

The Effect of Environmental Enrichment on Sun Bear (*Herlarctos malayanus*) Behaviour in Captivity

(Kesan Pengayaan Alam Sekitar terhadap Tingkah Laku Beruang Madu (*Herlarctos malayanus*) dalam Kurungan)

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ABSTRACT

One of the main concerns for animals kept in captivity is expression of stereotypic behaviour which could indicate stress in the animals. To ensure the welfare of animals are adequate for conservation and to promote species specific behaviour that similar to those in the wild, most of zoos are implementing environmental enrichment. The effect of environmental enrichment on behavioural changes was studied in seven captive sun bears kept in an enclosure at Zoo Negara, Kuala Lumpur, Malaysia. Bear behaviours are divided into three categories: Active, passive, and abnormal behavioural. The study involved three period: baseline, enrichment, and post-enrichment period. The activity budget was recorded as a single animal scan. A total of 210 h of baseline data was collected over 36 weeks at varying times of days. Three different environment enrichment tools were used; buoy with dog food, hidden fruit mixed with honey, and gunny sack filled with cinnamon powder. They were installed in the enclosures for 10 consecutive days on a rotational basis. Both enrichment and post-enrichment observations were done for 210 h using the same methods as in baseline sampling. Baseline data showed greater passive and abnormal behaviours than active behaviour. With the introduction of the enrichment tools, the sun bears displayed decreased passive and abnormal behaviours with an increment of active behaviour. For post-enrichment period, there was no significant difference when compared with the baseline between all behavioural categories. Among three enrichment tools, hidden fruit mixed with honey was the most preferred enrichment followed by buoy filled with dog food and gunnysack with cinnamon powder. It is suggested that food-based enrichment should be lasting until evening for the sun bear to engaged longer to the enrichment. Although less preferred, cinnamon powder introduction as sensory enrichment was recommended as well. However, it is crucial to ensure that the cinnamon's odour lasting until late evening, where the bears are ready to enter their night den. It can be concluded that the application of various enrichment tools may help to alleviate abnormal behaviour in captive bears.

Keywords: Environmental enrichment; sun bear; zoo behaviour

ABSTRAK

Salah satu kebimbangan bagi haiwan yang ditempatkan di dalam kurungan ialah ekspresi kelakuan stereotip yang boleh menyebabkan tekanan pada haiwan tersebut. Untuk memastikan kebajikan haiwan sesuai untuk pemuliharaan dan untuk membentuk kelakuan khusus spesies yang sama dengan haiwan di kawasan liar, kebanyakan zoo menjalankan pengayaan persekitaran. Kajian ke atas kesan pengayaan persekitaran pada perubahan kelakuan telah dijalankan ke atas tujuh ekor beruang madu yang diletak di Zoo Negara, Kuala Lumpur, Malaysia. Kelakuan beruang dibahagi kepada kelakuan aktif, kelakuan pasif dan kelakuan abnormal. Kajian ini melibatkan tiga tempoh; tempoh garis dasar, tempoh pengayaan dan tempoh fasa selepas pengayaan. Peruntukan aktiviti harian telah direkodkan sebagai cerapan haiwan tunggal. Sejumlah 210 jam data dasar telah dikumpul selama 36 minggu pada masa dan hari yang berbeza. Tiga peralatan pengayaan persekitaran yang berbeza telah digunakan; pelampung bola berisi makanan anjing, buah-buahan bercampur madu disembunyikan di sekitar kawasan pameran dan guni berisi serbuk kayu manis. Kesemua peralatan

ini telah dimasukkan ke dalam kawasan pameran selama 10 hari berturut-turut mengikut giliran. Pemerhatian fasa selepas pengayaan dilakukan selama 210 jam menggunakan kaedah yang sama dengan persampelan dasar. Dengan pengenalan kepada peralatan pengayaan, beruang madu menunjukkan penurunan pada kelakuan pasif dan abnormal dengan kenaikan pada kelakuan aktif. Untuk fasa persampelan selepas pengayaan, tidak terdapat perbezaan bererti apabila dibezakan dengan fasa dasar antara semua kategori kelakuan. Antara tiga peralatan pengayaan, buah bercampur madu yang disembunyikan merupakan pengayaan yang paling diminati diikuti oleh pelampung bola berisi makanan anjing dan guni berisi serbuk kayu manis. Adalah dicadangkan agar pengayaan makanan seharusnya bertahan sehingga ke lewat petang untuk beruang madu terikat lebih lama dengan pengayaan ini. Walaupun kurang digemari, pengenalan serbuk kayu manis sebagai pengayaan deria juga dicadangkan. Walau bagaimanapun, adalah penting untuk memastikan bau kayu manis kekal sehingga lewat petang apabila beruang bersedia untuk memasuki kurungan tempat bermalam. Dapat disimpulkan bahawa aplikasi pelbagai peralatan pengayaan boleh membantu meringankan kelakuan abnormal pada beruang dalam kurungan.

Kata kunci: Beruang madu; kelakuan zoo; pengayaan persekitaran

INTRODUCTION

Keeping animals in captivity such as in a zoo is one of the widely accepted approaches in the conservation and management of threatened species. These animals will receive veterinary care and free from starvation and predation (Clubb & Mason 2007). Various studies on different animal species indicated that fecundity and survival rates are generally higher in captivity than wild populations (Lahdenperä et al. 2018; Robeck et al. 2015). However, captive animals live in an environment that is totally different from their original habitat (McPhee & Carlstead 2010). For many captive wild species, numerous difficulties exist. One of the main concerns for animals kept in captivity is abnormal behaviour expression such as stereotypic behaviour. It can be one of the indicators of poor animal welfare and often a sign of decreased welfare in an animal (Wolfensohn et al. 2018) as their choice to express natural behaviour has become limited (Clubb & Mason 2007). A comparative study on behaviour between captive and semi-captive sun bear in Sabah showed that captive sun bears exhibited higher stereotypic behaviour compared to semi-captive sun bears (Abdul-Mawah et al. 2021).

Most of the bear species, such as sun bear kept in captivity exhibited abnormal behaviour due to many factors including the size of the enclosure (Berghammer 2008; Tan et al. 2013), barren or unexciting environment (Carlstead & Shepherson 2000; Morgan & Tromborg 2007) and no opportunity for exploration and foraging inside the exhibit (Carlstead & Shepherson 2000; McPhee & Carlstead 2010). Apart from that, anticipatory behaviour towards the bear keeper has also increased the stereotypic behaviour in cubs' sun bear (Izzat-Husna et al. 2021). The issue has received much attention

from the zoo animals' behaviour literature over several decades (Abdul-Mawah et al. 2021; Izzat-Husna et al. 2021; Shepherdson et al. 2013; Tan et al. 2013; Vickery & Mason 2005). Restrictions in the ability to perform normal species-specific behaviours may lead to stress and frustration and detrimental to their welfare. This is often manifested as alterations to behavioural patterns, such as the development of stereotypical behaviours (Mason et al. 2007).

In order to ensure the success of welfare and occupational engagement of animals for conservation and breeding animals in captivity, most zoos are implementing environmental enrichment (Veeraselvam et al. 2013). Environmental enrichment is defined as 'the provision of stimuli that promote the expression of species-appropriate behavioural and mental activities under stimulating environment' (Reinhardt & Reinhardt 1998).

Environmental enrichment is widely used to enhance the quality of life for animals in captivity by providing stimuli necessary for psychological, physiological, and behavioural well-being (Swaisgood & Shepherdson 2005). The ultimate goal of environmental enrichment is to improve the 'quality of life' of the animals by meeting their physiological and psychological needs (Kuczaj et al. 2002). The use of environmental enrichment simultaneously reduces the stereotypic and abnormal repetitive behaviours and enhances the well-being of zoo animals (Carlstead et al. 1991; Kuczaj et al. 2002; Mason et al. 2007). Many forms of enrichment programmes have been utilised and tested according to species and situations that show positive results. For example, a study on the effect of computerised testing on sun bear behaviour in captivity (Perdue 2016) found

that sun bear preferred interacting with touchscreens than other forms of enrichment. Another study on the environmental enrichment for the captive spectacled bear (Renner & Lussier 2002) shows reduced pacing with the introduction of enrichment such as ice block. Meanwhile, a study on captive sloth bears' behaviour using various environmental enrichment tools (Veeraselvam et al. 2013) found that abnormal behaviour reduced when the bear was introduced to enrichment tools, such as honey logs. Many studies also showed that environmental enrichment variability could stimulate natural behaviour and prevent animals from expressing abnormal behaviour such as stereotypical behaviour.

Therefore, the purpose of this study was to determine the effectiveness of environmental enrichment with various types of a model, such as food, occupational, and sensory enrichment, on the behavioural activity patterns of sun bear in National Zoo, Kuala Lumpur, Malaysia. It is predicted that the introduction of this enrichment will reduce stereotypic behaviour, such as pacing in the bear.

MATERIALS AND METHODS

ETHICAL APPROVAL

The protocol used in this study was approved by the Institutional Animal Care and Use Committee of Universiti Malaya with the reference no of S/03022020/06122019-01/R.

SUBJECTS

The observation was carried out on two adult males, two adult females, two juvenile males and one juvenile female sun bear housed in National Zoo, Kuala Lumpur, Malaysia. Based on the records, the bears' ages were approximately four to 25 years. Most of the animals were donated by the public while some were adopted as a pet, and some were rescued from the wild. The bears were housed in separate cages when the zoo is closed and released into the enclosure each morning at 0900 h. There were two enclosures; the first enclosure holds three bears, and the second enclosure holds four bears. The management routine included the delivery of the primary daily feeding in the cages twice daily, early morning at 0700 to 0800 h, and at the end of the day at 1700 h, and thus ensuing the bears to enter the cages voluntarily when the cage doors were opened in the late afternoon at 1630 h.

PROCEDURES

Preliminary observations were conducted on all seven bears in the enclosures to develop an ethogram (Table 1), which was adapted from Stokes (2014) and Veeraelvam et al. (2013) using *ad libitum* sampling. This was done a day before the scan sampling was conducted from morning to evening. All bears exhibited between 0900-1600 h daily were studied. The types of behaviour were group into three categories: active, passive, and abnormal behaviours. The activity budget was recorded as a single animal scan (Altmann 1974).

For baseline behavioural data, instantaneous scan sampling was conducted at 5 min intervals to record all individual activity data in two 3 h segments every day, each at 0900-1200 and 1300-1600 h segment times. Focal individual sampling was conducted for 20 min in the morning and afternoon session to continuously record each bear's behaviour, frequencies, and duration of each behaviour throughout the observation duration. In this focal sampling, each of the individuals was sampled once before second observation being conducted on the same individual in same day (Amato et al. 2013). A total of 210 h baseline behavioural data was collected over approximately 36 weeks at different times of the day.

All enrichment tools were installed in the outdoor enclosures on a rotational basis for ten consecutive days for each enrichment tool; whereby every morning the enrichment tools were placed in the exhibit area before the bears were sent out. Each tool, namely buoys filled with dog food (occupational enrichment), fruits mixed with honey, scattered visibly, and hidden around the enclosure (food enrichment), and gunny sack filled with cinnamon powder (sensory enrichment) was installed randomly in various locations. The occupational and sensory enrichments tools used in this study were following enrichment programme conducted in Bornean Sun Bear Conservation Centre, Sandakan, Sabah (Yvonne 2019). Cinnamon was used as a scent track as it always succeeds according to the experience of a sun bear keeper in Cologne Zoo (Schneider et al. 2014). Data were collected for 210 h (30 days), using the same method for baseline behavioural data collection during the enrichment period. All enrichment materials were refilled daily. Post-enrichment data were collected after all the enrichment tools were removed from both enclosures. Data were collected for 210 h using the same methods as those for baseline data.

To avoid missing of any important data during observation, behavioural data for each selected bear

was also recorded via videotape throughout the study period while the observation for continuous focal was conducted (Shepherdson et al. 2013; Stokes 2014; Vickery & Mason 2005).

Kruskal-Wallis test analysis was used to evaluate the differences in time spent in behavioural categories

of baseline, enrichment, and post-enrichment. Kruskal-Wallis test was also performed to analyze the differences in times utilized on each enrichment tool. To observe the exploratory and abnormal behaviour between baseline and enrichment period in all age-sex group, Mann-Whitney U test was used. For all tests, a value of $P < 0.05$ was considered significant.

TABLE 1. An Ethogram for the categories of active, passive, and abnormal behaviours in the sun bear captivity study

Active behaviour	
Activities	Description
*Exploring	Searching for objects inside the enclosure such as stones, dead branches, and artificial objects
Locomotion	Moving from one location to another inside the enclosure bipedally or quadrupedally in the low-speed movement without sniffing the ground horizontally
Climbing	Actively moving in a vertical motion either ascending or descending movements typically associated with arboreal movements
Digging	Breaking up soil or making a hole on the ground with its paws and claw
Social	Interacting or engaging with another bear, including touching, chasing, playing, allo-grooming, and non-aggressive wrestling/fighting
*Solitary	Playing all by itself with inanimate objects inside its enclosure
Foraging	Actively searching for food items; feeding on edible material, drinking water
Auto-grooming	Physical hygiene including cleaning body parts with its mouth and paws, scratches, licking, rubbing, examining its body parts
Passive behaviour	
Activities	Description
Resting	Non-locomotion behavior (sits or lies, stationary with eyes open)
Sleeping	Sits or lies, stationary with eyes close
*Alert	Bear lies, sit, and stand with head up and eyes open and responds to any stimuli
Elimination	Urinating or defecating
Abnormal behaviour (Stereotypic behaviour)	
Activities	Description
Pacing	Bear moving in the same path repetitively (left to right, right to left), stepping forward and backward without turning the body)
*Head tossing	Moving the head up and down
Swaying	Rocking of the head from side to side continuously
Head throwing	Throwing head back and over a shoulder during locomotion
Allo-sucking	Repetitive sucking of a part of conspecific's body area
Self-sucking	Repetitive sucking of a part of their own body is often accompanied by a distinct humming vocalization
Begging	Sitting or standing up while looking and staring at humans (bear keepers/visitors) to communicate with them
Circling	Locomotion tracing in circular path

*Modified from Veeraselvam et al. (2013)

RESULTS AND DISCUSSION

In this study, environmental enrichment has shown a significant difference (18.54 ± 0.69 for active behaviour, 7.75 ± 0.38 for passive behaviour and 3.71 ± 0.06 for abnormal behaviour) in the sun bears several behaviours compared to the baseline study. This is supported by studies on the American black bear (*Ursus americanus*) (Carlstead & Seidensticker 1991), captive spectacled bear (*Tremarctos ornatus*) (Renner & Lussier 2002), captive sloth bears (*Melursus ursinus*) (Veeraselvam et al. 2013) and captive sun bears in Cologne Zoo (*Helarctos malayanus*) (Schneider et al. 2014). All these studies showed that environmental enrichment has significantly changed various behavioural categories in the bear species. Izzat-Husna et al. (2021) suggested that the introduction of food or creative enrichment tools can minimize stereotypic behaviour in sun bear. The introduction of environmental enrichment is one of the strategies used by zoos to alleviate or even eliminate animals' stereotypic behaviour (Montaudouin & Le Pape 2004). One way of incorporating environmental enrichment is to increase physical complexity by designing enclosure features, such as natural flora and fauna and artificial features that can stimulate species-specific behaviour (Shepherdson et al. 1998). In the current study, all seven bears entered the enclosure immediately upon release during the enrichment period, rather than remaining at the entrance to their night den, as shown in the baseline period. Pacing in front of the door to the night den, which was predominant for adult females has also reduced significantly after the introduction of enrichment tools. Mason et al. (2007) stated that enrichment could ensure animals perform their natural behaviour in the wild and reduce stereotypic behaviour.

For active behaviour, the mean \pm SE values for each period were 6.99 ± 0.61 (baseline), 18.54 ± 0.69 (enrichment), and 10.54 ± 0.37 (post-enrichment). There was a significant difference ($H=5.3$, $DF = 20$, $P<0.05$) in the enrichment period compared to the baseline and post-enrichment period (Table 2). All bears showed an overall increase in time spent on active behaviour, less time spent on passive behaviour, and less engagement in abnormal behaviour after the introduction of novel enrichment tools in the enclosure. The bears spent more time on active behaviour, such as foraging, exploring, and digging. This finding is corroborated by Carlstead and Seidensticker (1991) in their study on the black bear, study by Veeraselvam et al. (2013) on sloth bears; and

another study by Schneider et al. (2014) on captive sun bear in Cologne Zoo, where all studies found a similar pattern.

For passive behaviour, the mean \pm SE values for baseline, enrichment, and post-enrichment period are 15.51 ± 1.22 , 7.75 ± 0.38 , and 11.70 ± 0.27 , respectively. The results also show significant differences between baseline and enrichment ($H=4.6$, $DF = 20$, $P<0.05$). However, there is no significant difference between baseline and post-enrichment in the mean value (Table 2). For abnormal behaviour, the mean \pm SE values for baseline, enrichment, and post-enrichment period were 10.54 ± 0.37 , 11.70 ± 0.27 , and 7.76 ± 1.67 , respectively. In this behavioural category, the mean value for the enrichment has a significant difference compared to the baseline and enrichment periods ($H = 5.33$, $DF = 20$, $P < 0.05$) (Table 2). Abnormal behaviour engagement has also reduced in all bears during the enrichment period. Renner and Lussier (2002) stated that the introduction of novel enrichments led to a decrease in the previously exhibited stereotypies of a captive spectacled bear (*Tremarctos ornatus*). These changes are evidence of improvements in the welfare of the bears during the enrichment period.

The introduction of the enrichment also generated significant changes in the overall behaviour patterns of the bears at all age-sex level. All bears spent less time in abnormal behaviour and passive behaviour during the enrichment period (Figure 1). Pacing in adult males decreased from 14.17 to 7.56%, 49 to 20% in adult females, 32.67 to 17.76% in juvenile males, and 7.46 to 3.17% in juvenile females. Head tossing also showed a similar pattern, whereby in adult males, the behaviour decreased from 17 to 11.89%, 20 to 17.31% in adult females, 17.76 to 9.46% in juvenile males, and 3.17 to 0% in juvenile female.

Exploratory behaviour has also changed significantly between the baseline and enrichment periods (Figure 2). Specifically, bears performed more exploratory behaviour during enrichment ($30.4 \pm 6.9\%$ overall) than the baseline ($17.6 \pm 4.6\%$ overall) in all age-sex groups. The adult male showed the highest percentages of exploratory behaviour at 35.2%. There was a significant difference in exploratory behaviour between adult males and adult females during the enrichment period compared to the baseline period ($H = 3.05$, $DF = 25$, $P < 0.05$).

The patterns of approach and retreat towards the novel objects can be seen clearly through the videotape

analysis taken during the sampling. The animals had little or no more contact with the objects once they could not extract additional food from the enrichment object.

A total of 110 h were utilized on these enrichment tools cumulatively by all the seven bears (Figure 3). More time were spent on food enrichment (banana and honey dew mixed with honey), i.e., 42.9 h than occupational types of enrichment (buoy filled with dog food), i.e. 36.12 h and sensory type of enrichment (gunny sack filled with cinnamon powder), i.e. 30.98 h. The mean \pm SE values were 4.89 ± 0.02 , 6.01 ± 0.1 and 3.05 ± 0.08 , respectively. No significant disparities were showed in the usage and preferences of these enrichments' tools (Table 3). Out of the three enrichment tools introduced to the bears, food enrichment seems to be preferred by the bears at Zoo Negara. A study on sloth bears (Anderson et al. 2010) showed that the introduction of food enrichment has decreased stereotypic behaviour during the enrichment period and increased exploration post enrichment. Food enrichment, combined with greater feeding and unpredictable feeding time, has also increase foraging activity in black bears (Carlstead et al. 1991). Meanwhile, Wagman et al. (2017) study on food enrichment of four species of bears found that feeding enrichment increased the exploratory behaviour of all studied bears. However, scattering the food items around the enclosure seems not working for captive brown bears as it did not change the bears' behaviour in captivity (Grandia et al. 2001). In this study, since the food enrichment reduced abnormal behaviour in these bears, it is likely that the abnormal behaviour was at least partly driven by frustration because of lacking in foraging opportunities in the enclosure. Food enrichment is important as it can encourage species-typical foraging behaviour; thus,

food treats should be provided in ways that would lead to the animal utilising more time to procure the food provided.

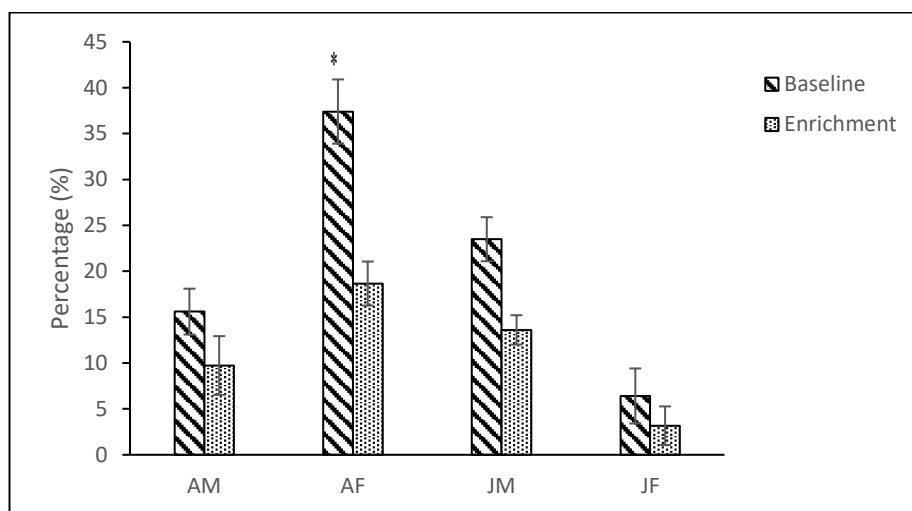
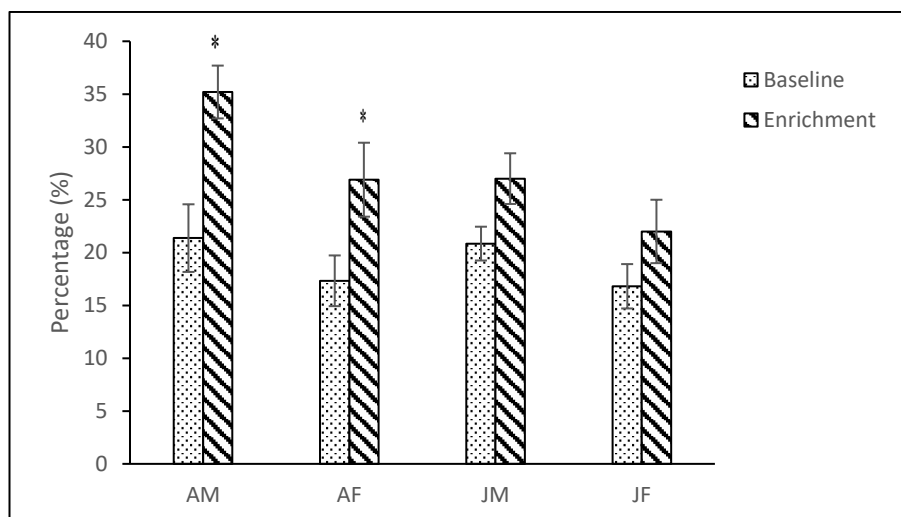
Maple and Perdue (2013) suggested that olfaction is an important sensory mode for many animals' species. Animals can smell an odour from other individuals, even manmade odours, such as cinnamon, vanilla, mint, and tabasco. The sun bear depends on olfactory sense rather than sight to detect food. It has a strong sense of smell for finding and locating honeybees' nests inside trees in the wild. In Zoo Negara, even though sensory enrichment was the least preferred, the sun bears still showed interest in cinnamon powder's odour mixed with dry leaves placed inside a gunny sack. They will play with the gunny sack and even brought it with them while they were sleeping. This action usually provides a joyful opportunity for the visitors to watch animals, such as monkeys rubbing themselves with anion and panda rolling around in Tabasco sauce (Maple & Perdue 2013). In oncilla cats (*Leopardus tigrinus*), the introduction of cinnamon scent as sensory enrichment had decreased stereotypical pacing of the wild cat (Resende et al. 2011). For sun bears in Cologne Zoo, the usage of a pinch of cinnamon had successfully assisted the bears to locate hidden food in their enclosure (Schneider et al. 2014). However, for the sun bear in Zoo Negara, as the cinnamon's smell dwindled in the afternoon, the bear started to show aggressiveness towards themselves; whereby they soaked the gunny sack in the water and hit their body with the wet gunny sack. This observation suggests that it is suitable to introduce this type of sensory enrichment to the sun bear in captivity. However, it is crucial to ensure that the cinnamon's odour lasting until late evening.

TABLE 2. Effect of environmental enrichment on behavioural categories (* $p < 0.05$, Kruskal-Wallis)

Source	Mean \pm SE values		
	Active (min)	Passive (min)	Abnormal (min)
Baseline	6.99 ± 0.61	15.51 ± 1.22	9.49 ± 0.4
Enrichment	* 18.54 ± 0.69	* 7.75 ± 0.38	* 3.71 ± 0.06
Post-enrichment	10.54 ± 0.37	11.70 ± 0.27	7.76 ± 1.67

TABLE 3. Activity budget with environmental tools preferences ($p < 0.05$, Kruskal-Wallis)

Treatment	Types of enrichment	Mean \pm SE values (min)
Buoy filled with dog food	Occupational	4.89 \pm 0.02
Fruits mixed with honey	Food	6.01 \pm 0.11
Gunny sack filled with cinnamon powder	Sensory	3.05 \pm 0.08

FIGURE 1. Abnormal behaviour before (baseline) and after enrichment (post-enrichment) periods according to age group, in adult males (AM); adult female (AF); juvenile male (JM); juvenile female (JF) ($*p < 0.05$, Mann-Whitney U)FIGURE 2. Exploratory Behaviour before (baseline) and after enrichment periods according to age group, in adult males (AM); adult female (AF); juvenile male (JM); juvenile female (JF) ($*p < 0.05$, Mann-Whitney U)

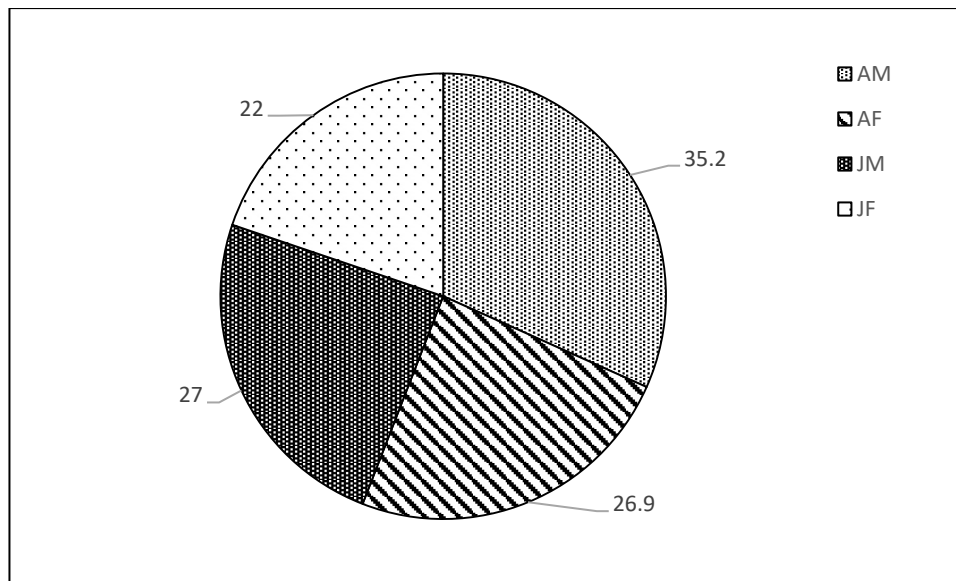


FIGURE 3. Investigation time spent (in h) for all three enrichment tools by different age group (AM : Adult male; AF : Adult female; JM : Juvenile male; JF : Juvenile female) ($p < 0.05$, Kruskal-Wallis H test)

CONCLUSION

Environmental enrichment is an important aspect of zoo management. It can enhance captive animals' environment and trigger these animals to demonstrate more attractive and acceptable behaviours that appeal to the public (Robinson 1998). All three environmental enrichment tools; buoy filled with dogfood, fruits mixed with honey, and gunny sack filled with cinnamon powder are effective in eliciting naturalistic behaviour and reducing the abnormal behaviour such as pacing among all seven bears in Zoo Negara. However, it is crucial to ensure all the enrichment tools are lasting until evening for the sun bear to engaged longer to the enrichments especially for food and sensory enrichment. Thus, it is concluded that the application of enrichment tools is important in reducing stereotypic behaviour to ensure that the bears' stress levels are minimal, and their overall welfare is not compromised.

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