Research article

A preliminary study of the effects of enrichment tools on stereotypic behavior in captive Sun Bear (*Helarctos malayanus*)

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Abstract

The stereotypic behaviors are common in captive bear. The objectives of study were to investigate 1) the effects of new enrichment tools on frequency of hand sucking/licking (HS) and pacing in captive sun bear; 2) the response of sun bear to each new enrichment tool. The data collection was divided into 5 parts: 1) before using enrichment 2) using puzzle feeder (PF) 3) using bamboo cradle) (BC) 4) using container (C) and 5) without using any new enrichment tool. The results showed that the frequency of HS in sun bear was not significantly affected by new enrichment tools (P>0.05). The lowest frequency of pacing was found after using new enrichment tools (P<0.001). However, it was not significantly different between before and after using new enrichment tools. The frequency of pacing using PF was lower than that of using BC and C. The highest duration of response to the new enrichment tool was in PF (P=0.002). In conclusion, using new enrichment tools could not significantly reduce the frequency of hand-sucking/licking in captive sun bear. However, it could stimuli the frequency of pacing in sun bear. The captive sun bear would be more interested in the edible enrichment tool, which could reduce the frequency of pacing compared with using other types of enrichment tools. Therefore, it is necessary to conduct a long-term experimental enrichment tool using program in the future study.

Keywords: Enrichment, Hand sucking/licking, Pacing, Stereotypic, Sun bear *(Helarctos malayanus)*

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INTRODUCTION

The sun bear (*Helarctos malayanus*) which is the smallest of the world's bear species, occurs throughout South-east Asia (Krishnasamy and Shepherd, 2014). It is classified as vulnerable by IUCN (Scotson et al., 2017) as the large-scale deforestation that has occurred throughout Southeast Asia over the past three decades has dramatically reduced suitable habitat for the sun bear (Thai National Park, 2021). Stereotypic behaviors are the most common behavioral abnormalities in captive bears all over the world (Shih et al., 2016). The 48%-100% of Ursidae family was found to exhibit stereotypic behaviors (Mason et al., 2007), which is a repeated, relatively invariant sequence of movements with no obvious function (reviewed by Huo et al., 2021). The stereotypic behaviors are thought to be a consequence of suboptimal environmental or housing conditions in captivity, including pacing, begging and hand sucking (reviewed by Izzat-Husna et al., 2021).

Garner (1999) claimed that a bear's stereotypy frequency did not predict its level of compulsive or repetitive self-sucking behavior, which suggested that different motivations and/or processes may underlie these different abnormal. It was found that the locomotor stereotypies to be significantly more prevalent than oral or other forms of stereotypy in sun bears, with pacing being the most common (Vickery and Mason, 2003; Perdue, 2016; Lewis et al., 2017). Therefore, the various enrichment methods and experimental designs for environmental enrichment have been performed to stimulate and encourage active and exploitative bear behavior (Izzat-Husna et al., 2021), as changing to zoo habitats that provide animals with opportunities to perform behaviors important for their physiological and psychological well-being (Young, 2003; Swaisgood and Shepherdson, 2005).

Experimental enrichment programs have been shown that improving the captive environment alleviates the occurrence and frequency of behavioral anomalies and stereotypies, reduces fearfulness, and allows the animal to better manage confinement-related stress (Wagman, 2015). Many effective enrichment studies have combined multiple enrichment types, however, this has made it difficult to determine if one type of enrichment is more effective than others (Wagman, 2015). Therefore, a preliminary study was to investigate the effects of new enrichment tools on frequency of hand sucking/licking and pacing in captive sun bear. Moreover, to investigate the response of sun bear to each new enrichment tool. We hypothesized that the new enrichment tools could affect the frequency hand sucking/licking and pacing in captive sun bear. Moreover, the differences in response to enrichment tools existed.

MATERIALS AND METHODS

Animal and housing

A female Sun bear (*Helarctos malayanus*) was born in 2013, body weight 60 kg, housed with another sun bear (was born in 2011, male) together in Nakhon Ratchasima Zoo (Korat Zoo). Both were donated by people. There were a 4 % of body weight of feed were provided for each sun bear total 2.4 kg feed per day. The cage which was used for feeding and resting instead of

showing measured 4×4×3 m (L×W×H), were concrete floored covered by soil, and had 3 walls of bars and 1 of cement and doors. Water was available *ad libitum* and food was provided between 08:30 and 16:30 each day. The research proposal performed was approved by the Research and Conservation Supervisory Committee Zoological Organization of Thailand (document no.1108/1036). The procedures of the experiment were performed followed the guidelines for the ethical use of animals in applied ethology studies (Sherwin et al., 2003). The experiment was conducted from August to October 2017.

New enrichment tools

The original enrichment tools (blue feed bucket and swing, see Figure 1) were kept using. The new enrichment tools (Figure 2) which were not applied for those sun bears before were puzzle feeder (PF) which was the external physical accessories (Young, 2003); bamboo crib (BC) and container (C) which were the temporary internal physical accessories (Young, 2003). The PF was 4 inches wide, 22 cm length. There were 3 holes drilled in each feeder, the diameter of hole was 1 cm. The PF was filled 250 g pellet feed. There were four PF used in this study. Total pellet feed was 1 kg per day during experimental week. The BC was made by 15 pieces 120 cm length bamboo fixed by rope. Two containers (C) for sitting which were made of water tank (45cm height, 55 cm in diameter), tied to the cage.

Figure 1 The original enrichment tools (blue feed bucket and swing) for sun bears.

Figure 2 The new enrichment tools. (A) Puzzle feeder (PF); (B) Bamboo crib (BC); (C) Container (C).

Data collection

According to the ethogram by Izzat-Husna et al. (2021), the definition of hand sucking /licking means repetitively sucking or licking own hands. The pacing means continuously walking repetitively back and forth (at least three times). The focal behavioral observation (hand sucking/licking and pacing) was conducted in 5 weeks. The response to each enrichment tool means that the animal was using or investigating it. In the 1st weeks (Before), it was before using new enrichment tools. The new enrichment tools such as puzzle feeders (PF) were used in the 2nd week. The bamboo crib (BC) was used in the 3rd week. The containers (C) were used in the 4th week. In the 5th week (After), there was no new enrichment tools used. The observation period lasted three continuous days per week (Friday, Saturday and Sunday) from 09:00 to 11:45 and 13:00 to 15:45. The sun bears were not trained to use all the new enrichment tools in this premilitary study before data collection.

There were two researchers to collect the behavioral data. The data collection of 240 min in hand sucking/licking was 10 minutes with 5 minutes intervals from 09.00 to 11:45 (12 times data collection: 120min) and 13:00 to 15.45 (12 times data collection: 120min) by researcher A who recorded the frequency and duration of hand sucking and licking.

The video of pacing was taken by researcher B using smartphone (iPhone). The data collection of 120 min in pacing was 10 minutes with 20 minutes intervals during 09.00 to 11:45 (6 times data collection: 60min) and 13:00 to 15.45 (6 times data collection: 60min). At the meantime, the frequency and duration of response to the new enrichment tools were recorded by researcher B.

The SPSS software (version 23.0; SPSS Inc.; Chicago, IL, USA) was used for the statistical analysis. The frequency of hand sucking/licking behaviors and pacing, and the response to each new enrichment tool were analyzed by using ANOVA for a completely randomized design with three replicates (observed three days per week) per treatment. Means were compared by using Duncan's multiple-range test and the significance was determined at $P<0.05$.

RESULTS

The hand sucking/licking

The behavioral observation results showed that the frequency of hand sucking/licking of sun bear before using the new enrichment tools was 26.67 (Table 1), which was higher than using other treatments, however without any significantly different (P>0.05). When using three kinds of new enrichment tools (Figure 2), the frequency of hand sucking/licking of sun bear was reduced compared before and after using new enrichment tools (Table 1). The lowest frequency of sucking/licking of sun bear using BC was 6.67. However, the results of the frequency of sucking/licking were not significantly different (P>0.05) compared within three kinds of new enrichment tools.

Table 1 The effects of new enrichment tools on frequency of hand sucking/licking and pacing of sun bear.

Treatment	Hand sucking/licking (times)	Pacing (times)
Before	26.67±8.99	85.00±5.29[ab]
PF	17.00±5.50	140.67±27.91[b]
BC	6.67±3.53	325.33±21.23[c]
C	14.33±5.78	325.67±21.23[c]
After	14.00±6.25	54.00±20.21[a]
P value	ns	<0.001

Values are presented as Mean ± Standard error (SE). ns means not significantly different.
Before: before using any new enrichment tools. PF means using puzzle feeder, BC means using bamboo crib, C means using containers, and After means without using any new enrichment tools.
[a, b, c] means within the same column with different superscripts were significantly different at P<0.05

Pacing

The treatment significantly affected the frequency of pacing in sun bear during 120 min observation (P<0.001, df=4, F=28.68). The lowest frequency of pacing was found after using new enrichment tools. However, it was not significant different between before and after using new enrichment tools. During using new enrichment tools, the frequency of pacing using PF was lower than that of using BC and C. The frequency of pacing was not significant different between using BC and C (Table 1).

The response to new enrichment tools

Figure 3 showed the response of using new enrichment tools by sun bear. The duration of response to each new enrichment tool was showed that the highest duration of response to the new enrichment tool was in PF (P=0.002, df=2, F=19.12) (Table 2). There was no significant difference of response duration in using BC and C (P>0.05). The new enrichment tools did not affect the frequency of response of using each new enrichment tool (P>0.05).
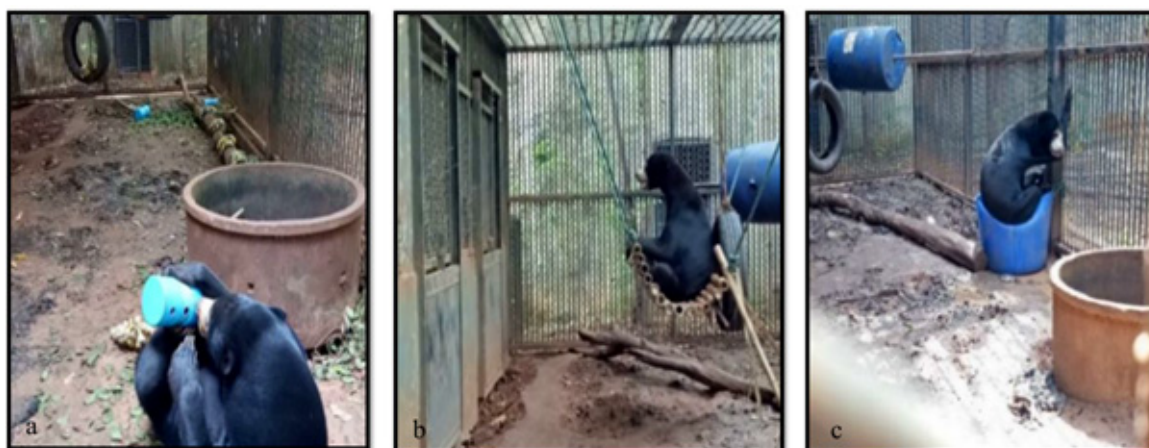
Figure 3 New enrichment tools using by sun bear. (a) Puzzle feeder (PF); (b) Bamboo crib (BC); (c) Container (C).

Table 1 The effects of using new enrichment tools on the frequency and duration of response to enrichment tools in total 240 min observation.

Treatment	Duration (mins)	Frequency (times)
PF	787.33±133.66[b]	12.33±3.53
BC	67.33±52.60[a]	6.33±3.76
C	172.33±55.69[a]	10.67±4.41
P value	0.002	ns

Values are presented as Mean ± Standard error (SE). PF means using puzzle feeder, BC means using bamboo crib, C means using containers. ns means not significantly different.
[a,b,c] means within the same column with different superscripts were significantly different at P<0.05

DISCUSSION

The hand sucking/licking

The stereotypies develop over a period of time rather than being immediate responses to the eliciting situation, has been taken by some as indicating that they are learnt, reinforced, behavior patterns (reviewed by Mason, 1991). Our study focused on a female captive sun bear who had performed stereotypic behaviors such as hand sucking/licking and pacing in the enclosure (not in the exhibit area) of Korat Zoo. Although using enrichment tools could reduce the frequency of hand sucking/licking in sun bear, there was no significant difference. Therefore, it was important to understand the underlying causes of a stereotypy to treat it, and to reduce such behaviors in the long term (Vickery and Mason, 2004).

We agreed with Mason and Latham (2004) suggest that the enrichments that do not immediately reduce stereotypies should not be assumed failures with respect to welfare. Moreover, it is necessary to understand the motivation of stereotypies rather than aim to reduce it. The main cause of hand sucking/licking in our female sun bear might be due to it did not stay with mother after birth (explained by keeper from Korat Zoo). It was consistent with the report of the Bornean Sun Bear Conservation Centre (BSBCC) in 2009

showed that most captive sun bears were being captured by poachers and separated with the mother when they were at very young age. Anyway, these baby bears grow up without mother and without a chance to suckle. However, suckling is an innate behavior. When the cub is hungry or feel uncomfortable, they suckle their mother's breast. For these poor captive bears, they do not have their mother around, but the urge to suckle is very strong. So, they learn to suckle on something handy. Therefore, the hand sucking/licking behavior in this sun bear could be a 'need' to relieve anxiety (Mason, 1991), which may act as a coping mechanism (Lewis et al., 2017).

Pacing

Pacing behavior is complex and identifying the motivational basis for pacing and designing an effective remedial strategy can be challenging (Rog et al., 2015). Our results showed that the stereotypic pacing of sun bear might be stimulated by using new enrichment tools, which might be related on exposure to a novel object (reviewed by Mason, 1991). Perdue (2016) also found that there was a significant increase in stereotypic pacing for one sun bear after the introduction of the computer. There might be other possibilities such as the stereotypies of some captive animals develop from what appear to be intention movements of escape. Pacing may also arise from thwarted intention movements of approach to conspecifics (reviewed by Mason, 1991). However, in our study we did not test the interaction between two sun bears, the further study might be needed.

In their natural habitat, sun bears move around eight km for foraging in one day (reviewed by Watiniasih and Rohmah, 2019). Our results showed that using PF could reduce the stereotypic pacing, compared with using other types of new enrichment tools. Because of hiding the feed significantly reduced stereotypic pacing from 125 min/day under standard condition to a median of 20 min/day (Carlstead et al., 1991). Therefore, give the animal the opportunity to perform other behavior patterns such as foraging behavior by using PF in order to slow, reduce or eliminate stereotypy (reviewed by Mason, 1991).

The response to enrichment tools

The high frequency and duration of response to PF was found. It might because feeding enrichment related feeding or foraging motivation (Vickery and Mason, 2004). Moreover, the nonedible items are not useful for enrichment purposes when horses are appropriately reared (reviewed by Huo et al., 2021). During the observation, the female sun bear did not often get chance to use BC when the male sun bear using, therefore, BC might be needed to add one more, in order to let every sun bear has equal change to use it. Huo et al. (2021) found that the different reactions to enrichment items occurred between stereotypic and non-stereotypic horses. Unfortunately, this study focused on a single bear, we did not compare the time budget between stereotypic and non-stereotypic sun bear, the future study should be needed. Although the established stereotypies typically are more difficult to alleviate by environmental enrichment (reviewed by Vickery and Mason, 2004), investigated the response to each enrichment tools of sun bear could be an effective way to understand how the enrichment tools work to the animals. Coe had defined 3-Cs: competence, collaboration and choice to support the idea

which was environmental and behavioral enrichment are strategies integrated into facility design, display and husbandry for developing, expressing, displaying and perpetuating captive animals' innate and learned competence to prosper (Con, 2009). Our premilitary study focused on the effects of each new enrichment tools on the frequency of hand sucking/licking and pacing in captive sun bear. It could be conducted the enrichment tools choices or preference test for the animals to improve their wellbeing in the zoo animal enrichment project, moreover, to assess animal the decision making and problem-solving ability, finally, to improve the competence for reintroduction to appropriate natural environments.

CONCLUSIONS

Although using new enrichment tools could not significantly reduce the frequency of hand-sucking/licking in captive sun bear, it was important to understand the cause of hand-sucking/licking in captive sun bear. The new enrichment tools could stimuli the frequency of pacing in sun bear. However, the captive sun bear would be more interested in the edible enrichment tool. Using the edible enrichment tool could reduce the frequency of pacing compared with using other types of enrichment tools. Therefore, it is necessary to conduct a long-term experimental new enrichment tool using program in the future study.

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AUTHOR CONTRIBUTIONS

Xin Huo: Conceptualization, Methodology, Project administration, Software, Writing original draft, Writing-Review & Editing, Supervision. Khwanchanok Ongpimai and Supattra Kamwongpanao: Resources, Investigation, Data curation. Tanat Uttaraviset, Wirongrong Changphet and Pariyakorn Lekthong: Resources, Investigation.

CONFLICT OF INTEREST

The author declare no conflicts of interests.

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