessary to decrease social tension (Price, 1999). In the absence of environmental constraints, many species can be housed in a greater diversity of social groups than observed in the wild, thus in some cases, solitary species can be kept in groups effectively (Price & Stoinski, 2007). As such, group size has a great impact on the behaviour and welfare of captive animals. For example, in nature, orang-utans are found alone or in small units with opposite sexes, only coming in to contact for a brief mating period (Bond & Watts, 1997). The species hardly benefit from group living as they have limited predation, but high costs as they depend on widely dispersed food resources, very similar to most bear species. However, in captivity, where food resources are guaranteed, they can be successfully housed in groups which provides social stimulation and in some cases, the opportunity to improve parental functioning (Bond & Watts, 1997).

One of the main goals of captive animal management is the promotion of natural behaviours and the prevention of abnormal behaviours (Farmer et al., 2011). This promotion includes the encouragement of positive social behaviour between individuals, as well as the prevention of aggression between individuals. Aggression between animals is part of normal social behaviour both in the wild and in captivity, but may increase in frequency if space is restricted, which is a common occurrence in captivity. Although aggression should not be entirely avoided in a captive setting as it can be used by animal groups to establish dominance and social hierarchy, it is suggested that in order for an animal to reach an optimum state of welfare, it should be free from fear and distress and pain or injury (Animal Welfare Act, 2006), all of which are a possible result from repeated aggression from an antagonist.

There are a number of factors which are likely to affect the frequency of social and aggressive interactions which occur within a group of animals being kept in captivity. In this environment, appropriate social groupings are of paramount importance to providing examples of species-typical behaviours, as well as attaining captive breeding goals (Price & Stoinski, 2007). There can be negative effects to keeping animals at high densities. In primates, overcrowded groups often show higher levels of aggression and stress-related behaviours (Plowman et al., 2005). These negative consequences have also occurred in cotton-top tamarins (*Saguinus oedipus)* when a group had visual access to other groups; they showed higher levels of non-contact aggression than those without access (Kuhar et al., 2003). In short, overcrowding can lead to the breakdown of hierarchical relationships, thus raising levels of aggression (Fradrich, 1980).

Food availability and diet is an additional factor which greatly affects the social interactions within a group. In many animals, diet has been known to not only influence physical well-being, but also psychological health, activity patterns, and social interactions (journal). For example, Latour (1981) studied wild polar bears around a food resource and found that social interactions occurred infrequently, however would increase when there was no competition for food. Furthermore the only known circumstance in which this species gathers in the wild is in the presence of plentiful food resources, suggesting a higher tolerance of one another when food scarcity is not a factor (Latour, 1981). Food seems to be the limiting resource that stimulates territorial behaviour by many animals and with that, territorial defence decreases in individuals as productivity or availability of food increases (Powell et al., 1997). As aforementioned, aggression can become common in captive environments. For example, territorial birds defend concentrations of resources and under captive conditions; this behaviour is greatly accentuated (Gibbons et al., 1995). Additionally, submarine foraging alcids engage in numerous attacks and chases around feeding areas as they attempt to steal food from one another (Duffey et al., 1987). Supporting this statement, Goss-Custard & Durell (1987) stated that large groups often result in an increased local density of consumers, with competition leading to aggression and kleptoparasitism. Though commonplace in captivity, fortunately these acts of stealing food usually result in minimal consequence, such as the possibility of a short, aggressive encounter with another individual before then being able to find another piece of food nearby, suggesting this level of aggression does not detriment the animals' wellbeing and is instead related to exhibiting mild irritability. Clumping food has been known to promote competition and increase the probability that subordinate individuals do not receive adequate nutrition (Feare & Inglis, 1979), with an increase in aggression as this spatial clumping increases (Goldberg, 2001). Thus, in order to reduce the frequency of aggressive interactions and to promote feeding by subordinates, feeders can be spread further apart, made bigger, and increased in number throughout enclosures (Duffey et al., 1987).

Other studies looking at how spaciousness affects group dynamics report decreases in social behaviour, both positive and negative, as a result of the increase in private spaces. In other words, larger, more complex exhibits (Lukas et al., 2003) have a strong impact on the dynamics of social groups. This is because a number of remediating measures can be employed if larger spatial areas are available, such as: avoidance of sharp or right angle corners in the fence so subordinates cannot be cornered, several well-distributed feeding areas attended to simultaneously so subordinates can feed undisturbed, and separation of certain individuals into isolated stalls during certain periods (Gibbons et al., 1995). Therefore if the group size is too large, or during situations when social tension may be of a higher frequency, adequate escape paths and visual barriers can decrease tension between individuals, and thus reduce the incidence of aggression (Price & Stoinski, 2007).

Keeping captive animals gives humans the opportunity to observe social behaviour in species that are too difficult to study in the wild. One of the reasons for this may be the fact that solitary species in the wild are known to frequently inhabit areas with dense vegetation cover, are nocturnal and are consequently hard to observe (Wiens and Zitzmann, 2003). These difficulties have consequently limited the study of social behaviour to more companionable species and as a result the title of ‘solitary’ for some species could have arisen from our inability to study them successfully rather than from the actual nature of their social systems (Prange et al., 2011). As an example, only 10-15% of all carnivore species are classified as gregarious, or were observed in groups exhibiting cooperative behaviour outside of breeding season (Prange et al., 2011), and the remainder are classed as solitary (Sandell, 1989).

Similar to this study, in 2005, Montaudouin & Pape compared the stereotypic and social behaviour of brown bears *(Ursus arctos)* and found that keeping more than two bears together was a source of social conflict. Grouping individuals of the same species is generally considered as decreasing boredom, even if the species is solitary in nature, and several authors have speculated that social housing can reduce stereotypy and thus be wholly beneficial to the animal (Cooper et al., 2000). Montaudouin & Pape (2005) studied brown bear males in particular, as they are generally solitary animals and thus compared enclosures with different grouping situations, ranging from isolated subjects to groups of up to six. It was found that competition for social contact, including sexual attraction, was very common of groups of three and above. Other examples of aggression occurred due to familial protection. Finally, the social relationships were seen to be less agonistic and more playful if bears were kept in pairs, as well as providing food as a scatter as it likely promotes curiosity and food-exploration, thus hopefully reducing the likelihood of fighting over food.

As the Asiatic black bear *(Ursus thibetanus)* is generally viewed as a solitary species both in the wild and in captivity, this study looked at how the species fared in a captive setting in much larger group sizes, determining whether this gave rise to more positive social interactions or a higher incidence of aggression. It was hypothesised that the larger the group, the more interactions that would take place, both affiliative and aggressive, thus resolving in higher levels of aggression.

Methods

Ethical approval

Before bear observations began, an ethical approval application form was completed, along with a risk assessment, and submitted to The University of Plymouth Ethical Approval Board and after consideration; consent was given to go ahead with data collection.

Study site

Data collection took place at the Chengdu Bear Rescue Centre in the Sichuan Province of China. The centre occupies 26 acres and contains thirteen bear houses, all holding different sized groups. The centre is owned by Animals Asia, a charity which rehabilitates bears that have been rescued from the bear bile extraction industry. They operate sanctuaries with natural habitats and dens for the bears to survive their remaining years in the company of others.

In regards to enclosure layout, House 5 (Fig. 1) had one pool, twelve enrichment structures, two log piles, 8 trees and 1 e-fenced area housing two bears separately; House 6 (Fig. 2) had two pools (one without water), ten enrichment structures, four log piles, eleven trees and two e-fenced areas, housing one bear separately. The House 5 enclosure encompassed 2,727m² and House 6 occupied 3,272m².

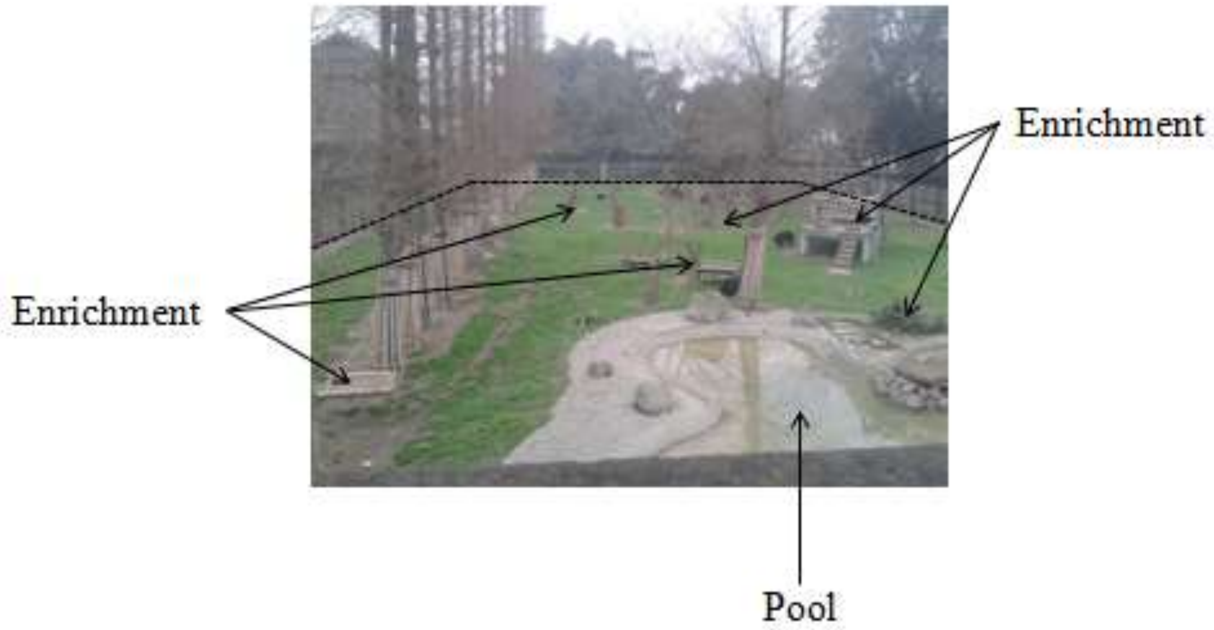

Figure 1: Image of outside section of House 5 enclosure (2,727m^2). Visible pools and enrichment structures are labelled.

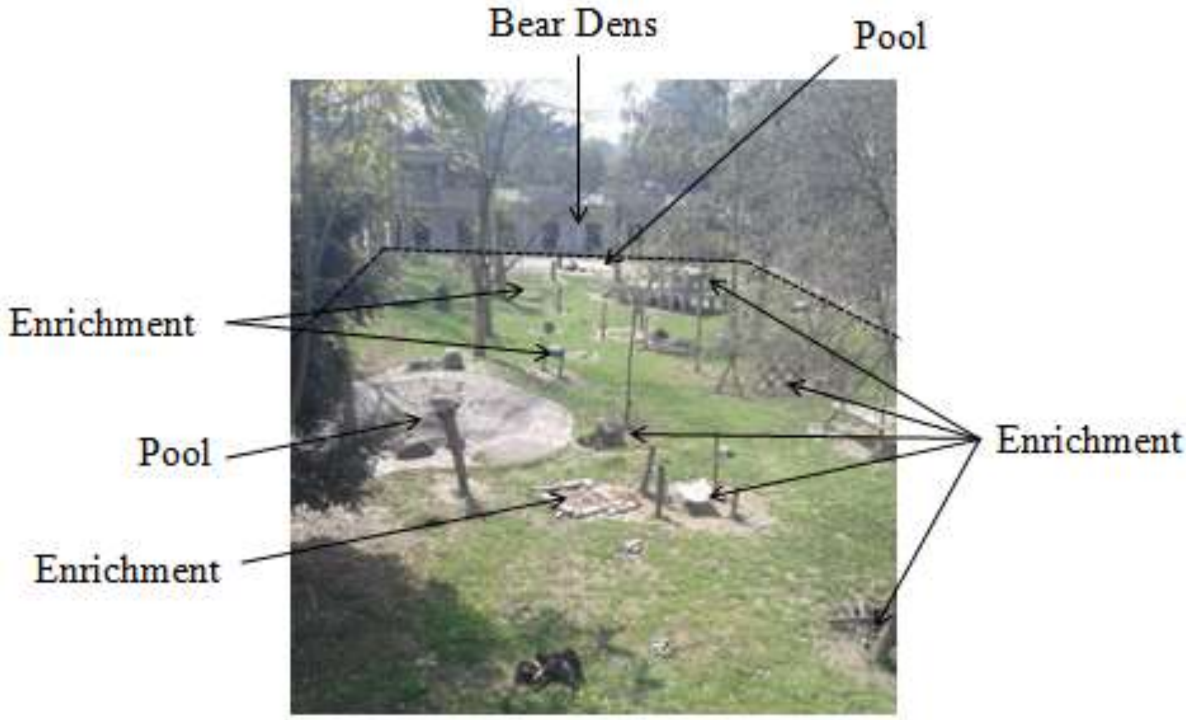

Figure 2: Image of outside section of House 6 enclosure (3,272m^2). Visible dens, pools and enrichment structures are labelled.

Subjects

Two bear houses were studied in total. House 5 had the smallest group number on the property, enclosing a group of nine bears; two males and seven females. House 6 enclosed the largest group on site with fifteen bears; eight males and seven females.

The weather conditions and temperature were recorded at the beginning of each period and the medicinal requirements for each bear were also noted. Of the 24 individuals, 16 were taking some form of medication. These included enalapril to treat high blood pressure, meloxicam; an anti-inflammatory used for pain relief against arthritis, ligajoint for pain relief, amylodopine for high blood pressure, doxycycline; an antibiotic, urso to prevent gallstones and gabapentin to treat nerve pain. These medications were given to the bears in the form of a shake or marshmallows any time from 8:00am onwards daily, and again at 4:30pm for certain individuals.

Similar to previous studies (Correa et al., 2013; Davenport, 2010), various marking identification techniques were employed by the bear centre. The most effective were ear tags, in addition to natural markings as many bears had come from ill-treated backgrounds leading to loss of fur, limbs and facial features. Of the 24 bears observed, three had missing or damaged facial features, one had bald scarring and five had at least one missing limb. The animal care staff were contactable by means of radio if the bears could not be identified.

Table 1: List of medications taken by subjects during observations.

Medication being taken	Number of subjects being treated by drug
Enalapril	5
Meloxicam	10
Ligajoint	8
Amylodopine	2
Doxycycline	1
Urso	5
Gabapentin	4

Data collection

The data for each house was collected in 90-minute intervals. There were four time periods in which data was collected, five times for each period, they were: 9:00am-10:30am, 10:30am-12:00pm, 1:30pm-3:00pm and 3:00pm-4:30pm. The first period was after the morning medication shakes were given and as the morning feed began. The final period was prior to afternoon recall and the afternoon feed which was at 4:30pm.

For House 5, data collection took place between 26-02-15 until 18-03-15 and for House 6, between 28-02-15 and 28-03-15. The observations were recorded from a rooftop observation platform, which had compartments in the ceiling to look into bear dens, as well as access to the bear house itself. Continuous, behavioural scan sampling was used to record any social interaction, positive or negative, which occurred between two or more bears. Instantaneous sampling was also used every five minutes to note down the location of each bear whether they were located inside or outside and what type of activity they were doing.

Interactions between particular pairs of individuals within a session were recorded as to whether they were positive or negative as well as which of the pair instigated the interaction and the duration (see Table 2 for behavioural definitions). Each unique pairing was identified with a number e.g. pair 1 = Harley and Kainara.

Table 2: Definitions of positive and negative behaviours recorded between individuals.

Behaviour Context	Type of Behaviour	Definition
Positive	Playing	Engaging in an activity for enjoyment with another bear.
	Mating	Two bears coming together to copulate, in the form of one bear mounting another.
	Sleeping/Sitting Together	Two or more bears resting (2-4 limbs on the ground) or sleeping (all limbs on ground with eyes closed) together within 1m.
	Sniffing/Contact/Pawing	Any bears which come into contact, even momentarily, to either sniff (drawing air through the nose) or paw at each other.
	Foraging within 1m	Searching the ground for food in the same vicinity of another bear, within

		1m.
Negative	Chasing	The act of one bear running after another in an aggressive manner.
	Growling	When a bear produces a low, harsh sound of hostility in its throat toward another bear.
	Fighting	When a bear engages in combat with another bear, can be in the form of swatting another with its paws as well as standing on its hind legs or baring its teeth.

Data analysis

All analyses used IBM SPSS Statistics 22. For analysis, Generalised Linear Models (GLMs) were used with a negative binomial link function. The data was collated in Microsoft Excel with each pair of social bears being given a number (e.g. Pair 1 for Kainara and Harley), noting also which was the instigator of the interaction and which was the reactor. The total duration of both positive and negative interaction for that pair was noted in minutes, as well as the day it occurred, and in which time period. The total duration across all time periods between each pair was then recorded and used to calculate average time spent interacting between each pair of bears. As pairwise comparisons were made, the Bonferroni test was also used. Bar charts were created to illustrate the average number of positive vs. negative interactions, by certain individuals, as well as across each time period in each house.

Finally, sociograms were constructed as a visual representation of positive interactions carried out in each house using the program, 'Sociogram'. After consulting the original observation data, a total time spent socialising for each pair was collected. This was then divided by the total time spent observing the bears in that house and percentages of total time spent together throughout the entire study were calculated. For example for Harley and Kainara in House 5; (453/1800 x 100) = 25.2%. Therefore, the percentage score which bears received was then prescribed as a value equivalent to the thickness of the line, hypothetically Harley and Kainara have a line thickness of 25, the highest for this set of data, As Harley initiated 329 minutes of social play (=18.3%) and Kainara initiated 124 minutes (= 6.9%), the line thickness was 18 from Harley's circle and 7 from Kainara's. This was applied to all bears in the sociogram. The relationship percentage was labelled on the sociogram so that relevant patterns could be easily seen and compared. The only bears involved in the sociogram were those which spent at least 10 minutes interacting (= 0.5% of total time) as otherwise the values were too small. This is why a sociogram was only made for positive interactions, as the values for negative interactions were generally much lower in frequency.

Hence, for House 5, six bears are present on the sociogram even though nine bears inhabited the area; the other three did not interact with a fellow bear for at least 0.5% of the time, thus in this instance, are not deemed 'social' with the other individual. For House 6, three bears are not present in the sociogram due to the previous constraints mentioned.

Results

In House 5, there is a significant difference in positive interactions between time periods (Wald Chi-Square = 15.562; df = 3; P = 0.001), although the Bonferroni pairwise test showed no significant results. The highest number of positive reactions occurred between 1:30pm-3:00pm and the lowest occurred between 9:00am10:30am (Fig. 3a).

There is also a significant difference in negative interactions in House 5 across time periods (Wald Chi-Square = 15.876; df = 3; P = 0.001); Periods 1 and 3 are very similar in their results and Period 4 encompassed the most negative interactions (Fig. 3b).

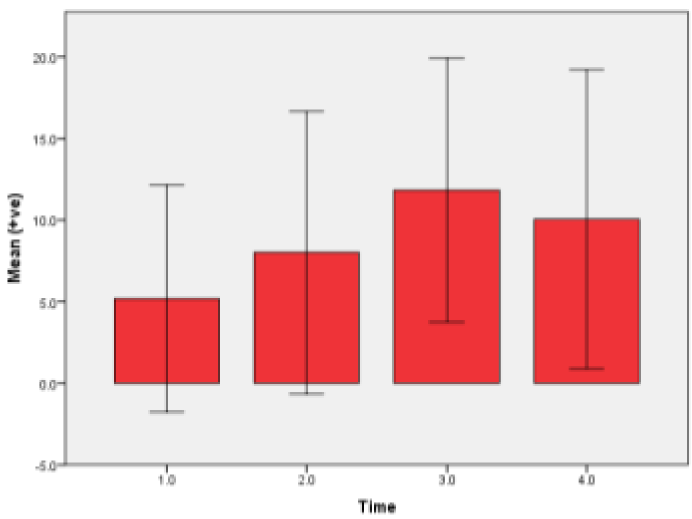

Figure 3a: Mean (±SD) duration of positive interactions across four time periods in House 5.

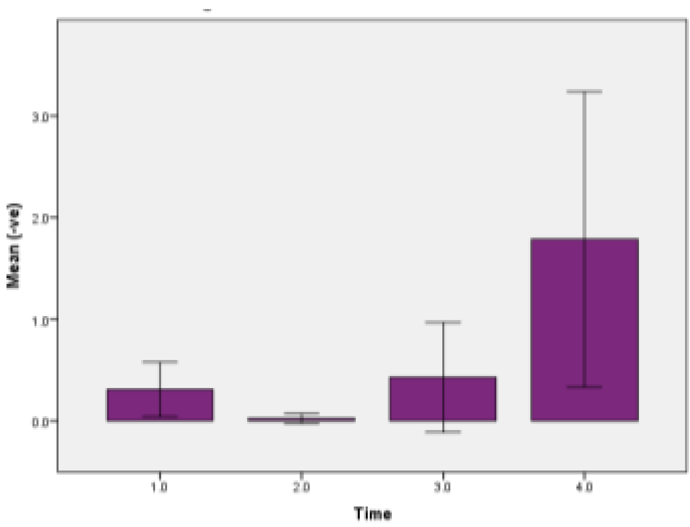

Figure 3b: Mean (±SD) duration of negative interactions across four time periods in House 5.

1.0 = 9:00-10:30 2.0 = 10:30-12:00 3.0 = 13:30-15:00 4.0 = 15:00-16:30

There was a significant difference in who instigated positive interactions (Wald Chi-Square = 76.600; df = 6; P < 0.001); Birragai, Gladly, Monkey, Nina and Xuan Xuan all instigated a similar quantity while Harley and Bodo are also quantitatively similar, with Harley instigating the most positive interactions (Fig. 4a). On the other hand, negative interactions were not significantly different between individuals (Wald Chi-Square = 12.437; df = 7; P = 0.087), the results show that all the bears were similar in their instigation of aggressive behaviour (Fig. 4b).

Many bears in House 5 are similar in their instigation of positive interactions. If a bear had a value of P > 0.05 with another bear, they were seen to be comparable in their frequency of interactions; if it was lower they were not (see Table 3 for pairwise comparisons).

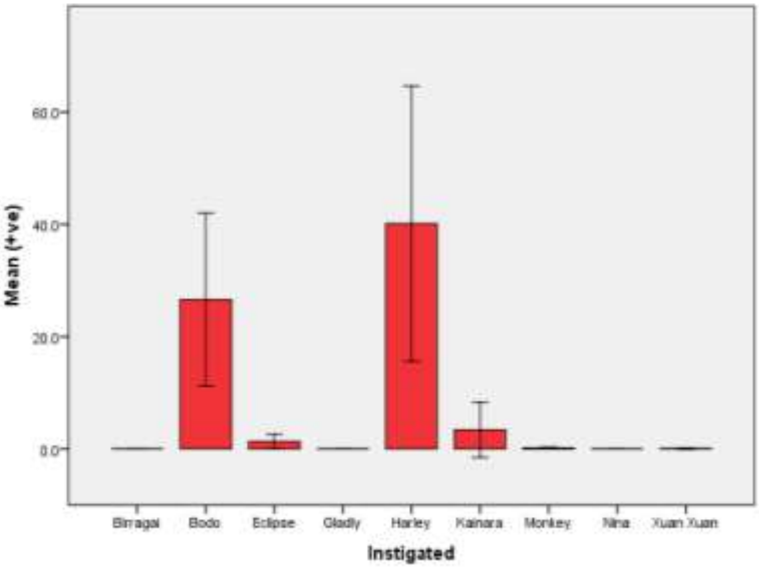

Figure 4a: Mean (±SD) duration of positive interactions instigated by individuals in House 5.

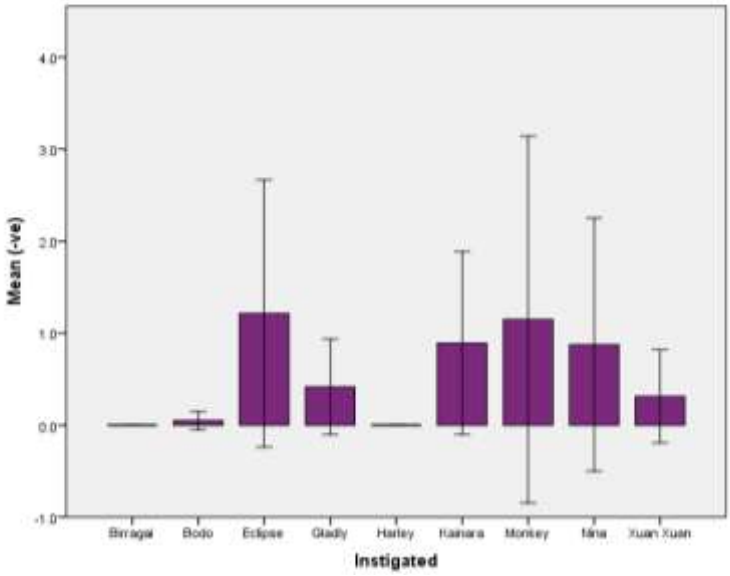

Figure 4b: Mean (±SD) duration of negative interactions instigated by individuals in House 5.

Table 3: Positive interactions instigated between certain individuals in House 5.

Key:

● = Bonferroni Sig. of P > 0.05 ◯ = Bonferroni Sig. of P < 0.05

(+ve)	Birragai	Bodo	Eclipse	Gladly	Harley	Kainara	Monkey	Nina	Xuan Xuan
Birragai									
Bodo	◯								
Eclipse	◯	◯							
Gladly	●	◯	◯						
Harley	◯	●	◯	◯					
Kainara	◯	◯	●	◯	◯				
Monkey	●	◯	◯	●	◯	◯			
Nina	●	◯	◯	●	◯	◯	●		
Xuan Xuan	●	◯	◯	●	◯	◯	●	●	

In House 6, there is a significant difference in number of positive interactions across time periods (Wald Chi-Square = 59.916; df = 3; P < 0.001), with all periods differing greatly from each other. Similar to House 5, the highest number of positive interactions occurred between 1:30pm-3:00pm, as well as the lowest number of interactions occurring between 9:00am-10:30am (Fig. 5a). Furthermore there was also a significant difference in negative interactions across time periods (Wald Chi-Square = 24.524; df = 3; P < 0.001), with the most frequent aggression occurring between 9:00am-10:30am and the least between 10:30am-1:00pm (Fig. 5b).

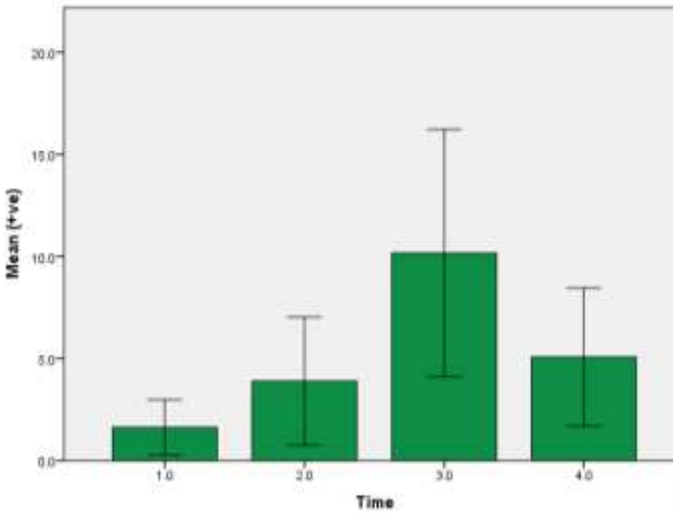

Figure 5a: Mean (±SD) duration of positive interactions across four time periods in House 6.

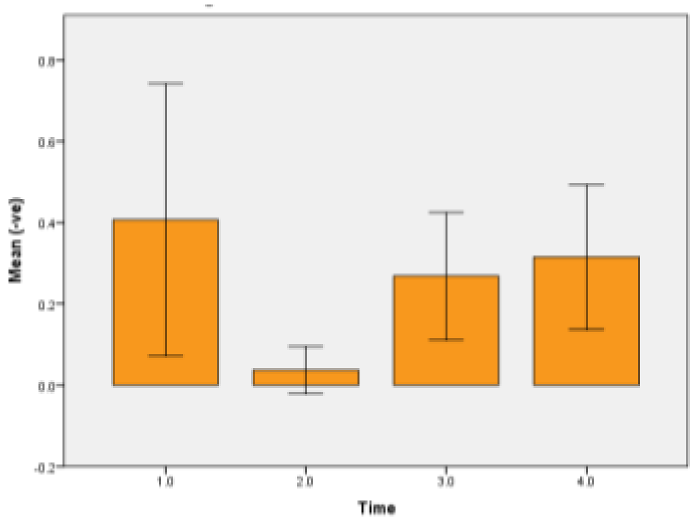

Figure 5b: Mean (±SD) duration of negative interactions across four time periods in House 6.

1.0 = 9:00-10:30 2.0 = 10:30-12:00 3.0 = 13:30-15:00 4.0 = 15:00-16:30

Finally, in House 6 there was a significant difference in who instigated the positive interactions (Wald Chi-Square = 252.969; df = 12; P < 0.001), with a whole range of bears being responsible for initiating positive interactions, Pearl being accountable for the most (Fig. 6a). As regards to negative interactions, there is also a significant difference between the results (Wald Chi-Square = 39.871; df = 12; P < 0.001), with Paddy exhibiting the most aggressive behaviour, closely followed by Squash and Weston (Fig. 6b).

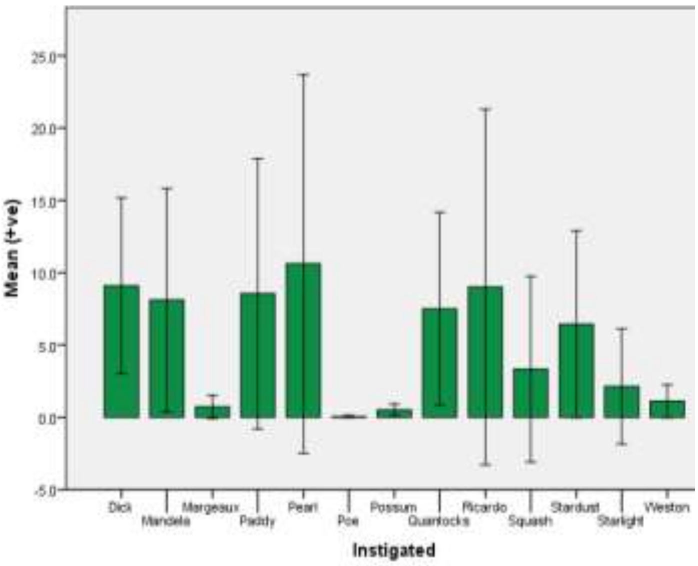

Figure 6a: Mean (±SD) duration of positive interactions instigated by individuals in House 6.

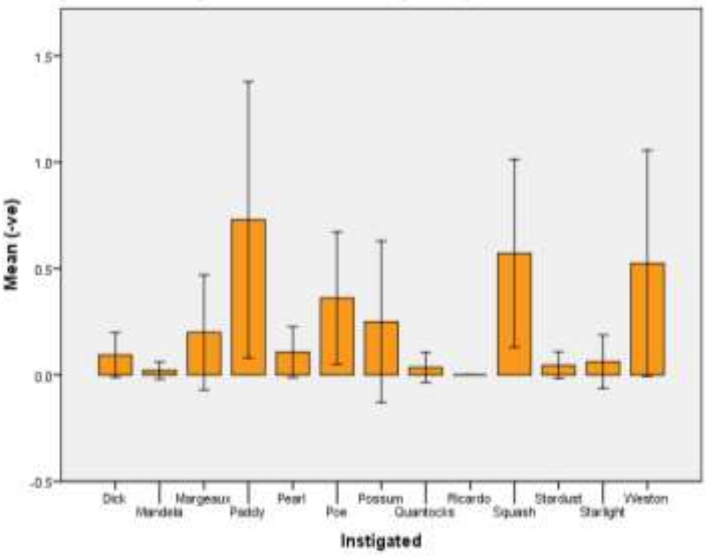

Figure 6b: Mean (±SD) duration of negative interactions instigated by individuals in House 6.

Similar to House 5, many bears in House 6 are quantitatively similar in their initiation of positive interactions (Table 3). In any case, each bear is at least similar to five other bears (P > 0.05). Dick, Mandela, Paddy, Pearl, Quantocks, Ricardo and Stardust are similar in the number of positive interactions they instigate (Table 4), while other bears with a value of P < 0.05 in contrast to Dick initiated less positive interactions on average (Fig. 6a).

Table 4: Positive interactions instigated between certain individuals in House 6, calculated using the Bonferroni test.

Key:
● = Bonferroni Sig. of P > 0.05 ○ = Bonferroni Sig. of P < 0.05

(+ve)	Dick	Mandela	Margeaux	Paddy	Pearl	Poe	Possum	Quantocks	Ricardo	Squash	Stardust	Starlight	Weston
Dick													
Mandela	●												
Margeaux	○	○											
Paddy	●	●	○										
Pearl	●	●	○	●									
Poe	○	○	○	○	○								
Possum	○	○	●	○	○	●							
Quantocks	●	●	○	●	●	○	○						
Ricardo	●	●	●	●	●	○	○	●					
Squash	○	○	●	○	○	○	●	●	●				
Stardust	●	●	○	●	●	○	○	●	●	●			
Starlight	○	○	●	○	○	●	●	●	●	●	●		
Weston	○	○	●	○	○	○	●	●	●	●	○	●	

Contrary to House 5, House 6 showed a significant difference in bears that instigated negative interactions. If a bear had a value of P < 0.05 with another bear they were comparable, and if lower, they were not (see Table 4 for pairwise comparisons).

Most of the bears in House 6 are similar in their initiation of negative interactions; however Paddy contributed the highest number of interactions (Fig. 6b and Table 5).

Table 5: Negative interactions instigated between certain individuals in House 6.

Key:
● = Bonferroni Sig. of P > 0.05 ○ = Bonferroni Sig. of P < 0.05

(-ve)	Dick	Mandela	Margeaux	Paddy	Pearl	Poe	Possum	Quantocks	Ricardo	Squash	Stardust	Starlight	Weston
Dick													
Mandela	○												
Margeaux	○	○											
Paddy	○	○	○										
Pearl	○	○	○	○									
Poe	○	○	○	○	○								
Possum	○	○	○	○	○	○							
Quantocks	○	○	○	●	○	○	○						
Ricardo	○	○	○	●	○	○	○	○					
Squash	○	○	○	○	○	○	○	○	○				
Stardust	○	○	○	●	○	○	○	○	○	○			
Starlight	○	○	○	○	○	○	○	○	○	○	○		
Weston	○	○	○	○	○	○	○	○	○	○	○	○	

In House 5, males initiated more positive interactions than females (Fig. 7). Harley and Bodo, the only two males residing in House 5 were also the most commonly sociable bears; they socialised with the most number of individuals. The highest strength of association is between Harley and Kainara, socialising for 25.2% of the time, shortly followed by Harley and Monkey for 23.7%, both of which are male-female interactions.

Key
A = Harley
B = Kainara
C = Monkey
D = Xuan Xuan
E = Bodo
F = Eclipse

Blue indicates a male, red indicates a female.

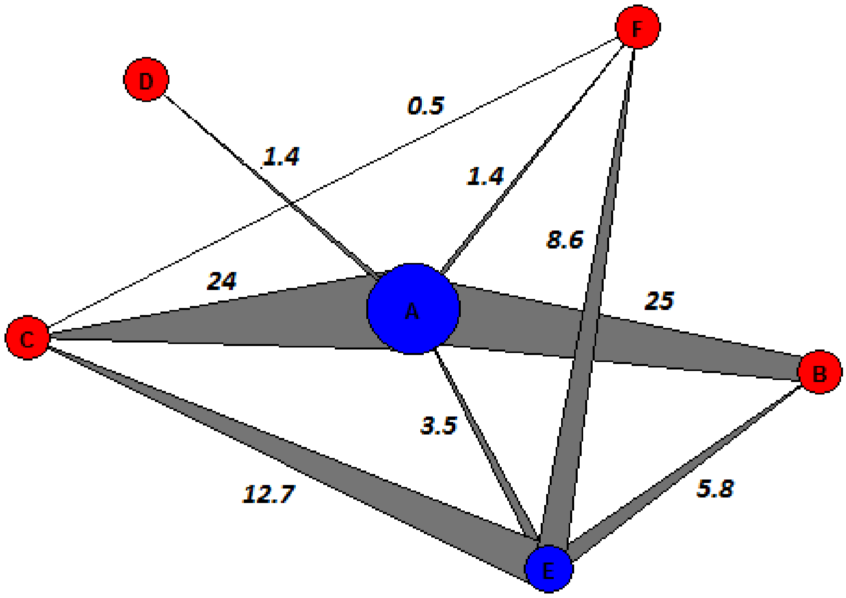

Figure 7: A sociogram of strengths of association between House 5 individuals.

In House 6, there are a number of associations between individuals (Fig. 8), the most sociable being Paddy and Ricardo [male-male] socialising for 24.7% of the time, Pearl and Squash [female-female] for 19.1%, followed shortly by Mandela and Stardust [male-male] for 18.7%. Mandela is responsible for initiating positive social behaviour with the highest number of individuals. The interactions comprise of eleven being same-sex interactions while the other ten are opposite sexes socialising.

Key
A = Quantocks
B = Dick
C = Margeaux
D = Mandela
E = Stardust
F = Weston
G = Pearl
H = Paddy
I = Poe
J = Starlight
K = Ricardo
L = Squash

Blue indicates a male, red indicates a female.

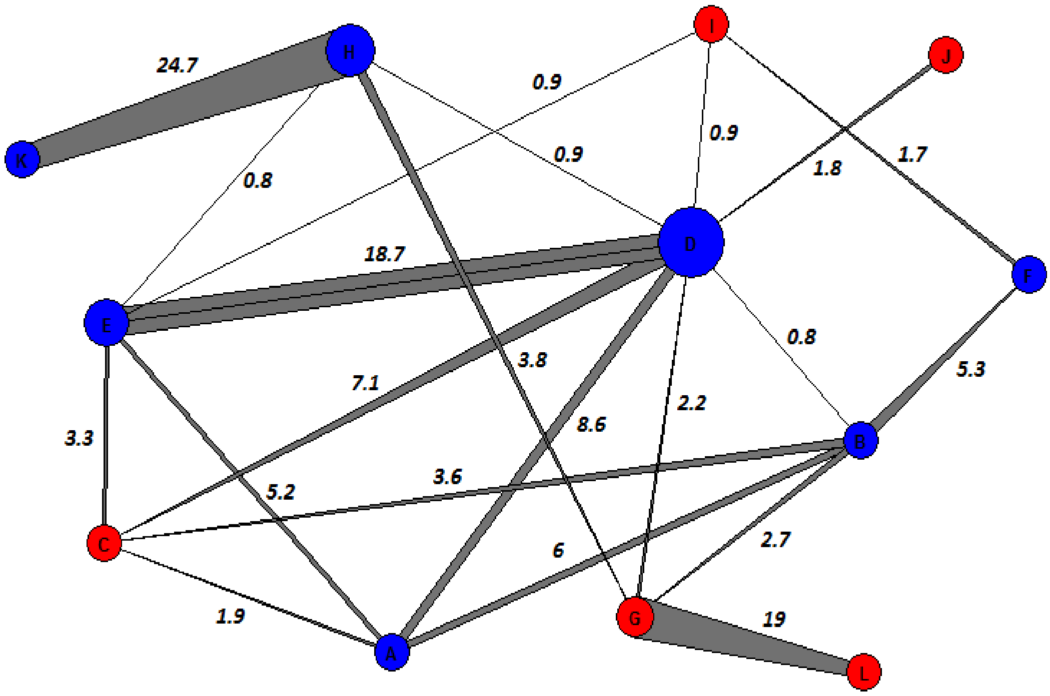

Figure 8: A sociogram of strengths of association between House 6 individuals.

Discussion

In both houses, although aggression did occur, it was in small quantities and not enough to detrimentally affect the group's wellbeing. House 6 had a high quantity of agonistic interactions, likely due to the fact there were more individuals which increased the likelihood of a confrontation. Similarly to incidence of positive interactions, more occurred in House 6 as there were a larger number of individuals present. However, the highest average duration of agonistic behaviour across time periods occurred in House 5, the smaller group, which supports the idea that a larger group size does not necessarily correlate with more aggression between conspecifics.

Regrettably, at this time there is very little literature relating to the social behaviour of bears in captivity. It is, however, quite exhaustive in a number of other species such as primates. Group size has already been shown to influence quantity of play behaviour in a number of studies. In squirrel monkeys, group size influences play by affecting the number and propinquity of potential playmates, and thus playful behaviour is observed more frequently in larger groups as a whole (Baldwin and Baldwin, 1971). In this study, there was a higher duration of positive and negative interactions in House 5 where there was a smaller group of bears, suggesting they are more interactive as a group. However, it showed that though positive interactions in House 5 generally last longer in frequency, there was a higher number of instigators in House 6. This suggests that though social bonds created in House 5 were stronger, there were more social pairs in House 6, likely due to a higher companion choice. This therefore supports the findings of Baldwin and Baldwin (1971). However, given that bears differ greatly from primates, physiologically and in relation to social structure, it is not practical to assume that merely because these studies concur in their findings that all bear groups will have the same results as this study.

Foraging behaviour and food spatiality

The bears exhibited lower frequencies of social behaviours as a whole in the mornings, which coincided with the placement of their morning feed at 9:00am. This is likely due to the fact that almost all bears spent the majority of the first time period foraging for food. Though 'foraging within 1m' was categorised on the ethogram, it appeared that bears still generally preferred to forage alone. Food availability has been seen to have a profound effect on playful behaviour. For example, in a group of squirrel monkeys, social play was almost completely extinguished when the population was free-ranging and food was scarce (Baldwin and Baldwin, 1973; 1974). Hence, food competition is a clear indicator influencing the capacity for social behaviour within a group. Studies with chimpanzees (Kollar et al., 1968; Wilson and Wilson, 1968) found that competition during feeding was one of the prime factors contributing to intragroup aggression, and that presentation and location of the food is critical to reducing the incidence of aggression. Pajetnov and Pajetnov (1998) studied brown bear *(Ursus arctos)* cubs and found that between 3 to 45 days of age, the cubs showed no aggression toward each other and after 60 days of age, aggressive reactions were observed *near food*, including milk bottles, food cups, or natural foods, concluding that this concept does not just apply to primates.

Therefore, it appears that the technique adopted by the centre of spatially placing food as far apart as possible in many different enrichment structures generally encourages the bears to forage away from each other, and thus avoid any possible aggressive encounters related to food. As aforementioned regarding lack of literature, it is difficult to back this hypothesis with previous findings within the species until more research is done. However, though extremely different from bears physiologically, this idea is supported by a study observing southern rock lobster (*Jasus edwardsii*), where agonistic behaviours were rarely observed in fish where food was more freely available (Thomas et al., 2003) as well as in alcids (Duffy, 1987). Much like previously in relation to primates, it should be understood that more studies should be done with similar bear species to gain a better understanding, as the differences between bears, crustaceans and primates are without a doubt vast.

Medication

The lack of sociality between 10:30am-12:00pm could be due to the large variety of medications most of the bear participants were prescribed to for their health and welfare. As previously described, a large proportion of the bears in this study were taking pain relief medication, the side effects of which can be fatigue or drowsiness (Karaman, 2015), leading to very low activity levels for a majority of bears for the first part of the morning.

Males vs. females

Almost all aggressive encounters which occurred in House 5 were between two females and often occurred when one of the males was interacting with another female. This is likely due to competition for affection and companionship from males, leading to an increase in aggression between females. This has been observed in prairie vole (*Microtus ochrogaster)* colonies where female-female aggression increased and associative behaviour declined massively 8-12 days after male cohabitation (Bowler et al., 2002). Therefore, social experiences associated with long-lasting cohabitation with a male assists the induction of female-female aggression (Bowler et al., 2002). Female aggression also increases after exposure to males in bank voles (*Clethrionomys glareolus*) (Marchlewska-Koj et al., 1989; Kapusta and Marchlewska-Koj, 1998), suggesting that if the behaviour has been observed in a number of rodent species it may apply to other mammalian species. More studies looking at larger mammals would be required if a strong connection is to be made.

In other words, it is possible to suggest that negative encounters are more likely to occur in same-sex pairings. In House 5, females were often very aggressive toward each other, yet would not engage in belligerent behaviour when socialising with a male. The same applies to House 6 with males, whereby dominant males, often fought against each other but would not appear hostile toward a female. This behaviour, reliant on the presence of another sex, has been seen in studies using rat colonies; in one example of an all-male colony, there was a low mortality, but in a mixed colony, the mortality rate was much higher (Barnett, 2009). Extra fighting between males within the colony was said to resemble displacement behaviour due to induced excitement and frustration from the presence of females (Barnett, 2009). It appears that within their sexes, the bears are generally similar in their frequency of initiating positive behaviour; Harley and Bodo both carried out the same behavioural patterns on a daily basis when it came to enticing females. This was mirrored in how females in House 5 acted similarly when vying for males' affections. Competition for social contact, particularly sexual attraction has been observed in brown bears *(Ursus arctos),* predominantly in groups of three or more (Montaudouin and Pape, 2005). Consequently, though this competition has been viewed in other bear species, it does not necessarily have to lead to excessive aggression if the correct parameters are put into place, such as spacious exhibits that allow subordinates to hide or escape, or high food availability and spatiality, as aforementioned in this study.

The sociograms show that companionship was more common between different-sex pairings in House 5, with two associations being same-sex while the other seven are all male-female associations. This has been seen in chimpanzees and it was thought that females may forgo intrasexual competition to engage in affiliative interactions with males or that females may groom males more often because relationships with males are seen as more valuable (Kahlenberg et al., 2008). When applied to this study, it could be especially true for the bears in House 6 where the associations were more common as well as evenly spread. Associative relationships were strong between males in House 6, however one of the strongest indexes of association was between two females, Pearl and Squash. Their affiliation was the most intriguing of all relationships in the houses, due to the fact that under observation, Squash had a very protective nature over Pearl. This protective companionship between females has not been reported much in current scientific literature in neither wild nor captive animals. This deficit is likely due to the fact that across many species, even in a captive setting where females are forced into close proximity, female-female interactions seem far less common and dramatic as those between males and thus, the concept as a whole has received less attention (Baker and Smuts, 1996). Therefore an improvement on this study could look particularly at same-sex dyads, predominantly females, and the basis behind why these close relationships occur.

Aggression

The frequency of positive interactions was ultimately observed in much longer duration compared to negative. Initially, this should suggest it is more beneficial to house bears in larger groups, however any aggressive behaviour was much more short-lived and rarely lasted over a few minutes. This is because either the bears consciously ended the fight themselves with one of them backing down or running away or because it was mediated by staff that intervened in order to end the encounter if it became too prolonged or hostile. The fact that these short aggressive encounters still occur in groups in captivity is likely beneficial to the group in order to maintain dominance hierarchy as well as stabilising relationships. Aggression is a natural behaviour in animals and therefore if carried out in quantities which do not invoke lasting psychological or physical harm to the receiving individual, should be permitted to provide the animals with as natural a life as possible as to what they would experience in the wild.

Both houses have high frequencies of negative behaviour between 3:00pm-4:30pm, likely due to it being close to afternoon recall at 4:30pm when they were to be fed. Many bears exhibited pacing behaviour at the gates, resulting in the bears aggregating in one area of the enclosure, leading to an increased amount of contact and ultimately, aggression. These behaviours have been found commonly in the literature with a number of studies stating that social structure of animal populations may change when space becomes limited (Price, 1999; Schradin, 2013). Butler (1980) reported that in wild house mice (*Mus musculus*), the social organization alters from territoriality to what more closely resembles a dominance hierarchy if space is significantly reduced. The incapability of subordinates to escape from more dominant individuals may result in the formation of more highly polarized social hierarchies than if the animal had space to retreat. Therefore even though the enclosure is of adequate size normally, prior to feeding time when the bears become concentrated in a small area, aggression increases. This is coupled with the anticipation of food, also likely affecting each bear's behaviour.

Limitations

Unfortunately, the bears at this centre are not necessarily representative of the entire Asiatic black bear *(Ursus thibetanus)* species due to the vast psychological damage the majority of them have endured. Because of this, their behaviour is very likely to have been affected and thus they do not act in the same manner as others of the species. Therefore, in order to gain a better insight into the requirements of this species in captivity, more studies will need to be done in different environments taking other factors into account. More study sites, more individuals as well as more observations are all improvements which could be made to achieve a greater understanding in this field of study.

Conclusion

In conclusion, this study adds to the growing consensus in the literature that regardless of an animal's social nature in the wild, it is likely beneficial for the animal to live in social groups. Definitively, animals exhibit more playful behaviour in captivity compared to their wild counterparts, possibly due to a reversion to a more infantile state, as in captivity almost all of an animal's needed are catered for (Fagen, 1981). Social play in adult captive animals also likely provides the ability for them to maintain a healthy physical condition in an environment where opportunities to expend energy, such as when fleeing a predator or searching for food, are deficient (Fagen, 1981). Therefore it can be deduced that generally, the benefits of having fellow conspecifics to socialise with far outweigh the costs of minor aggressive encounters that can occur in captive conditions for whatever cause.

It appears that a number of factors do indeed affect the incidence of positive and agonistic behaviour in a group of captive bears, but that at least for the bears at this centre, the benefits of living in a group are far greater than that of keeping them isolated.

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