Cognitive Abilities of the Asian Elephant: A Comprehensive Zoological Study.

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ABSTRACT

Animal cognition research has expanded significantly over the past forty years, primarily focusing on lab animals with varying cognitive abilities, such as rodents, birds, and primates. Despite their reputation as highly social, cooperative, and intelligent animals, elephants have received surprisingly little direct cognitive research, aside from long-term behavioral studies in the wild. Both Asian (Elephas maximus) and African (Loxodonta africana or L. cyclotis) elephants have been notably underrepresented in cognitive research. This paper discusses the potential and justification for investigating elephant cognition within zoological settings and reviews recent advancements in this area, including our latest study on mirror self-recognition in elephants.

Keywords: Cognition, psychology, zoology, elephant, behavioral study, self recognition, Elephas Maximus, intelligent animal.

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1. INTRODUCTION

Two notable aspects of human-elephant history stand out: elephants are among the few, if not the only, animals used by humans without a history of formal domestication or selective breeding, and they are widely regarded as intelligent and socially complex, despite limited controlled cognitive research supporting this view. This paper emphasizes the need for more behavioral and cognitive research on elephants in zoological settings, particularly given their intelligence and social complexity. While African elephants have been studied in the wild for over 30 years, focusing on population dynamics, social interactions, and vocal communication, Asian elephants (Elephas maximus) have received less research attention, with scant behavioral data available in peer-reviewed journals.

Elephants, with their long lifespans, complex social structures, and large brains, have been the subject of extensive ethological research, revealing substantial evidence of cooperation and social dynamics. However, this ethological research only offers a partial view of their cognitive abilities, and experimental studies are needed for a deeper understanding. Just as studies on nonhuman primates' behavior are complemented by research on their cognition to reveal underlying cognitive mechanisms, a similar approach is only beginning to be developed for elephants.

Cognition and Intelligence

The concept of elephants as highly intelligent animals is not new. There are numerous anecdotes highlighting their exceptional memory, problem-solving abilities, attention to deceased companions, and even behaviors like covering carcasses, which suggest potential for deception. Notably, elephants have been observed demonstrating targeted helping, a behavior where assistance is tailored to another's specific needs, linked to empathic perspective-taking. This form of Cognitive Empathy, which involves understanding the cause of another's emotional state, is rare in the animal kingdom and is seen in great apes, bottlenose dolphins, and elephants. Predictions by Gallup about elephants' potential for mirror self-recognition (MSR) and advanced self-awareness have been supported by subsequent research by Plotnik. Rensch's initial systematic study of elephant cognition involved a 5-year-old Asian elephant at the Münster Zoo, Germany. Despite the elephant needing over 300 trials to master a basic discrimination task, it eventually learned to distinguish between more than 20 pairs of shapes.

Visual discrimination tasks are commonly used in cognitive studies across various species, including primates and birds, which rely heavily on vision. Elephants, however, predominantly use their auditory, olfactory, and seismic senses for environmental interaction and communication. There is speculation that elephants' visual capabilities may be underestimated. While some studies have explored the physiology and anatomy of the elephant eye, only one other study has examined shape and color discrimination in elephants. Another significant research area is tool use, which is considered a marker of advanced cognition. Tool use is documented in various animal species, including corvids, chimpanzees, orangutans, and bottlenose dolphins. Asian elephants have also shown tool use, such as using branches to swat insects, and their prehensile trunks enable complex manipulative behaviors akin to primates, suggesting a high level of cognitive ability.

Recent studies have started to revitalize the field of elephant cognition. For instance, wild African elephants can classify potential predators based on visual and olfactory cues, and recognize up to 30 family members through urine and earth samples. These findings suggest that elephants' social complexity might be linked to their cognitive abilities. In captivity, studies have investigated elephants' causal reasoning and quantity judgment abilities. One study found that elephants could make relative quantity judgments of bananas, consistently choosing the larger amount, suggesting they use a different cognitive mechanism than other animals. Another study tested elephants' understanding of means-end relationships using a tray-pull task. One elephant performed significantly above chance, indicating a goal-directed behavior similar to that observed in nonhuman primates. This performance suggests that experimental methods used in primate cognition research may also be applicable to studying elephants.

Self Awareness and Recognition

Our latest research on elephant cognition involved examining their capacity for mirror self-recognition (MSR). This ability, traditionally seen as a key indicator of intelligence and self-awareness, has long been associated with cognitive development, such as theory of mind, and is typically observed in children between 18 and 24 months of age. Gallup's landmark study in 1970 revealed that chimpanzees share this ability with humans. He observed chimpanzees interacting with mirrors and identified three phases of behavior. Initially, mirror-naïve chimpanzees displayed exploratory and social behaviors towards their reflection, treating it as another animal. This was followed by mirror testing behavior, where the animals repetitively acted as if experimenting with the reflection's responses. The final stage involved self-directed behavior, where the chimpanzees used the mirror to examine parts of their bodies not visible otherwise.

To more objectively measure self-recognition, Gallup used the mark test. In this test, a mark is placed on the subject in a location only visible via the mirror. Success is indicated if the subject touches the mark on their own body or, in species like dolphins that lack hands, immediately investigates the marked area. MSR has been a key comparative measure in cognitive studies and has spurred discussions about the evolution and development of self-awareness. Follow-up research confirmed MSR in other anthropoid apes, including bonobos, gorillas, and orangutans, but not in other primates or non-ape species. Studies with Old and New World monkeys generally did not show MSR, though some research with capuchin monkeys suggests they may exhibit a form of self-recognition intermediate between viewing their mirror image as another and recognizing it as themselves.

This indicates a potential cognitive continuum across species. Gallup proposed a link between MSR and expressions of empathy, hypothesizing that other large-brained, socially complex animals like elephants and dolphins might also exhibit MSR. This hypothesis has been validated by recent studies. MSR has been demonstrated in bottlenose dolphins and Asian elephants. Reiss and Marino's study provided evidence of cognitive convergence between dolphins and hominoids, while Plotnik et al.'s research extended this evidence to Asian elephants. Both studies were conducted in zoological settings where rigorous experimental controls and collaborative efforts with zoo and aquarium staff facilitated the research.

Concluding Outlook

Our recent study on elephant mirror self-recognition (MSR) generated significant public and media interest in the fact that elephants share this cognitive ability with humans. This high level of public engagement in animal cognition offers zoos a valuable chance to educate visitors about these discoveries and to actively contribute to ongoing research. While there are established fields of research into the cognition of nonhuman primates and birds, with growing studies conducted in zoological parks, the study of cognition in elephants remains underdeveloped despite the public's keen interest in these intelligent creatures. Modern zoos and aquariums face the challenge of educating an increasingly informed audience while also participating in both field research and studies on animals in human care. Achieving this requires a collaborative approach involving wildlife biologists, veterinarians, conservationists, and cognitive scientists.

Although there is a wealth of research on reproductive and behavioral aspects of zoo animals, cognitive research in these settings is relatively scarce. Engaging the public by showcasing zoo-based research that highlights the cognitive abilities of animals like elephants can inspire conservation efforts and increase appreciation for these species. Despite criticisms from animal protection groups regarding the captivity of elephants, noninvasive cognitive research is generally well-received and enhances our understanding of these animals. Recent advancements in animal husbandry training have improved the welfare and management of captive animals, facilitating their participation in research. For instance,

zookeepers at the Smithsonian's National Zoo have used these techniques to manage elephants more effectively, allowing them to undergo various procedures without chemical restraint.

Conducting cognitive studies with free-ranging elephants presents significant logistical challenges, making zoo and aquarium environments more practical for such research. Nonetheless, conducting these studies requires considerable effort and collaboration with experienced zoo staff. Even with these challenges, collaborative cognitive research can advance scientific knowledge and improve the physical and mental well-being of the animals involved. Elephants, with their large brains and social complexity, are particularly suitable for such research, which benefits both scientific inquiry and conservation efforts. Therefore, integrating cognitive research with conservation and education initiatives is both practical and essential for the ongoing study and protection of elephants

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