Exploring Lemur Memory: Examining *Eulemur mongoz* (mongoose lemurs) and *Lemur catta's* (ring-tailed lemurs) Memory Through a Novel Enrichment Item

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Abstract

Millions of years divide strepsirrhine evolution from that of anatomically modern humans. Researchers' fascination with understanding humans and their closest nonhuman primate relatives, creates a lack of thorough research completed on the cognition of early primates, such as lemurs. This study sought to investigate the memory of three lemurs living in a zoo facility, two mongoose lemurs and one ring-tailed lemur, using a self-designed enrichment item. Enrichment items are included in zoo exhibits to add variation to the nonhuman animal's lives through stimulation of their senses and natural behaviors. My enrichment item targeted the lemurs' foraging behavior by covering a favored fruit with moveable discs. Four experiments were conducted between the lemurs and the novel enrichment item to determine if they 1) interacted with the device 2) were able to retrieve the concealed food and 3) remembered the item during subsequent interactions. Through an analysis of the four experiments, the lemurs demonstrated clear signs of short-term and long-term memory through their increased ease in retrieving the fruit from the device. These results support the conclusion that lemurs have working memory, which can be exercised and researched through enrichment activities in zoo facilities.

Background

Examining the cognitive capabilities of nonhuman primates has been a common pursuit amongst primatologists for over 50 years. Early studies mainly focused on chimpanzees due to chimpocentrism, which argued that the evolutionary proximity of chimpanzees to humans inherently made them the second most intelligent animal (Beck 1982, 3). Over the past two decades, primatologists have made their studies more inclusive to a range of primate species. However, there are still many knowledge gaps related to lemur cognition (Rosati, Rodriguez, and Hare 2014, 947). This study seeks to lessen those gaps by exploring the memory of three lemurs at the Oglebay Good Zoo in Wheeling, West Virginia.

This study draws on a previous one I conducted that explored how enrichment affects the educational experiences of the zoo-going public (Buchman 2020). Enrichment is used to stimulate zoo animals through various sights, scents, sounds, and objects that break up the monotony of their daily activities (Westlund 2014, 1). Ideally, enrichment targets an animal's natural behaviors. My enrichment item focuses on the lemur's foraging skills by encouraging them to 'forage' for fruit within the device. I was able to examine if the lemurs appeared to remember the item and how to manipulate the discs to retrieve the enclosed fruit.

Zookeepers often space out the distribution of individual enrichment items because they assume lemurs and other animals will not remember the stimulants after a couple of weeks, thus making each sequential placement in the exhibit just as exciting as the first. I approached this project without that bias in order to examine if the lemurs are in fact remembering their enrichment after a couple of weeks or even after a couple of months. If they can remember it, and still choose to interact with the item, I hypothesize that increases the effectiveness of the device because it is able to elicit interactions based on choice rather than ignorance or curiosity.

Methodology

I collected four data sets of lemurs interacting with my enrichment item and compared them to a literature review of previous lemur memory studies. Each of the three lemurs was given with a letter to make their reference more concise, the female mongoose lemur as A, the male mongoose lemur as B, and the male ring-tailed lemur as C. The enrichment item was designed to target their natural foraging behavior by evenly distributing fifteen halved grapes in the domes before covering them with moveable discs (**Figure 2**).

I collected data on the lemurs' interactions with the device until they ceased to engage with it, between 20 minutes to 2 hours per session. Data collection Days 1, 2, and 3 all occurred within the span of one month and Day 4 was recorded 5 months later. During ¾ of the data collection days, the enrichment item had a slight variation to its set up:
- Day 1: the enrichment item's domes were left completely uncovered, allowing the lemurs to freely explore the device and see its desirable contents (**Figure 1**).
- Day 2: Dome 1 was covered, dome 2 was half covered, and dome 3 was uncovered (**Figure 2**).
- Day 3 and 4: All three domes were entirely covered (**Figure 3**).

Incrementally increasing how many domes were covered was incorporated based on zookeeper recommendations and the techniques' effectiveness with the lemurs' daily training programs. The data from each day was collected through field notes and digital recordings that tracked three predetermined behaviors: the number of attempts the lemurs took to uncover the domes, their paths to the item, and their reaction time to approach the item. Each of the data sets were analyzed by comparing the lemurs' individual results for each behavior against their own across all four days. For example, the number of attempts Lemur A took to open the enrichment item on Day 1 was compared to their results on Days 2, 3, and 4 (**Table 1**).
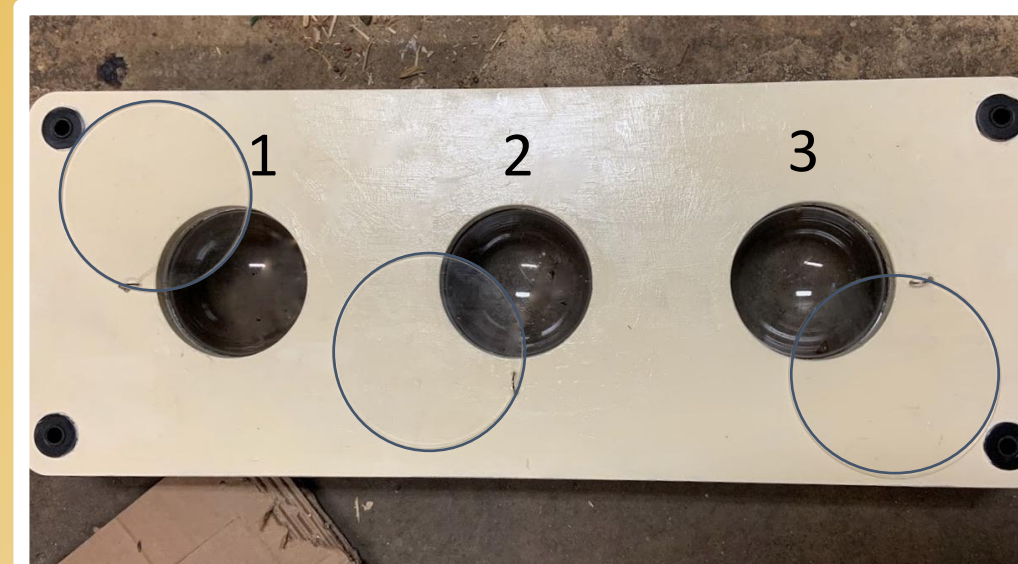

Figure 1: Enrichment Item on Day 1 (shown without grapes, but with labeled holes)
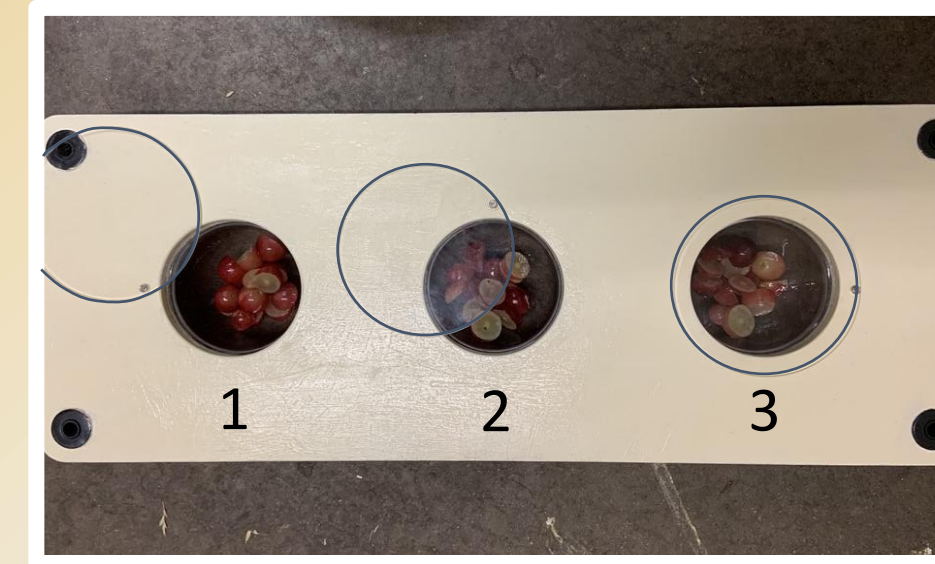

Figure 2: Enrichment item on Day 2 (shown with grapes and labeled holes)

Table 1: The Number of Attempts Each Lemur Took to Solve the Enrichment Item's Puzzle on Each Experiment Day

Number of attempts to solve the enrichment item's puzzle	Lemur A (Female *Eulemur mongoz*)	Lemur B (Male *Eulemur mongoz*)	Lemur C (Male *Lemur catta*)
Day 1 (10/03/2020)	N/A*	N/A*	N/A*
Day 2 (10/17/2020)	7	0	10
Day 3 (10/24/2020)	6 (solved two)	4	3
Day 4 (03/20/2021)	4	4	2

*The puzzle entered the exhibit already solved, this was done to get the lemurs familiar with the item and allow them to see that there were desirable grapes inside
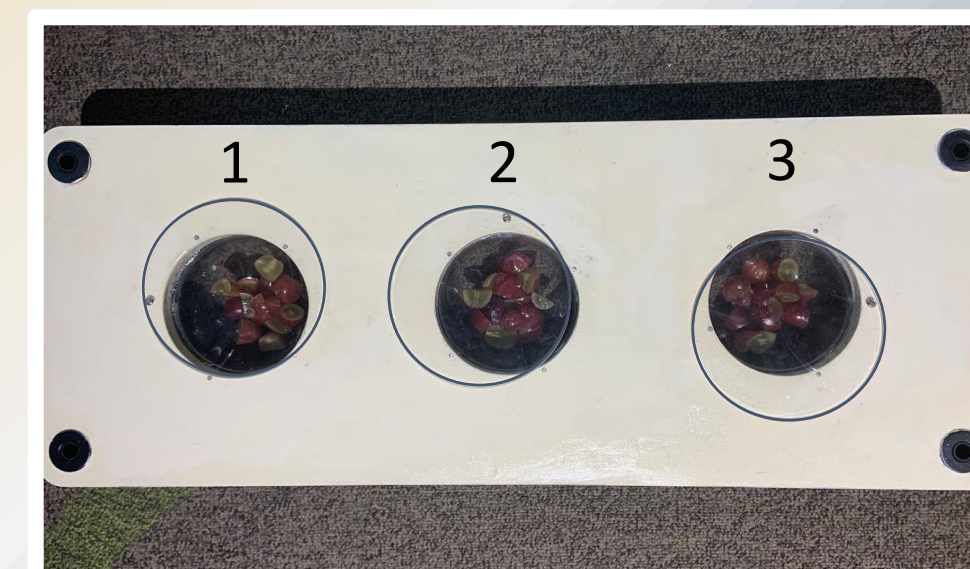

Figure 3: Enrichment item on Days 3 and 4 (shown with grapes and labeled holes)

Figure 4: Lemur A (left) and Lemur B (right) eating the enrichment item's grapes

Results

The most compelling expression of lemur memory collected in this study was the reduced number of attempts it took for the lemurs to retrieve the grapes from the enrichment item after each subsequent interaction with the device. **Table 1** depicts how many attempts each lemur took to uncover one (or more) dome(s) during each of the four data collection days.
- Day 1: Lemur A interacted with the disc attached to dome 1 by scratching at it.
  - This was determined to be solely out of exploration, since the disc had been moved to the side before it was brought into the exhibit
- Day 2: Lemur A uncovered the first dome and Lemur C uncovered the second dome.
- Day 3: Lemur A uncovered the first and second dome and Lemur B uncovered the third dome (**Figure 4**).
- Day 4: Lemur B uncovered the first dome, Lemur C uncovered the second dome, and Lemur A uncovered the third dome.

Lemur A attempted to uncover the domes and successfully solved the puzzle most frequently of all the lemurs. Their success rate was even more compelling than the chart makes it appear because ¾ of their attempts to uncover the dome on Day 4 occurred with a disc that Lemur C was sitting on and therefore was unable to be moved. Disc 3, the disc Lemur A opened on Day 4, was successfully moved on the first attempt of that particular disc.

Conclusions

The study I completed has revealed new ways to deconstruct the theory of chimpocentrism. The results illustrated evidence of lemur memory that was visibly displayed by the lemurs while they interacted with the new enrichment item. The gradual decline in the number of attempts it took the lemurs to solve the enrichment item's puzzle showcased their memory most effectively because it highlighted both short-term and long-term memory. The short-term memory was seen in Days 1-3, which all occurred in one month's time, and the long-term memory was evident on Day 4, which was conducted 5 months later. The other two behaviors that were recorded in this study, the lemurs' pathways and reaction times to approach the item further supported the claim that they displayed clear signs of memory toward the enrichment item. Being able to showcase short-term, and long-term memory with an enrichment item in this way is not something that has been demonstrably explored before and highlights an aspect of cognitive complexity that was not previously recorded in lemurs. While researchers have been deconstructing chimpocentrism over the last 20 years, many researchers still focus their primate cognition studies on hominids. This study highlights that it is just as important to examine the primates that are far removed from the Hominidae family in order to understand how long ago various cognitive elements arose. My study opens a door to further research on lemurs and their enrichment possibilities in order to more accurately understand their cognitive complexities.

References

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Acknowledgements