Picture Recognition of Food by Sloth Bears *(Melursus ursinus)*

Tabellario, S., Babitz, M.A., Bauer, E.B., Brown-Palsgrove, M.

Abstract

Pictures are often used in cognitive research to represent objects and many species have demonstrated the ability to recognize two-dimensional pictures as representations of their three-dimensional counterparts. However, for ursids picture recognition has been reported in only one study of a single 11-year-old female American black bear (Johnson-Ulrich et al. 2016). We tested the picture recognition abilities of an additional species, the sloth bear. After a food preference test by which the bears' food options were ranked and categorized as high-, mid-, and low-preference items, we tested a sub-adult male and an adult female sloth bear by presenting two pictures of food in each testing trial – a high-preference food and a low-preference food. Both bears met criterion by choosing the pictures of their preferred foods in at least 80% of the trials in three consecutive testing sessions. We then presented never before used pictures of high-preference versus low-preference food items and they again met our criterion.

Keywords

Picture recognition, sloth bear, *Melursus ursinus*, choice, control

Introduction

In 2017, Amici pointed out that "studies of animal cognition are not equally distributed across taxa". Scientists focused mainly on non-human primates or birds. However in investigations of how animals see the world and process information, research has demonstrated that several other species have the ability to recognize two-dimensional (2D) pictures as representations of their three-dimensional (3D) counterparts, including a number of sheep, fish, and lizards, as reviewed by Bovet and Vauclair (2000), horses (Hanggi 2001), and tortoises (Wilkinson et al. 2013). However only one bear, an American black bear (Johnson-Ulrich et al. 2016) is noted in the literature to have displayed this ability.

Recognizing 2D pictures can be a starting point for many cognitive tests – discrimination tasks, categorization, and memory tests. It is not a given that all animals understand the correspondence between 2D pictures and the real life objects that they represent. Even some adult humans who have not previously been exposed to photographs are not able to identify objects in photographs (Miller 1973) and on some occasions chimpanzees have been unable to recognize 2D photographs (Winner and Ettlinger 1979).

People generally perceive bears as intelligent (Nakajima et al. 2002). In fact, animal trainers and zookeepers regard bears as the most intelligent carnivore, with intelligence levels comparable to primates (Breiter 2008). However, the cognitive abilities of bears are understudied (Perdue 2016; Vonk 2016; Vonk and Jett 2018) and there is little scientific research to back up these claims. Even less is known about sloth bears in particular. Finding evidence that sloth bears can recognize 2D pictures as representations of their real life counterparts will add to our knowledge base about sloth bear cognition (Amici et al. 2017; Hartmann et al. 2017). Once we know this cognitive task is possible, other avenues of investigation open up, allowing the development of a deeper understanding of how the cognitive ability of bear species compare to one another, and to other carnivores.

If we can learn more about the cognitive abilities of bears, then we will be able to take better care of them in captivity, managing their mental and emotional well-being in addition to their physical health (McGuire et al. 2017; Perdue 2016; Vonk 2016).

One main source of abnormal stereotypic behavior in captive animals is an animal's lack of control over their environment (Leotti et al. 2010). Bears in particular are a species that are prone to stereotypies in captivity (Shih et al. 2016; Vickery and Mason 2004). Giving an animal an opportunity to make choices gives them the perception of control (Leotti et al. 2010). Control and the choices that are so closely associated with feeling in control in captivity are critical elements of good animal welfare (Mellor 2014; Reiss 2006). Giving captive animals a way to communicate their preferences and increasing their opportunities to make choices could help reduce stereotypic behaviors and improve their well-being, consequently increasing their overall welfare (Buchanan-Smith 2011; Ross 2006).

This project emerged as a novel approach to give Smithsonian National Zoological Park's (NZP) sloth bears an opportunity to make choices and communicate their preferences to their keepers about their daily management.

Methods

Subjects

Two captive born sloth bears participated in the study – one 3-year-old, mother-reared male (Niko) and one 5-year-old, hand-reared female (Remi). They both reside at NZP. Although they regularly participate in operant conditioning tasks for husbandry behaviors, they were both experimentally naive. Neither bear had any history with pictures of food prior to these experiments. Each bear was tested in his or her regular night house while temporarily separated from his or her conspecific. Each testing session was voluntary, and the subject could choose to participate or not.

Materials

The testing board was approximately 25 ½” x 9” x 3” (65cm x 23cm x 8cm). During the food preference test, the surface was flat, and items were placed approximately 16” (40cm) apart in plastic plates on opposite ends of the flat board (Figure 1). During the picture recognition tests, a card stand was added to the board so that the picture cards would stand at a 45° angle facing the bear. Dividers kept the centers of the cards 12” (30cm) apart (Figure 2).

The picture cards were color photos of familiar foods displayed in the same form as the foods were presented to the bears throughout the food preference test (for example, a 1” (2.5cm) piece of apple, 3 almonds, 1 prune, etc.). The pictures were printed life sized, in color with a matte finish and white background on 5”x7” (13cm x 18cm) cardstock. There was a single image of each food, but the picture cards were randomly rotated 180 degrees throughout the tests.

Procedure

No pre-training took place before the food preference test or before either phase of the picture recognition tests. No novel food items were included in any of the tests. The testing took place in the afternoons when the bears would normally have a training session – after a snack, but before their large PM diet. The coder was blind to the “right” answer.

Food Preference Test

Twenty-five foods were presented in all possible combinations, two at a time using a paired stimulus preference assessment (Hopper et al. 2019). Foods were counter balanced for left/right placement and trial order was randomized as determined by an online generator.

Foods were presented simultaneously side by side on the testing board approximately 16” (40cm) from the mesh. Then the board was immediately pushed up to the mesh bear enclosure (see Figure 1) so the bear could make a choice. Each bear was tested in a total of 42 sessions. Each of the first 41 sessions contained 14 trials. The last session contained 26 trials to reach the 600 trials needed to make all possible combinations of food counterbalanced for left/right placement. During the first trial of the first session of the food preference test the bear was given free choice to choose how to indicate their choice (by blowing, pawing, or nosing towards the food they wanted). Both bears chose to indicate by blowing in the direction of one item or the other. The bear was given the food they chose, which they were free to eat or discard. The food the bear did not choose was taken away. If the bear did not select either food after five seconds, the testing board was momentarily withdrawn and the trial was immediately repeated. Foods were scored based on how many times the bear selected each food and whether or not a chosen food was eaten or discarded (1 point for choosing and eating, 0.5 points for choosing and discarding, 0 points if not chosen). Out of all of the foods in the preference test, 12 were selected by the experimenters to use in the picture recognition phase– these foods included six of the most preferred foods (mealworms, almonds, leafeater biscuits, raisins, prunes, and grapes for Niko and raisins, prunes, mealworms, pecans, brazil nuts, and cheerios for Remi) and six of the least preferred foods (butternut squash, turnip, banana, omnivore kibble, orange, and mango for Niko and honeydew, orange, omnivore kibble, broccoli, celery, and zucchini for Remi), omitting foods in the mid-value preference range to clearly delineate high-value versus low-value preferences. Niko’s preferences remained consistant over time. Remi’s preferences changed during hyperphagia, when bears typically eat more. At this time, Remi would eat even her least preferred foods, causing the experimenters to take a break from testing until her appetite returned to normal. Remi was tested on 42 days over an 8 month period. Niko was tested on 42 days over a 2 month period. Roughly the same volume of each type of food was used so that quantity would not likely influence the bears’ choices.

Picture Recognition - Phase 1

Using the testing board from the food preference test with the addition of a card stand (see Figure 2), the bear was presented with two picture cards. Again we presented the stimuli – this time the pictures of food – simultaneously while the testing board was approximately 16” (40cm) away from the mesh. Then the board was immediately pushed up to the mesh for the bear to make a choice. We used three of each bear's most preferred foods and three of each bear's least preferred foods from the food preference test (the other three most preferred and three least preferred food items were reserved for use in Phase 2). When each bear indicated one of the pictures by blowing at it, the keeper gave them the food they chose. The picture of the unselected food was taken off the testing board and the picture of selected food remained on the board while the bear ate or discarded the food. Across all phases of the experiment, roughly the same volume was used for each type of food so that the bear would not likely learn to associate larger or smaller quantities to the pictures.

Photos were paired by matching every most preferred food with every least preferred food and counterbalancing those pairings for left/right placement. Each session consisted of 15 randomized individual trials. When each bear selected their preferred foods in 80% of the trials over three consecutive testing sessions, we concluded that that bear recognized the pictures and moved to Phase 2. Note that this is a more stringent criteria than that used in other similar studies, which required reaching 80% in 2 consecutive trials (Spetch and Friedman 2006; Truppa et al. 2009; Wein et al. 2015). Remi was tested on 7 days over a 9 day period. Niko was tested on 3 days over a 7 day period.

Picture Recognition Transfer - Phase 2

In Phase 2, we tested whether the picture recognition transferred to novel stimuli (i.e., pictures that the bear had never seen before). For the transfer, we used pictures of the three most preferred foods and three least preferred foods that were not used in Phase 1 of the experiment. The experiment followed the same procedure as in Phase 1. Each session consisted of 15 individual trials. When the bear selected their preferred food in 80% of the trials on three consecutive testing sessions, we concluded that the bear recognized the pictures. For Phase 2, Remi was tested on 5 days over a 5 day period and Niko was tested on 3 days over an 8 day period.

Results

Phase 1: With no prior exposure to pictures of food, Niko showed evidence of spontaneous picture recognition, scoring at or above the 80% correct criteria in the first three sessions. Remi also showed evidence of picture recognition; however, it took her seven sessions to reach the 80% correct criteria in three consecutive sessions (Table 1). Although, Remi scored 93% and 100% on her first and second sessions, her performance dropped off before she was successful.

Phase 2: In the picture recognition transfer phase, Niko met the criteria immediately, scoring above 80% correct on the first three trials. It took Remi five trials to meet the criteria in this phase (Table 2).

Discussion

This task showed that sloth bears have the ability to recognize 2D pictures as equivalents of their real, 3D counterparts. Both bears responded to the pictures of food just as they did the pieces of food during the preference test phase, by using a characteristic sloth bear behavior of blowing (Laurie and Seidensticker 2009) to select the one they wanted. While both bears recognized the pictures relatively quickly, Niko recognized the pictures spontaneously, without any training, in both phases of the experiment. Remi acquired the skill through learning (Bovet and Vauclair 2000) after a few sessions. We suspect it took Remi longer to acquire this skill because her testing was impacted by factors of natural bear biology – hyperphagia, breeding season, and a pseudo-pregnancy – which affected her food preferences, hunger, and motivation. Hyperphagia and breeding season did not affect Niko's performance since he was immediately successful and therefore went through the tests so quickly that he did not encounter hyperphagia and breeding season during his tests. These physiological changes should be considered when doing cognitive tests with any bear species. In order to properly assess food preferences in a species with such seasonal variation, a wide variety of choices should be tested to create the clearest possible delineation between high and low value foods. Alternatively, preferences could be tested at various times throughout the year, addressing each physiological change.

Notably, Niko was able to demonstrate a spontaneous preference for photos that represented his preferred foods. However, it is unclear what this truly means about a sloth bear's cognition. Some hypothesize that animals that recognize pictures spontaneously are simply confusing the pictures with the real objects (Bovet and Vauclair 2000).

It is unlikely that an animal with such a strong olfactory sense would make that mistake. Interestingly, when humans are capable of picture recognition from a very early age (2-3 months old), those same researchers hypothesize that the ability is simply innate (Bovet and Vauclair 2000). More research is needed to reveal the cognitive implications of Niko recognizing all of the pictures spontaneously.

When animal caretakers are more familiar with the cognitive abilities of the animals in their care, they are better able to provide the best possible care to their animals, addressing both their physical and mental needs. Utilizing methods similar to those used in this study (choice between picture cards) could provide an opportunity for sloth bears to communicate other preferences to their keepers (for example, preferences for specific enrichment items, yard or enclosure access, or social partners). Adding this type of choice and control into their daily management can positively enhance the welfare of bears under human care (Mellor 2014; Reiss 2006).

In conclusion, this study provides evidence that sloth bears can recognize 2D pictures of food as representations of their 3D counterparts. Their ability to recognize 2D pictures of other items is likely. However, further research on the cognitive abilities of sloth bears is recommended. Since little is known about the cognitive abilities of bears in general, comparative studies with other bear species are also warranted. Future studies could include increasing the sample size and comparing inter-individual differences for this methodology, comparing 2D picture recognition ability in sloth bears to other bear species, as well as exploring whether this ability transfers to more abstract picture representations such as black and white pictures, illustrations, or line drawings.

Acknowledgments

Thank you to Dr. Betsy Herrelko for her guidance and support as well as the entire NZP Asia Trail team who made this work possible.

Compliance with ethical standards

All applicable international, national and/or institutional guidelines for the care and use of animals were followed. All procedures performed in studies involving animals were in accordance with the ethical standards of the institution or practice at which the studies were conducted. (Smithsonian National Zoological Park Animal Care and Use Committee #18-15)

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Table 1: *Phase 1 Results*

Session	1	2	3	4	5	6	7
NIKO	14/15 (93%)	14/15 (93%)	12/15 (80%)				
REMI	14/15 (93%)	15/15 (100%)	10/15 (67%)	8/15 (53%)	12/15 (80%)	12/15 (80%)	13/15 (87%)

Caption for Table 1: Number of correct trials out of 15 trials per session for Picture Recognition – Phase 1.

Table 2: *Phase 2 Results*

Session	1	2	3	4	5
NIKO	13/15 (87%)	13/15 (87%)	14/15 (93%)		
REMI	9/15 (60%)	10/15 (67%)	12/15 (80%)	12/15 (80%)	12/15 (80%)

Caption for Table 2: Number of correct trials out of 15 trials per session for Picture Recognition Transfer – Phase 2.