UNIVERSITI PUTRA MALAYSIA

SELF-AWARENESS IN MALAYAN SUN BEAR (*HELARCTOS MALAYANUS*): A CASE OF COGNITIVE STUDY

MOHD HANAFI BIN RAMALI

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SELF-AWARENESS IN MALAYAN SUN BEAR (*HELARCTOS MALAYANUS*): A CASE OF COGNITIVE STUDY

MOHD HANAFI BIN RAMALI

A project submitted to the

Faculty of Veterinary Medicine, Universiti Putra Malaysia

In partial fulfillment of the requirement for the

DEGREE OF DOCTOR OF VETERINARY MEDICINE

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It is hereby certified that we have read this project paper entitled "Self-awareness in Sun bear (*Helarctos malayanus*): A Case of Cognitive Study", by Mohd Hanafi bin Ramali and in our opinion it is satisfactory in terms of scope, quality, and presentation as partial fulfillment of the requirement for the course VPD 4999 – Project.

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DEDICATION

I dedicate this thesis to:

My dearest family:

Faridah Abdullah

Siti Nazhirah

Saiful Amir

Rashid Ramali

Nor Ezzati

Zoo Negara, Kuala Lumpur

Doctors and staffs

My supervisor

DR. HAFANDI AHMAD

My co-supervisor

DR. TENGKU RINALFI PUTRA TENGKU AZIZAN

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ABSTRAK

Abstrak daripada kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada kursus VPD 4999 – Projek.

Pengenalpastian Diri dalam Malayan Sun Bear (*Helarctos malayanus*): Kes Berkenaan Kajian Kognitif

Oleh

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2016

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Penyelia bersama: Dr. Tengku Rinalfi Putra Tengku Azizan

Fungsi kognitif haiwan adalah proses pemahaman dan penambahbaikan kapasiti memori haiwan, rangsangan-tindak balas dan permerhatian. Dalam sesetengah haiwan, fungsi kognitif merujuk kepada kesedaran diri, yang digambarkan sebagai pemahaman seseorang terhadap imej cermin di mana imej tersebut tidak mewakili individu lain namun imej tersebut merujuk diri sendiri. Ujian pengenalpastian diri di cermin, *mirror self-recognition* (MSR) *test*, atau ujian bertanda adalah teknik perilaku untuk menentukan sama ada haiwan tersebut mempunyai keupayaan mengenalpasti diri/kesedaran diri. Oleh itu, objektif kajian ini adalah untuk mengukur keupayaan beruang Matahari, *Malayan Sun bear*, melalui pengenalpastian diri di hadapan cermin. Sebanyak seekor haiwan dipilih (n = 1; *Helarctos malayanus*) dari Zoo Negara Malaysia dan cermin akrilik (saiz A1 - 60x84cm) diletakkan di luar sangkar. Haiwan itu juga ditandai menggunakan cat putih yang bukan toksik di dahi. Ia kemudiannya dipantau di bawah berlainan jenis ujian; ujian cermin bertutup (CMT), ujian cermin terbuka (OMT) dan ujian bertanda (MAT) untuk tempoh 5 hari dengan 4 slot setiap hari. 15 minit diperuntukkan untuk setiap slot ujian. Tingkah laku MSR telah dirakam menggunakan kamera video dan

dianalisis menggunakan ethogram. Haiwan yang dianggap mengenal diri sendiri kebiasaanya melalui 4 peringkat; responsi sosial, pemeriksaan fizikal, tingkah laku berulang-ulang dan kesedaran tingkah laku. Hasil kajian menunjukkan bahawa tingkah laku MSR tersebut tidak konsisten dan ianya tidak jelas melalui 4 peringkat tingkah laku. Keputusan juga tidak meyakinkan kerana ketidakupayaan haiwan untuk mengenali diri sendiri dalam CMT, OMT dan MAT. Kajian ini menyediakan maklumat berharga mengenai keupayaan kognitif beruang matahari sebagai satu usaha untuk membantu haiwan, seperti untuk meningkatkan pengurusan dan program untuk mewujudkan semula populasi spesies terancam.

Kata kunci: ujian pengenalpastian diri di cermin, beruang matahari (*Helarctos malayanus*), kesedaran diri

ABSTRACT

An abstract of the project paper presented to the Faculty of Veterinary Medicine in partial fulfillment of the course VPD 4999 – Project

Self-awareness in Malayan Sun Bear (*Helarctos malayanus*):

A Case of Cognitive Study

By

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Animal cognitive function is the process of understanding and improvement of animal's memory capacities, stimulus-responses and attention. In some animals, cognitive function refers to self-awareness, which described as an understanding that one's own mirror reflection does not represent another individual but oneself. The mirror self-recognition (MSR) test or mark test is a behavioral technique to determine whether an animal possesses the ability of self-recognition or self-awareness. Thus, the objective of this study is to measure the ability of Malayan Sun bear in mirror self-awareness. An animal was selected (n=1; *Helarctos malayanus*) from Zoo Negara Malaysia and the acrylic mirror (A1 size - 60x84cm) is placed outside of the cage. The animal also was marked using a non-toxic white paint on its forehead. It was then monitored under different type of tests; covered mirror test (CMT), open mirror test (OMT) and mark test (MAT) for a period of 5 days with 4 slots in 15 minutes per day. The MSR behaviors were recorded using video camera and analyzed using the ethogram procedure. Animals that are considered to recognize themselves typically through 4 stages; social responses, physical inspection, repetitive and realization behavior. Results showed that the

MSR behavior were inconsistent and did not clearly undergo 4 stages of behavior. The results also were inconclusive due to inability of the animal to recognize their own reflection in the CMT, OMT and MAT. This study provides valuable information on the cognitive ability of sun bears as an effort to help animals, such as to enhance management and in program to re-establish populations of endangered or threatened species.

Keywords: mirror self-recognition, Malayan sun bear (*Helarctos malayanus*), self-awareness

1.0 Introduction

Cognitive function is an intellectual process by which one becomes aware of, perceives, or comprehends ideas (O'Toole, 2013). Cognitive function mainly involves learning, cognitive and memory. Learning is the activity or process of gaining knowledge or skill by studying, practicing, being taught, or experiencing something (Webster, 2005). Meanwhile, cognitive is a process where knowledge and understanding is developed in the brain (Bakker *et al*., 2003). Memory can be defined as the capacity to recall previously experienced sensations, information, data and ideas.

Animal cognition describes the mental capacities and the memory of animals in exploring the new environment. For instance, rodents traditionally have been used to study learning and memory functions (Hafandi *et al.*, 2014). In animal behavior, cognitive function may apply to assess the ability of the animal to be aware and responsive towards its environment which can happen through though and experience (Blood *et al*, 2007). In the other hand, cognitive function provides some evidence in some of animals for cognitive self-awareness, which described as the ability to recognize oneself as an individual separate from the environment and other individuals (Yang, 2005). Moreover, based on Bekoff and Sherman (2004), cognitive process enables an individual to discriminate between its own body or possessions from those of others.

Previous researchers have conducted various self-awareness studies through mirror self-recognition (MSR) test. The MSR test or also called as mark test is a behavioral technique to determine whether an animal possesses the ability of self-recognition or self-awareness (Gallup, 1970). The MSR paradigm has been applied as to evaluate self-awareness in a wide range of species (Sua´rez and Gallup, 1981). The number of touch to the mark area has been accepted as an indication of MSR (Asendorpf *et al.*, 1996). Several studies had been done

previously in human and animals. However only some of them possess MSR such as chimpanzees (Gallup, 1970), orangutans (Lethmate and Dücker, 2010), pygmy chimpanzees (Walraven *et al.*, 1995), dolphins (Reiss and Marino, 2001), elephants (Plotnik *et al.*, 2006), and magpies (Prior *et al.*, 2008).

Malayan sun bear (*H. malayanus*) is the smallest of the extant bear species and inhabits the equatorial lowland rainforest of parts of mainland Asia and its adjacent islands (Servheen, 1999). Sun bear generally is a solitary animal in the wild. The only times when wild sun bears are not solitary is during the breeding season when male and female bears travel together for several days until mating takes place (Siew Te Wong, 2010). Malayan sun bear currently listed as "Vulnerable" in the IUCN Red List of Threatened Species 2011 (Fredriksson et al., 2008) and its population gradually decline due to habitat loss and commercial hunting (Tumbelaka and Fredriksson, 2006). Only a few studies have been done for the *H. malayanus* and lack of biological information has been recognized as a serious limitation to conservation efforts. Therefore, any research for this species should be prioritized than any bear species worldwide (Servheen, 1999).

Performing MSR test on the sun bear could provide us some information regarding its cognitive function. Furthermore, most previous MSR studies were focused on social animals, and there is only one published research on solitary mammals which was performed on Giant pandas (Ma *et al*, 2015). Solitary living animals also have less chance to encounter and interact with conspecifics in comparison social living animals (Davies *et al.*, 2012). Thus, these MSR findings could provide information for detail understanding in its cognitive ability and future conservation efforts.

1.1 Objectives

The objective of this study is to measure the ability of Malayan sun bear (*Helarctos malayanus*) in a mirror-induced behavior (self- recognition/self-awareness).

1.2 Hypothesis

The Malayan sun bear (*Helarctos malayanus*) is capable of understanding that the mirror images belongs to their own body.

1.3 Justification

Animal's cognitive research has contributed in understanding the cognitive ability of the sun bears as an effort to help animals, such as enhance management; design of captive individuals' enclosures and exhibits; and in program to re-establish populations of endangered or threatened species. Severely decrease of their populations and lack of biological information on *H. malayanus* has been recognized as a serious limitation to conservation efforts, and it has been advocated that research on this species should be of the highest priority for any bear species worldwide (Servheen, 1999).

2.0 Literature review

2.1 Cognitive function

Learning and memory are closely related in cognitive function concepts. Learning is the acquisition of skill or knowledge (Shacter *et al.*, 2009, 2011) and memory is the process in which information is encoded, stored, and retrieved (Giovanello *et al.*, 2010). In animals, cognition, broadly defined, include all in ways which animal takes in information through the senses, process, retain and decide to act in. This cognitive process such as perception, learning, memories, and decision making play an important role in mate choice, foraging and many other behaviors (Shettleworth, 2001). Learning is remembering associations. While memory is the capacity to recall previous experienced sensations, information, data and ideas. This is essential for the process of learning by animals (Blood *et al.*, 2007).

Cognitive function provides some evidence in some of animals for cognitive self-awareness, which described as the ability to recognize oneself as an individual separate from the environment and other individuals (Yang, 2005). According to Griffin (1981), awareness involves the experiencing of interrelated mental images and awareness has been defined as ‘a state in which complex brain analysis is used to process sensory stimuli or constructs based on memory’ (Broom, 1998). The term ‘complex brain analysis’ implies that there is some degree of interpretive thought over and above perceptual processing and a gradation has been proposed with four categories of awareness: unaware but responsive, perceptual awareness, cognitive awareness, assessment awareness and executive awareness (Sommerville and Broom, 1998).

According to Mendl and Paul (2004, 2008), ‘basic awareness’ involved sensations, feelings, emotions ad memories. In addition, Gallup (1998) stated that awareness refers to the social context and to whether animals are able to infer the mental states of others. Self-

awareness also restricted to mammals with large brains and highly evolved social cognition but absent from animals without a neocortex (Prior *et al.*, 2008).

2.2 Mirror Self-Recognition (MSR) test

MSR test or also called as mark test is a behavioral technique to determine whether an animal possesses the ability of self-recognition or self-awareness (Gallup, 1970). MSR is an informative index of self-recognition by which it indicates an ability of an animal to recognize oneself in a mirror and also indicates brain size (Liu and Yang, 2009). Animals that demonstrate MSR usually will undergo four stages: (i) social response, (ii) physical mirror inspection (e.g., looking behind the mirror), (iii) repetitive mirror-testing behavior (i.e., the beginning of mirror understanding), and (iv) self-directed behavior (i.e., recognition of the mirror image as self) (Reiss & Marino, 2001; Keenan *et al.*, 2003). Animal that has passed MSR exhibit spontaneous touching the mark by using the mirror (Gallup, 1970) whereas animal without MSR tend to remain at stages 1 and 2. When a mirror was presented animals typically respond one of three ways: (1) they behave as though the mirror image is a conspecific or another animal and show aggressive behavior toward it; (2) they behave as though the mirror image is illusory and ignore it, showing interest only in the smooth surface; (3) they recognize themselves in the mirror, then decorate or groom themselves in front of the mirror (Wang 2010) or show self-directed behavior by using the mirror to respond to themselves (Gallup 1994). MSR ability is inferred when the subjects that touch a mark on their forehead more than under baseline conditions (without a mirror), or show decorating or grooming behaviors when they look at the mirror, or use the mirror to investigate parts of their bodies that they had not seen before. Otherwise, they show no MSR ability (Allen and Schwartz, 2008; Gallup, 1970, 1994; Lethmate and Dücker, 2010).

2.3 Malayan Sun bear (*Helarctos malayanus*)

Malayan sun bear is the smallest of the extant bear species and inhabits the equatorial lowland rainforest of parts of mainland Asia and its adjacent islands (Servheen, 1999). Sun bears rely on tropical forest habitat. Tropical evergreen rainforest is the sun bear's main habitat in Borneo, Sumatra, and Peninsular Malaysia where this aseasonal habitat receives high annual rainfall that is relatively evenly distributed throughout the year. Tropical evergreen rainforest, includes a wide diversity of forest types used by sun bears, including lowland dipterocarp, peat swamp, freshwater swamp, limestone/karst hills, hill dipterocarp, and lower montane forest.

Sun bears are omnivores, feeding primarily on termites, ants, beetle larvae, bee larvae and honey, and a large variety of fruit species, especially figs (*Ficus spp*.), when available (Augeri, 2005; Fredriksson *et al*., 2006). Occasionally, growth shoots of certain palms and some species of flowers are consumed (Fredriksson *et al*. 2006), but otherwise vegetative matter rarely occurs in the diet. In Bornean forests, fruits of the families Moraceae, Burseraceae and Myrtaceae make up more than 50% of the fruit diet (Fredriksson *et al*. 2006), whereas in western Thailand fruits of Lauraceae and Fagaceae are the most commonly consumed (Vinitpornsawan *et al*. 2006).

Little is known about social structure or reproduction in sun bears. Except for females with their offspring, sun bears are usually solitary. They may congregate to feed from large fruiting trees, but this behavior appears to be rare. Sun bears do not seem to have a defined breeding season anywhere in their range and usually give birth to only one cub, less commonly two (Schwarzenberger *et al*., 2004). Female bears use cavities of either standing or fallen large hollow trees as birthing sites. As sun bears occur in tropical regions with year-round available foods, they do not hibernate.

The sun bear is currently listed as "Vulnerable" in the IUCN Red List of Threatened Species 2011 (Fredriksson *et al*., 2008). This is due to 2 major threats to sun bears that are habitat loss and commercial hunting. In areas where deforestation is actively occurring, sun bears are mainly threatened by the loss of forest habitat and forest degradation arising from: clear-cutting for plantation development, unsustainable logging practices (Augeri, 2005; Meijaard *et al*., 2005; Wong, 2006), illegal logging both within and outside protected areas (Fuller *et al*., 2004), and forest fires (Fredriksson *et al*., 2006). Furthermore, sun bears also are commonly poached for their organs and bear-paws which is used as a Traditional Chinese Medicine (Nguyen Xuan Dang, 2006). Other motivations for killing bears include: preventing damage to crops (Fredriksson, 2005), subsistence use, fear of bears near villages, and capture of cubs for pets (the mother being killed in the process).

Global population of Sun Bears has declined by > 30% over the past 30 years (3 bear generations). Deforestation has reduced both the area of occupancy (AOO) and extent of occurrence (EOO) of Sun Bears, and has also reduced habitat quality in remaining forest. Lease number of researches have been done on the member of Ursidae family (Pereira et al., 2002). The lack of biological information on *H. malayanus* has been recognized as a serious limitation to conservation efforts, and it has been advocated that research on this species should be of the highest priority for any bear species worldwide.

3.0 Materials and methods

3.1 Subject

One subject was used throughout the trials. Subject named Baby Jean which is 2 years old, female Malayan sun bear that was kept at Zoo Veterinary Hospital ward, Zoo Negara (**Appendix D**). The history was palace staffs handed in the bear 5 days after received it from the local resident since it was young. She was raised up till today without any contact or interaction with other same conspecific. Last year, she was injured at the last claw of right forelimb and had old teeth retention at the left upper canine. Treatment was done promptly and she was then recovered fully. Her diet consisted of fruits such as papayas in the morning whereas rice, carrots and tapioca in the evening. The subject was healthy and unmedicated throughout the study. The tests had no negative effects on the bear.

3.2 Housing

The subject was kept in its enclosure in the hospital. The enclosure consisted of 2 cages where one cage usually used for playing area and another cage used to provide food. In the playing area, there were hanging rope, few wooden logs and a rattan basket, whereas the other cage was empty. Each cage was measured 2.7 m X 3.4 m, sufficient enough for the bear to move around. For the purpose of this study, the playing cage was assigned as observation cage and the other cage as holding cage. The observation cage will be used to record the sun bear behavior during interaction with the mirror whereas holding cage will be used for resting time. Each cage was separated by a manual gate where the animal will be transferred to holding cage through it. (**Appendix A**). The fence was made up of thick stainless steel wire mesh with each

gap between wire approximately about 10 cm wide. Thus, it provides enough view for the observation purposes.

3.3 Previous mirror experience

According to zoo keeper, there is no history of exposure to any reflective surface such as water, metal or mirror prior to the study. Thus, the subject was eligible to continue for the study because she did not have any previous experience with mirrors.

3.4 Apparatus and materials

The apparatus used in this study was a one-way glass mirror (60 X 84 cm) supported 45 cm above the ground by wooden stand. The glass mirror was made of highly durable and anti-shatter acrylic mirror. It was placed 20 cm away from the outside of the wire mesh fence of the cage, beyond the bear's reach (**Appendix A**).

GoPro Hero 3 with the memory capacity of 64GB was used as digital video camera to record any behavioral interaction of the sun bear with the mirror without presence of observer. Application of video camera in this study would help preventing any distraction and stress to the animal during the tests were conducted. The camera was placed on top of the mirror where any face expression and mirror-directed behavior could be recorded clearly (**Appendix B**).

An odorless, non-toxic white paint (AmeriColor™ Soft Gel Paste™ food color) was used during the mark test (**Appendix C**). The purpose of the mark was to attract the subject's attention in the mirror; any part of the body not visible to the subject without the use of a mirror is therefore suitable for marking (Gallup 1994). Therefore, we chose to mark the forehead instead of another frequently used body part. The measurement was 15 cm long with diameter

of 4 cm. None of mirror recognition test has been performed before on this species. Thus, we choose white paint due to its high contrast color and the location of paint at its forehead was suitable to be noticed once the subject appear in front of the mirror similar with a study conducted in giant panda (Ma *et al.*, 2015). Although a study has been done in Ursidae family where bears rely principally on their sense of smell, however the eye sight and hearing are comparatively poor (Prater, 1971).

3.5 Experimental procedure

In this study, only one subject was used throughout the experiment. Prior to tests, ad-libitum observation was done to identify mirror-directed behavior of the sun bear. Three type of tests were then performed; pretest, open mirror test and mark test. Each test required 15 min time spanned which was allocated for 4 recording per day. During 15 minutes of time interval, mirror was moved out promptly of the subject's sight and the subject was then transferred into holding cage.

The purpose of the pretest was to create a baseline behavior as it will be used to compare with other tests later. No mirror was used in the pretest and it was done only for 1 day. Morning session was chosen for video recording which began from 10.00 am until 12.00 pm. At this period, the subject was less distracted with the human intervention and feeding time thus allow aboriginal behavior to be recorded. The open mirror test and mark test were recorded for 2 days at different date. Thus, total observation time yielded from the pretest test was 60 minutes, open mirror test was 120 minutes and mark test was 120 minutes (**Figure 1**). Only the acrylic mirror was placed in front of the cage during the open mirror test to record any mirror-directed behavior whereas a mark was made during the mark test to record mark-directed behavior in front of the mirror.

Figure 1 *Information on test, period and total time yielded in this study*

Test	Period	Total time yielded
Pretest	20th January 2016	60 minutes
Open mirror test	21st & 22nd January 2016	120 minutes
Mark test	23rd & 27th January 2016	120 minutes

3.6 Behavioral observations

Immediately after the mirror had been placed in position, the subject was released into the observation cage (where it could see the mirror) and its behaviors were observed by the author and recorded by a digital video camera (GoPro Hero 3) throughout the trial. When each test trial video recording was played back with Windows Media Player, data were recorded in Microsoft Office Excel (version 2016) by the author. Information about the date and animal identity was removed from the video recordings before they were played back, so that analysis could be conducted blind. Behavioral data were collected from the videos by focal sampling and continuous recording methods (Martin and Bateson 1986).

The behaviors recorded in this study, and their definitions are listed in **Figure 2**. For subsequent analysis, all behaviors were grouped into two categories: non-mirror behaviors, including eating, resting, sniffing, scent-marking, grooming, and vocalizing; and mirror-directed behaviors, including viewing, investigating, attacking, threatening, backwards walking, foot scraping (Tan *et al.*, 2013) and playing. Attacking, threatening, backwards walking, foot scraping were further grouped into aggressive behavior (**Figure 2**).

Figure 2 *Definitions and categorization of coded behaviors*

Behavior	**Definition**
Non-mirror behavior	
Body-directed	Behaviors shown to meet physiological requirements without looking at the mirror
Mirror-directed behavior	
Viewing	The eyes target the mirror for two or more seconds
Investigating	Attempt to touch and sniff the object for a period of more than 5 s
Aggressive	*Attacking*: Violent attempt toward mirror by swiping its paws and trying to bite
	Threatening: Snout wrinkled upwards with mouth open, showing canines, and often vocalising loudly
	Backwards walking: Retreating five or more steps
	Foot scraping: Scraping the substrate with a backward motion of the hind paws
Playing	Attempting to interact with the mirror in an amicable manner

3.7 Data analysis

All trials were recorded on digital video camera (GoPro Hero 3). A total of 5 hours of video footage was analysed and time spent of 4 mirror responses listed in Table 2 was tabulated in ethogram. Only behaviors that comply with behavioral description (**Figure 2**) were taken note. Time spent in each of a mirror-directed behavior (**Figure 2**) was calculated using mean whereby the total time spent of a behavior is divided with frequency of the behavior. All the

data were then calculated in percentage and several graphs were plotted using Microsoft Excel 2016. Standard error for each mirror-directed behavior was calculated using standard deviation.

4.0 Results

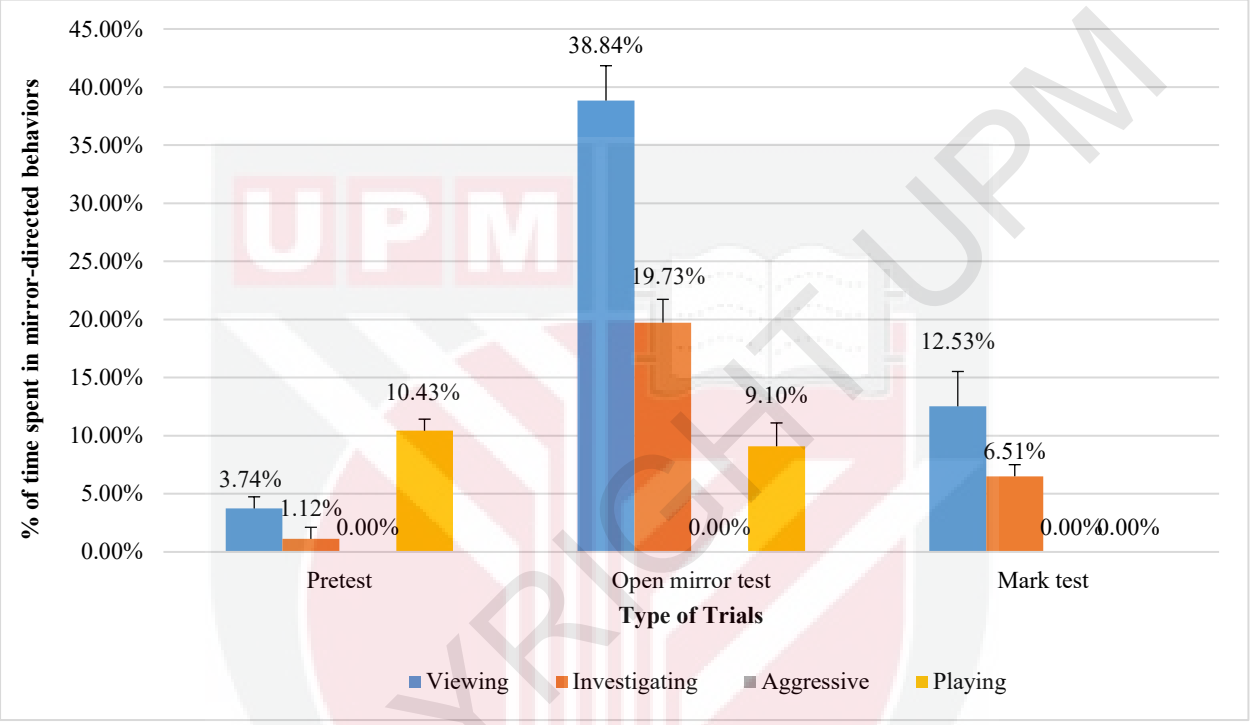


Figure 3 *Percentage of time spent the sun bear engaged in mirror-directed behavior between tests*

Figure 3 shows the percentage of time spent in mirror-directed behaviors in 3 different type of tests that were conducted: pretest, open mirror test and mark test. In the **Figure 3**, different colors were used as to differentiate according to mirror-directed behavior. They were differentiated as follows: blue (viewing behavior), orange (investigating behavior), grey (aggressive behavior) and yellow (playing behavior). Since the open mirror test and mark test were conducted, results showed a significant increase as compared to total percentage of time spent in mirror-directed behavior of the pretest (15.29%). Based on **Figure 3**, most of the

mirror-directed behavior were higher (67.67%) when the subject promoted with a mirror in open mirror test. However, the total percentage of mirror-directed behavior in mark test was lower (19.04%) as compared to open mirror test.

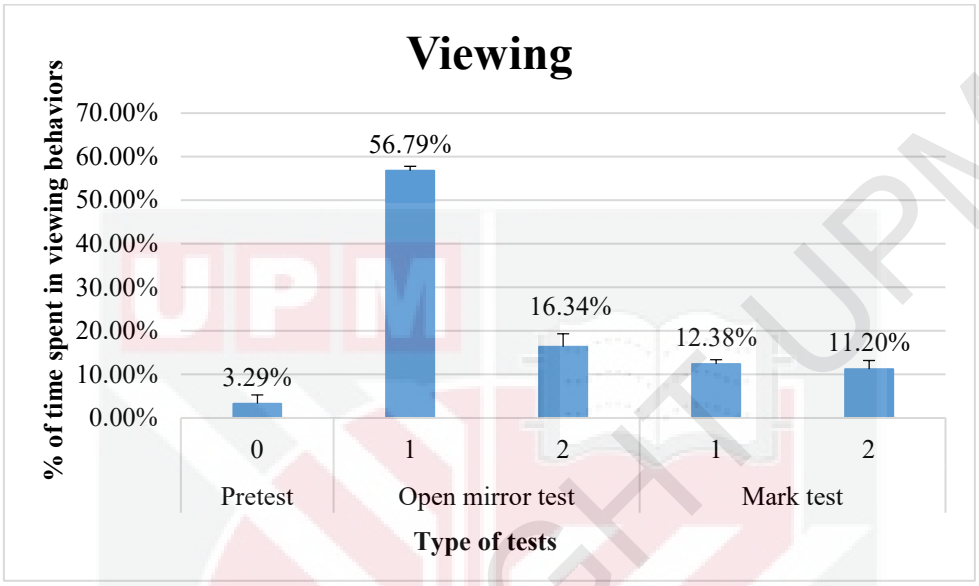


Figure 4 *Percentage of time spent the sun bear engaged in viewing behavior based on tests*

Based on **Figure 4**, total percentage of time spent in the viewing behavior in open mirror test was still at the highest (73.13%) as compared with mark test (23.58%). The highest percentage where the sun bear engaged in the viewing behavior could be seen in the first day of trial in open mirror test only (56.79%). Nevertheless, the sun bear began to less interact with the mirror on the second day of trial in open mirror test (16.34%). The result in the second day of trial in open mirror test which was already markedly low also happened on the first day and second day of trial in the mark test. The percentage of the sun bear engaged in viewing behavior during first day of trial in the mark test (12.38%) was significantly low and decreased on the second day of trial too (11.20%).

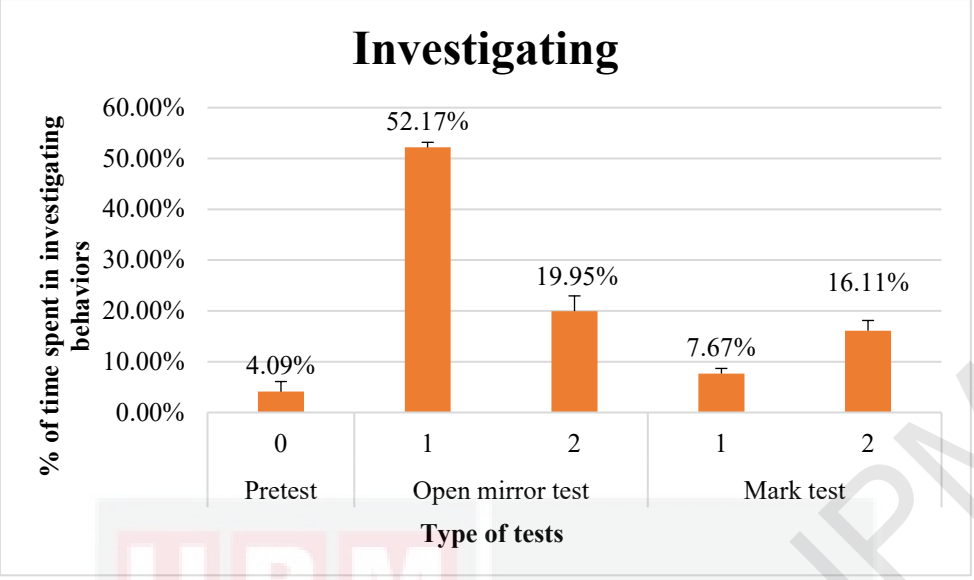


Figure 5 *Percentage of time spent the sun bear engaged in investigating behavior based on tests*

As for the investigating behavior in **Figure 5**, total percentage of time spent in investigating behavior in open mirror test was higher (72.12%) as compared in the mark test (23.78%). During the first day of trial in the open mirror test, the result showed that it was significantly high (52.17%) as compared to second day of trial. However, results on both days of trial in the mark test showed were significantly low (first day trial: 7.67%, second day trial: 16.11%) in comparison with open mirror test. The difference percentage of time spent the sun bear engaged in investigating behavior between open mirror test and mark test was greatly large (48.34%).

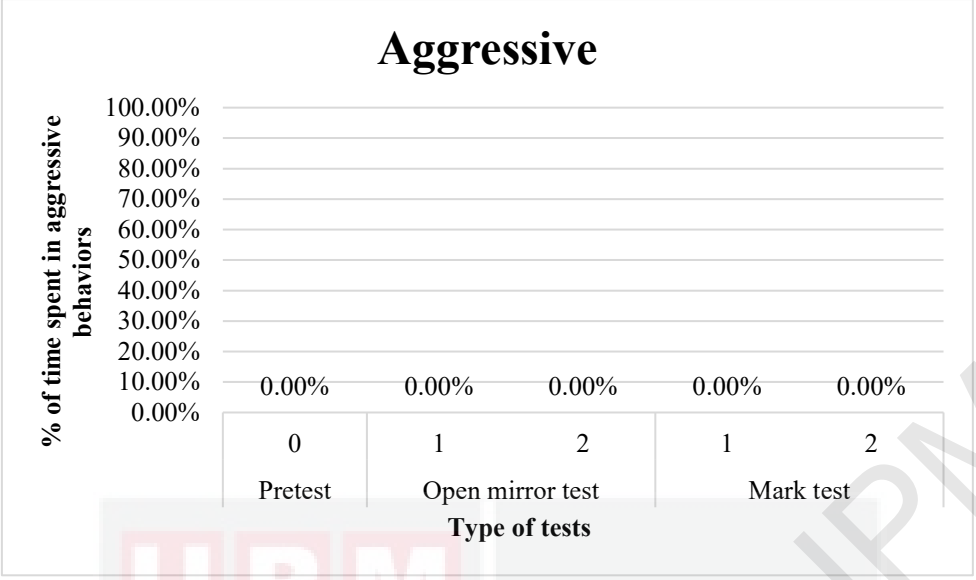


Figure 6 *Percentage of time spent the sun bear engaged in aggressive behavior based on tests*

As for the aggressive behavior in the **Figure 6**, no such behavior was recorded once the sun bear engaged in the pretest, open mirror test as well as mark test.

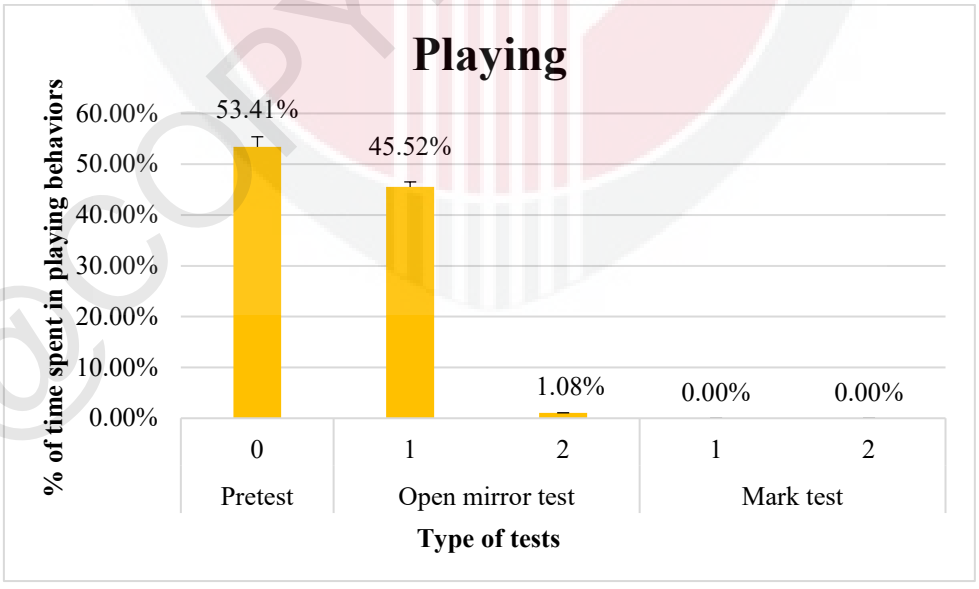


Figure 7 *Percentage of time spent the sun bear engaged in playing behavior based on tests*

According to the results of playing behavior in **Figure 7**, only during the pretest, the percentage of the sun bear spent time in playing behavior has at the highest (53.41%). The total percentage of time spent in playing behavior in open mirror test was just (46.60%). Whereas, the total percentage of time spent in playing behavior during the mark test is completely absent (0%).

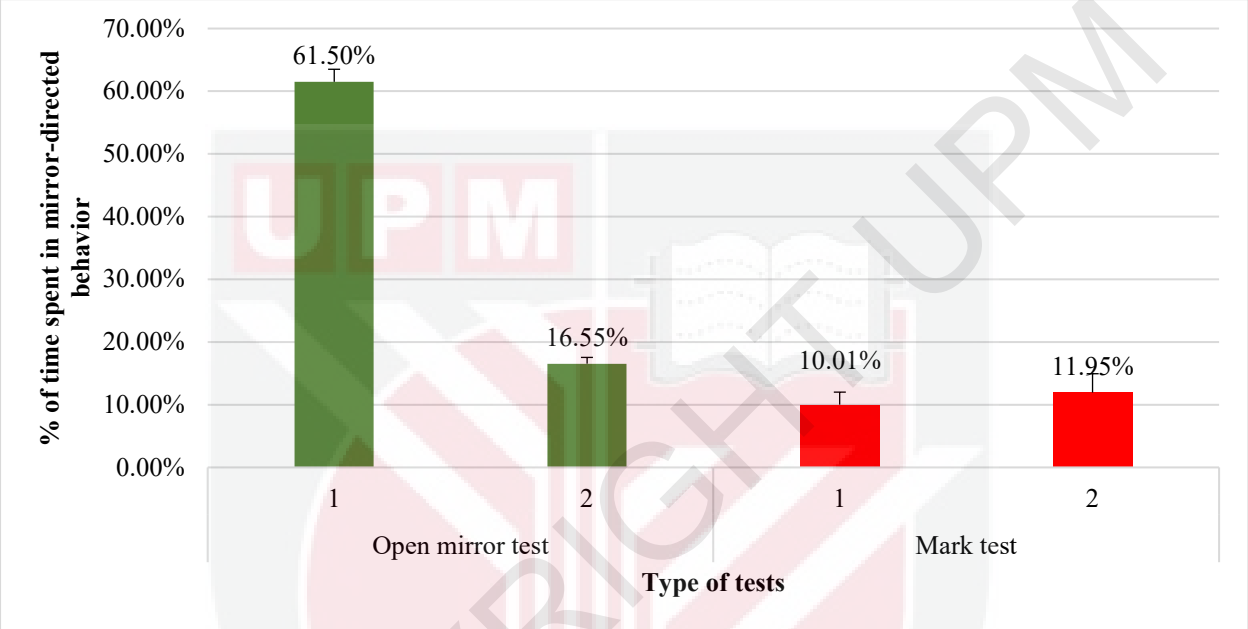


Figure 8 *Percentage of time spent the sun bear engaged in mirror-directed behavior in open-mirror test and the mark test*

Results in **Figure 8** showed a summary of total percentage of time spent in all mirror-directed behavior in comparison between open mirror test and mark test. From the **Figure 8**, the percentage of time spent in mirror-directed behavior during the first day of open mirror test found that it was markedly higher (61.50%) as compared to second day of trial (16.55%). However, the results in the mark test did not showed any significant outcome as the percentage in both trial days were lower than the open mirror test. The first day of trial in mark test was only 10.01% and the second day of trial was 11.95%.

5.0 Discussion

In general, mirror self-recognition (MSR) study is to measure the ability of self-recognizing when promoted with the mirror. It provides some evidence of cognitive level in particular animals (Yang, 2005). Self-recognition ability is restricted to animals with relatively large brains and highly evolved social cognition (Prior *et al.*, 2008). Ursidae species has a relatively large brain size and EQ, and highly developed an evolved brain (Dong and Zhang, 2011). Yet we found no evidence that the Malayan sun bear could recognize its self-image in the mirror. Moreover, results in mark test was did not show clearly that the sun bear successful in mirror self-recognition.

When we presented with a mirror, animals typically respond in one of three ways: (1) they behave as though the mirror image is a conspecific or another animal and show aggressive behavior toward it; (2) they behave as though the mirror image is illusory and ignore it, showing interest only in the smooth surface; (3) they recognize themselves in the mirror, then decorate or groom themselves in front of the mirror (Wang, 2010) or show self-directed behavior by using the mirror to respond to themselves (Gallup, 1994). If the sun bear touch a mark on its forehead more then under baseline conditions (without mirror), or show decorating or grooming behaviors when they look at the mirror, or use the mirror to investigate parts of their bodies that they had not seen before, MSR ability is inferred. Otherwise, they show no MSR ability (Allen and Schawrtz, 2008).

During the first day of open mirror test, the sun bear showed viewing and investigating the most (**Figure 3**). Subsequently, they habituated to the mirror image. However, they never observed displaying ark-touching, decorating or self-directed response behaviors. In addition, during a prolonged test (5 days in total) of the subject exposed to the mirror, observations revealed no increase in self-modifying behaviors. Therefore, our data suggest that the sun bear

recognize the mirror images as illusory image, rather than as conspecific or as itself. Our mark test results provide further evidence that sun bear recognized their image only as illusory image, since they did not show increased mirror-directed behavior to the white-marked image (**Figure 8**). Only in open mirror test showed increase in mirror-directed behavior. This suggests that they recognize the difference in appearance between non-marked image and marked image yet cannot identify the white color-marked individual image as themselves (**Figure 8**). Due to little known biological study in this species, few information regarding interaction and social structure causes limitation in understanding the behavioral pattern.

The Malayan sun bear appear to be incapable of learning to use mirrors to integrate features of their own reflection and respond appropriately. This results may be related to or determined by their living style in the field by which Malayan sun bear used to be solitary in the wild unless there is mating season yet the season is still undefined (Schwarzenberger *et al*., 2004). Moreover, the sun bear is believed to have limited vision compared to olfactory and auditory cues (MacDonald, 1985). Especially in the forest where the sun bear uses its olfactory ability to search for foods. From evolutionary perspective, MSR may not be a requisite adaptation in this species: animals lacking the capacity for MSR are not hindered by reflective surfaces, such as standing pools of water. Sun bear do not appear to need the capacity for MSR to survive.

The present study indicates that the sun bear did not recognizes itself in the mirror, instead, they perceived the mirror image as an illusory image, and thus only viewing and investigating behavior could be observed increase (**Figure 3**). However, it rapidly realized that the image posed no threat and reduced its vigilance due to the fact that they habituated to the image along the study. This results suggest that when keeping sun bears in captivity, frequently switching them between enclosures may promote communication and familiarity between conspecific. This may be useful for both captive breeding and the reintroduction of captive sun bear into the wild.

6.0 Conclusion

From this study we can conclude that, the sun bear was not pass the mark test. When there is touching or grooming behavior towards the mark location, it indicates that the animal is successful in MSR. However, throughout 2 trials in mark test, the results showed the sun bear in unsuccessful in MSR. Based on this results, it would be useful for future management and environmental enrichment of captive Malayan sun bear (*Helarctos malayanus*). Moreover, this study provides valuable information regarding recognition in large mammals, particularly in solitary species.

7.0 Recommendation study

Future work can be done on conducting experiment under control luminosity especially in the mark test whereby sun bear typically habituated under tropical forest with enough sunlight penetrated to the floor of the forest assisted the sun bear in search for food. In addition, the subject in this study should be increase to reduce sampling error and improve validity of the results. Besides that, strong adhesive edible paint should be used in the mark test to prevent easily disappearance of the paint throughout the observation and enable the sun bear easily identifies the mark when observe the mirror image. Lastly, the experiment should be performed under a naturalistic area instead of in front of a wire fence, which may improve the ecological validity of the test results.

8.0 References

Allen, M., & Schwartz, B.L. (2008). Mirror self-recognition in a Gorilla (*Gorilla gorilla gorilla*). *J Integr Biosci*, 5, 19–24.

Asendorpf, J. B., Warkentin, V., & Baudonnière, P. (1996). Self-awareness and other-awareness. II: Mirror self-recognition, social contingency awareness, and synchronic imitation. *Developmental Psychology, 32*(2), 313-321.

Augeri, D. M. (2005). *On the biogeographic ecology of the Malayan sun bear* (Doctoral dissertation, University of Cambridge).

Bekoff, M., & Sherman, P. W. (2004). Reflections on animal selves. *Trends in Ecology & Evolution, 19*(4), 176-180.

Broom, D. M. (1998). Welfare, stress and the evolution of feelings. *Advances in the Study of Behavior*, 27, 371–403.

Dang, N. X. (2006). Bear parts trade in Vietnam and measures for its control. In *International Symposium on the Trade in Bear Parts*, pp. 61.

Davies, N.B., Krebs, J.R., & West, S.A. (2012). An introduction to behavioural ecology (4th ed). Oxford: Wiley, pp 147–178.

Dong, W., & Zhang, J. (2011). Evolution of cranial cavities in giant pandas (*Ailuropoda melanoleuca*, Carnivora, Mammalia). *Vertebrata Palasiatica*, 49, 241–252.

Fredriksson, G. (2005). Human-sun bear conflicts in East Kalimantan, Indonesian Borneo. *Ursus*, *16*(1), 130-137.

Fredriksson, G. M., Danielsen, L. S., & Swenson, J. E. (2006). Impacts of El Nino related drought and forest fires on sun bear fruit resources in lowland dipterocarp forest of East Borneo. In *Plant Conservation and Biodiversity* (pp. 249-264). Netherlands: Springer.

Fredriksson, G., Steinmetz, R., Wong, S., & Garshelis, D.L. (2008). *Helarctos malayanus*, In: IUCN 2011. IUCN Red List of Threatened Species, Version 2011.1. <www.iucnredlist.org>.

Fuller, D. O., Jessup, T. C., & Salim, A. (2004). Loss of forest cover in Kalimantan, Indonesia, since the 1997–1998 El Nino. *Conservation Biology*,*18*(1), 249-254.

Gallup, G. G. (1970). Chimpanzees: Self-Recognition. *Science, 167*(3914), 86-87.

Gallup, G.G. (1994). Self-recognition: research strategies and experimental design. In S.T Parker, R.W. Mitchell, M.L. Boccia (Eds.) *Self-awareness in animals and humans: developmental perspectives* (pp. 35-50). Cambridge: Cambridge University Press.

Gallup, G. G. (1998). Can animals empathize? Yes. *Scientific American*, 9, 66–71.

Giovanello, K. S., Kensinger, E. A., Wong, A. T., & Schacter, D. L. (2010). Age-related neural changes during memory conjunction errors. *Journal of Cognitive Neuroscience*, *22*(7), 1348-1361.

Griffin, D. R. (1981). *The Question of Animal Awareness*. New York: Rockefeller University Press.

Hafandi, A., Begg, D. P., Premaratna, S. D., Sinclair, A. J., Jois, M., & Weisinger, R. S. (2014). Dietary Repletion with ω3 Fatty Acid or with COX Inhibition Reverses Cognitive Effects in F3 ω3 Fatty-Acid–Deficient Mice.*Comparative medicine*, *64*(2), 106-109.

Keenan, J.P., Gallup, G.G., & Jr, Falk D. (2003). *The Face in the Mirror: The Search for the Origins of Consciousness.* New York: HarperCollins.

Labov, J. B. (1987). Social Odours in Mammals. Volume 1, Volume 2. Richard E. Brown David W. Macdonald. *The Quarterly Review of Biology, 62*(3), 348-349.

Lethmate, J., & Dücker, G. (2010). Untersuchungen zum Selbsterkennen im Spiegel bei Orang-Utans und einigen anderen Affenarten1. *Zeitschrift Für Tierpsychologie, 33*(3-4), 248-269.

Liu, L., & Yang, L.Z. (2009). Research progress in self-face recognition. *J Liaoning Normal Univ* (Social Science Edition), 32, 52–55. doi:10.3969/j.issn.1000-1751.2009.03. 014 (In Chinese with English abstract)

Ma, X., Jin, Y., Luo, B., Zhang, G., Wei, R., & Liu, D. (2015). Giant pandas failed to show mirror self-recognition. *Animal cognition*, *18*(3), 713-721.

Martin, P., & Bateson, P. (1986). Measures of behaviour. *An Introductory Guide Measuring Behaviour,* 62-83.

Meijaard, E., Sheil, D., Nasi, R., Augeri, D., Rosenbaum, B., Iskandar, D., & Soehartono, T. (2005). *Life after logging: reconciling wildlife conservation and production forestry in Indonesian Borneo*. Cifor.

Mendl, M., & Paul, E. S. (2004). Consciousness, emotion and animal welfare: insights from cognitive science. *Animal Welfare*, 13, S17–S25.

Mendl, M., & Paul, E. S. (2008). Do animals live in the present? Current evidence and implications for welfare. *Applied Animal Behaviour Science*, 113, 357–382.

Pereira, D., Loh, R., & Bjorkenstam Bonfiglio, M. (2002). Bear markets: Malaysia. *The business of bear bile*.

Plotnik, J. M., Waal, F. B., & Reiss, D. (2006). Self-recognition in an Asian elephant. *Proceedings of the National Academy of Sciences, 103*(45), 17053-17057.

Prater, S. H. (1971). *The book of Indian animals*. Bombay: Bombay Natural History Society.

Prior, H., Schwarz, A., & Güntürkün, O. (2008). Mirror-Induced Behavior in the Magpie (Pica pica): Evidence of Self-Recognition. *PLoS Biology PLoS Biol, 6*(8).

Prior, H., Schwarz, A., & Gunturkun, O. (2011). Mirror-Induced Behavior in the Magpie (Pica pica): Evidence of Self-Recognition. *Animal Behavior An Evolutionary Approach,* 164-182.

Reiss, D., & Marino, L. (2001). Mirror self-recognition in the bottlenose dolphin: A case of cognitive convergence. *Proceedings of the National Academy of Sciences, 98*(10), 5937-5942.

Schacter, D. L., & Addis, D. R. (2009). Remembering the past to imagine the future: A cognitive neuroscience perspective. *Military Psychology, 21*(Suppl 1), S108-S112.

Schacter, D. L., Guerin, S. A., & Jacques, P. L. S. (2011). Memory distortion: An adaptive perspective. *Trends in cognitive sciences*, *15*(10), 467-474.

Schwarzenberger, F., Fredriksson, G., Schaller, K., & Kolter, L. (2004). Fecal steroid analysisfor monitoring reproduction in the sun bear (Helarctos malayanus). *Theriogenology*, *62*(9), 1677-1692.

Servheen, C. (1999). Sun Bear conservation action plan: chapter 11. *Bears: status survey and conservation action plan*, 219-223.

Shettleworth, S. J. (2001). Animal cognition and animal behaviour. *Animal behaviour*, *61*(2), 277-286.

Sommerville, B. A. & Broom, D. M. (1998). Olfactory awareness. *Applied Animal Behaviour Science*, 57, 269–286.

Suarez, S. D., & Gallup, G. G. (1981). Self-recognition in chimpanzees and orangutans, but not gorillas. *Journal of Human Evolution, 10*(2), 175-188.

Tan, H. M., Ong, S. M., Langat, G., Bahaman, A. R., Sharma, R. S. K., & Sumita, S. (2013). The influence of enclosure design on diurnal activity and stereotypic behaviour in captive Malayan Sun bears (Helarctos malayanus).*Research in veterinary science*, *94*(2), 228-239.

Tumbelaka, L., & Fredriksson, G. M. (2006). The status of sun bears in Indonesia. *Understanding Asian bears to secure their future. In: Japan Bear Network, compiler. Ibaraki: Japan Bear Network*, 73-78.

Vinitpornsawan, S., Steinmetz, R., & Kanchanasakha, B. (2006). The status of bears in Thailand. *Understanding Asian bears to secure their future. In: Japan Bear Network, compiler. Ibaraki: Japan Bear Network*, 50-56.

Walraven, V., Elsacker, L. V., & Verheyen, R. (1995). Reactions of a group of pygmy chimpanzees (Pan paniscus) to their mirror-images: Evidence of self-recognition. *Primates, 36*(1), 145-150.

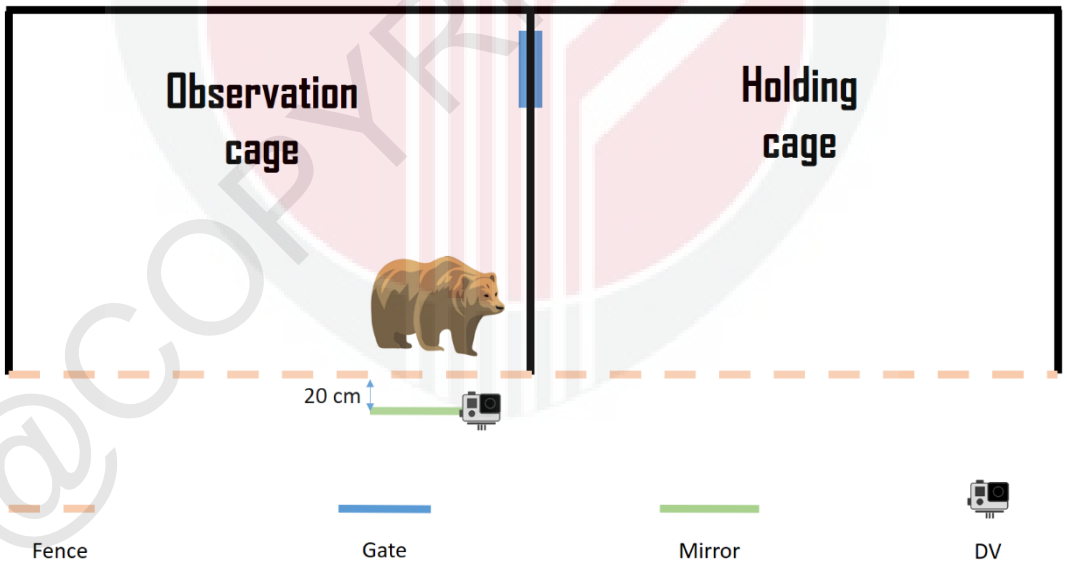
Wang, J. (2010). What are animal friends thinking. *Hubei Children Press*, Hubei (In Chinese).

Wong, S. T. (2006). The status of Malayan sun bears in Malaysia. *Understanding Asian bears to secure their future. Japan Bear Network, Ibaraki, Japan*, 66-72.

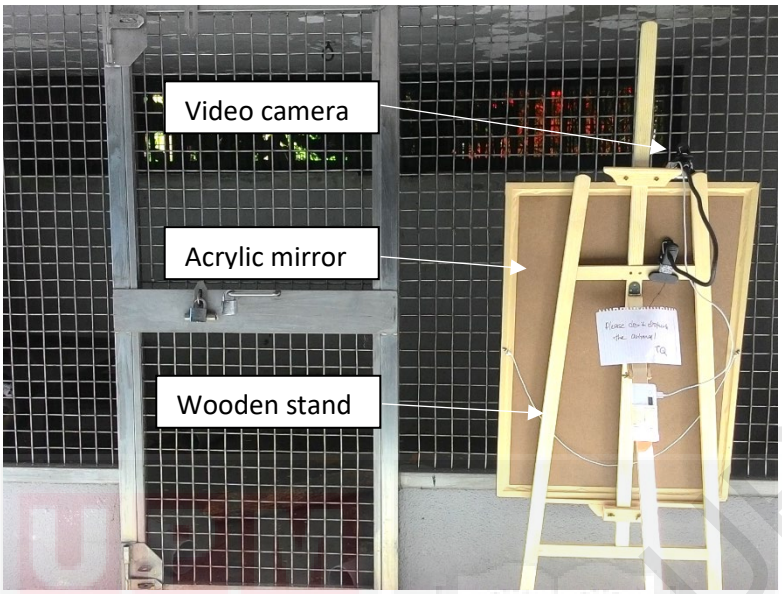
Wong, S. T. (2010, April 25). Integration of Om and Ah Chong. Retrieved January 10, 2016, from http://sunbears.wildlifedirect.org/tag/bear/

Yang, H. (2005). On the uniqueness of self-face recognition. *Psychol Sci*, 28, 1517–1519. doi:10.3969/j.issn.1671-6981.2007.05.026

9.0 Appendices



Appendix A: *A schematic diagram of the sun bear enclosure*



***Appendix B**: Example mirror and video camera setting during experiment*

***Appendix C:** Example of paint used in mark test*

Appendix D: *Baby Jean*